SESSION

E-LEARNING, LEARNING METHODOLOGIES, AND EDUCATION

Chair(s)

TBA

Little Botany: a Mobile Educational Game for Gardening

Suphanut Jamonnak
Department of Computer Science
College of Arts and Sciences
University of Akron
Akron, OH 44325-4003

En Cheng
Department of Computer Science
College of Arts and Sciences
University of Akron
Akron, OH 44325-4003

Abstract—**Mobile devices are rapidly becoming the new medium of educational and social life for young people, and hence mobile educational games have become an important mechanism for learning. To enhance plant science learning, we present a mobile educational game called Little Botany, where players can create their own dream gardens virtually in any location on earth. The virtual gardens created in Little Botany are augmented with real-world information. More specifically, Little Botany is using real-time weather data for the garden location to simulate how the weather affects plants growth. The game also teaches users how to care for the plants on a daily basis. With this game, users can also learn plant structure and track plant growth.**

Keywords: Educational Game; Virtual Garden; Unity3D; Plant Science; Plant development

I. Introduction

School-aged children worldwide are growing up immersed in a media-rich, "always connected" world. Game is an important element for healthy child development including learning development. Mobile educational games provide an opportunity for players to learn through simulated environments, these games are not necessarily a distraction from learning, but rather can be an integral part of learning and intellectual development. New technology has brought with it new tools for learning, and research has shown that the educational potential of mobile games resonates with teachers and students. Mobile devices are rapidly becoming the new medium of educational and social life for young people, and hence mobile educational games are a key topic for researchers and software developers. It is worth mentioning that the strengths of the mobile platform include its portability, context sensitivity, connectivity, and ubiquity, which make it ideal for educational games in elementary, secondary, university, and lifelong education.

Despite its apparent simplicity, gardening is actually a complex system involving the emergent interaction of multiple parameters. Successful gardeners usually need to juggle highly technical knowledge about a plant's sunlight and shade requirements, water needs, and what plants grow well together when placed near each other in a plot. To enhance plant science learning and improve student content retention, we present a mobile educational game called Little Botany, where players can create their own dream gardens in any location on earth. The principal environmental requirements for plant growth include adequate space for root and canopy development, sufficient light, water, oxygen, carbon dioxide, and mineral elements, and temperature suitable for essential physiologic processes. Weather plays a major role in the healthy growth and development of plants. To simulate how the weather affects plants growth, the virtual gardens created in Little Botany are using real-time weather data for the garden location. The game also teaches users how to care for the plants on a daily basis. An adequate amount of water is essential for plant growth and maintenance of essential plant processes. With this game, users can discover where our food comes from and learn how to tend and harvest crops.

The remainder of this paper is structured as follows: Section 2 presents the three-layered system architecture of Little Botany; Section 3 describes three service agents, which are backend support for Little Botany. Section 4 illustrates six functionalities provided by Little Botany; Section 5 concludes with discussions and future work.

II. System Design

The system architecture of Little Botany has three layers including presentation layer, business layer, and data layer. The Unity3D game engine [1] is the development framework for Little Botany. We used Unity3D to implement game mechanisms in C# and JavaScript programming languages. To generate 3D models and assets in our game, we use Autodesk Maya [2], a 3D computer graphics software that runs on Windows, OS X and Linux. Figure 1 illustrates the system architecture of Little Botany.
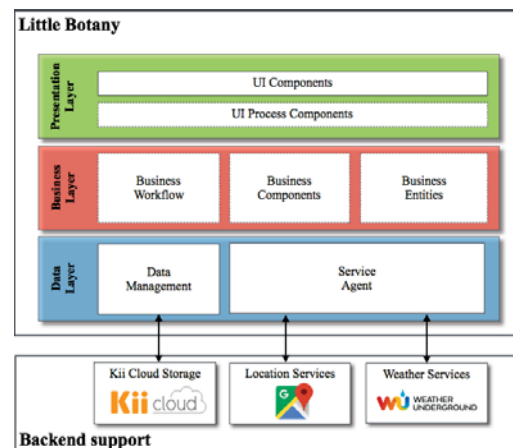

Fig. 1. System Architecture

1) Presentation Layer

The presentation layer contains the components for building user interface and managing user interaction. Unity3D new UI system provides an efficient approach to create UI components, such as buttons, input fields, images, panels, and texts, which are placed and displayed on the top of the game's canvas. Moreover, Unity3D also supports user input from multiple devices. Users can play our game by using gestures such as swiping, rotating, scaling, drag-drop. Figure 2 shows multiple gestures that users can provide as inputs.

Fig. 2.   Rotating, Scaling (Zoom in/ out), and Drag-Drop gestures

2) Business Layer

In Little Botany, business layer has three components, which include business workflow, business components, and business entities. We explain the roles and responsibilities of each component as follows:

- **Business workflow.** Users usually take multiple steps to accomplish a task. The steps must be performed in a correct order and orchestrated. For example, users need select a location and a specific date before creating their garden or users need follow the gardening steps by digging the soil first before sowing seeds.

- **Business components.** Little Botany provides three business components, which are 1) setting up user account, 2) user engagement, and 3) education module.

    1) *Set up users account:* Users are required to set up their accounts before creating gardens.

    2) *User engagement:* The component provides the entertainment content for users. The goal is to motivate users to play the game and learn how to grow plants. In addition, users can simulate plant development and track their plant growth.

    3) *Education module:* The component contains in-depth knowledge about gardening and plant growth. Users can learn about plant structure and plant growth factors including photosynthesis, respiration, transpiration, light, temperature, and water.

- **Business entities.** Game objects such as plant models, gardens, images, and colors are drawn under the Unity3D graphic pipeline. Ultimately, Little Botany can have twenty plants for users to choose. Each plant has thirty static models represented as plant development stages.

3) Data Layer

Data layer plays an important role in the three-layer architecture. Business layer cannot function properly without accurate data provided by data layer. Data layer stores each user's game data in Little Botany. This layer includes data management and service agent described as follows:

- **Data management.** This component centralizes the data access functionality, which makes the application easy to configure and maintain. In Little Botany, game data is stored in the cloud storage named "Kii Cloud" [3]. This cloud storage provides us the ability to develop our game application without worrying about server-side implementation and operations.

- **Service agent.** Business layer is built upon multiple external service agents, which provide data for business components implementation. In this component, we develop the code to manage and communicate with external services. To provide weather and location for a user, we have selected external services including wunderground.com [4] for weather data, and Google Maps Geocoding API [5] for location data.

III. Services

A. Location services

Little Botany provides users the flexibility to choose any location on earth to start a garden. To provide an easy way for users to choose a location, users can touch a spherical globe designed in Little Botany. With the Unity3D game engine, Little Botany can retrieve user-touched position in 3-Dimensional world, and convert it to the geographic coordinates with latitude and longitude values. Giving the geographic coordinates as inputs, we need use web services to retrieve a specific location. In Little Botany, we use Google Maps Geocoding API [5] provided by Google Inc. This API has the capability of converting latitude and longitude values to human-readable address. The returned addresses have four different formats. Given 40.714224 in latitude and 73.961452 in longitude as inputs, we illustrate how Google Maps Geocoding API retrieves a specific location in Figure 3 and 4. For Little Botany, it is sufficient to use a simple address format, which consists of city and country.

```
https://maps.googleapis.com/maps/api/geocode/json?latlng=40.714224,-73.961452
```

Fig. 3. **Input:** Google Maps Geocoding API (40.714224 in latitude and 73.961452 in longitude)

```
"formatted_address" : "277 Bedford Avenue, Brooklyn, NY 11211, USA",
"formatted_address" : "Grand St/Bedford Av, Brooklyn, NY 11211, USA",
"formatted_address" : "Grand St/Bedford Av, Brooklyn, NY 11249, USA",
"formatted_address" : "Bedford Av/Grand St, Brooklyn, NY 11211, USA",
"formatted_address" : "Brooklyn, NY 11211, USA",
"formatted_address" : "Williamsburg, Brooklyn, NY, USA",
"formatted_address" : "Brooklyn, NY, USA",
"formatted_address" : "New York, NY, USA",
"formatted_address" : "New York, USA",
"formatted_address" : "United States",
```

Fig. 4. **Output:** Different Formatted Address

B. Weather services

Users can have their garden in different locations, but also in different weather conditions. In Little Botany, users have an option to select historical time. For instance, users can have their garden in 2000s. To retrieve weather condition for a specific location, we considered several weather provider sites [6]. In order to select a suitable weather provider site, we have considered API call limit, cost, and data provided by the site. As a result, we discovered that weather information can be retrieved over HTTP requests instead of calling their APIs and paying for services. In the end, we selected Weather Underground [4] as the service that provides weather information to users. Weather Underground allows developers to query both current and historical weather data using HTTP links. Figure 5 illustrates the retrieved weather data from wunderground.com on October 9, 2014 from 12:00AM to 2:00 AM in Singapore airport. The link used for retrieving the data is:**https://www.wunderground.com/history/airport/SIN/2014/10/10 /DailyHistory.html?format=1**

TimeSGT	Temperature (F)	Dew Point (F)	Humidity	Sea Level PressureIn	Visibility (MPH)	Wind Direction	Wind Speed (MPH)	Events	Conditions	DateUTC
12:00AM	84.2	73.4	70	29.86	6.2	SSE	6.9	N/A	Mostly Cloudy	2014-10-09 16:00:00
12:30AM	84.2	73.4	70	29.86	6.2	SE	6.9	N/A	Mostly Cloudy	2014-10-09 16:30:00
1:00 AM	84.2	75.2	74	29.86	6.2	SE	6.9	N/A	Mostly Cloudy	2014-10-09 17:00:00
1:30 AM	82.4	75.2	79	29.86	6.2	SE	6.9	N/A	Mostly Cloudy	2014-10-09 17:30:00
2:00AM	83	74	69	29.84	9	SE	6.9	N/A	Haze	2014-10-09 18:00:00

Fig. 5.   A sample fo weather data

For Little Botany, we extract five attributes from Fig. 3 to describe weather condition for a specific location. The five attributes are time, temperature, humidity, events, and condition.

C. Mobile Backend as a Service (MBaaS)

MBaaS [7] provides various server-side features such as user authentication, data management, application analytics, and push notification. With MBaaS, we can develop our mobile application without burden by server-side implementation and operations. We considered several MBaaS providers [8]. In the end, we found Kii Cloud [3] provided by Kii Corporation, which can fulfill the needs for Little Botany.

Using Kii Cloud, We implemented server-side logics and applications for Little Botany. In addition, our application uses Kii Cloud to allow users to store game data on the server or share data among multiple devices. Kii Cloud let us manage our server 24 hours a day and 365 days a year. It also enables us react quickly to the issue and recover our service promptly. Furthermore, Kii Cloud is also enabling us to develop and distribute our application along with their provided Unity SDK. For developers, Kii Unity SDK is easy to work with in terms of developing server-side logics. This SDK consists of KiiObject, Bucket, User, Scope, and Push Notification. In Little Botany, we use KiiObject for storing application data. We can store values and string using key-value pair, and these key-value pairs are stored as JSON format. We also use Bucket to organize multiple KiiObjects, which act like a container for

KiiObjects. In order to store KiiObjects in a Bucket, we designed the schema of KiiObjects using UML diagram. Figure 6 illustrates the schema designed for Little Botany using UML diagram.
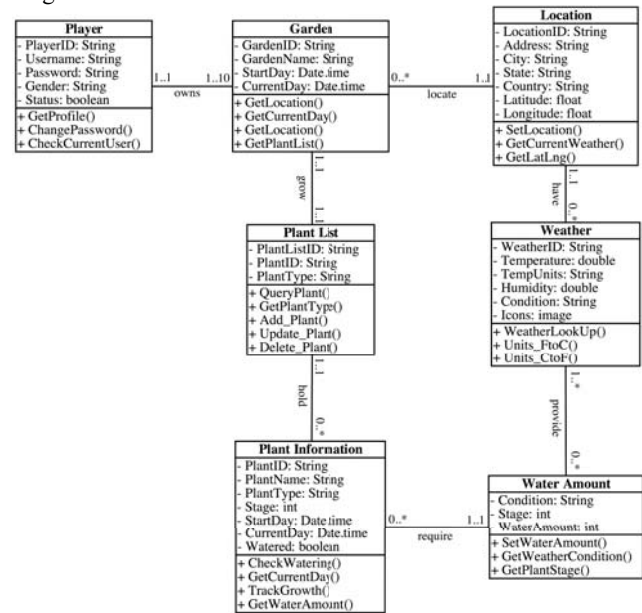

Fig. 6.   Little Botany UML Diagram

IV.   FUNCTIONALITIES

In Little Botany, we provide six functionalities for users to create their own dream garden. By playing with Little Botany, users can learn to grow and maintain their plants in different locations and weather conditions. Users can also track their plant growth. In addition, Little Botany provides an education module that teaches about in-depth gardening such as plant structure and factors affecting plant development. Figure 7 illustrates Little Botany functionalities diagram.
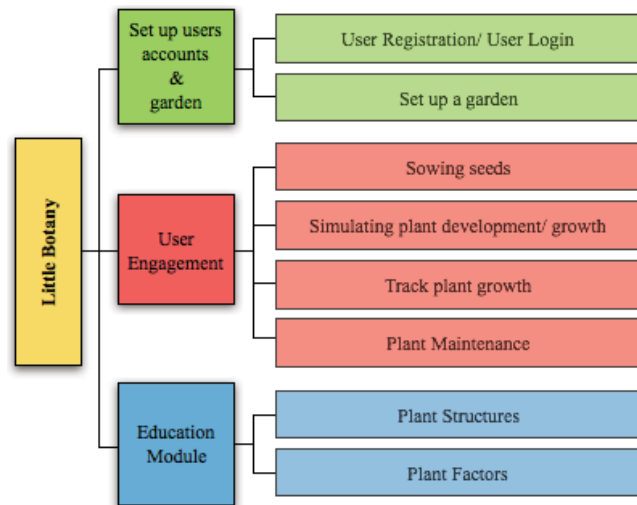

Fig. 7.   Functionalities Diagram

A. Set up accounts & garden

1) *User Register/ Login*

After a user installs Little Botany on a mobile device, he must create his account if he wants to start the game and create a garden. The user can create his account by filling in the registration form on the register panel illustrates in Figure 8. However, the user can also use his Facebook account to register by clicking on the "Connect to Facebook" button in the bottom of the login panel illustrates in Figure 8. Little Botany authenticates username and password using Kii cloud services. More importantly, Little Botany offers Single Sign-on feature with the support of Kii cloud services, because Kii cloud can automatically authenticate users by checking the current user's account or the user's session that appeared on the system.
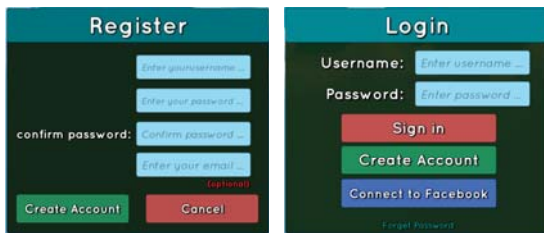

Fig. 8.   Login and Register Panel

2) *Set up a garden*

Users can create their dream gardens in different locations and seasons. Once users want to create their garden, Little Botany brings users to the location selection scene. In this scene, users will be able to select location by touching or clicking on the spherical globe. With the Unity3D game engine, we can retrieve user-touched position in 3-Dimensional world, and convert it to the geographical coordinates with latitude and longitude values. This technique can be achieved by using the formulas (see Eq.1-3) to convert Cartesian to Spherical coordinates, where $r \in [0, \infty), \theta \in [0, \pi], \varphi \in [0, 2\pi)$, by

$$r = \sqrt{x^2 + y^2 + z^2} \qquad (1)$$

$$\theta = \arccos\left(\frac{z}{\sqrt{x^2+y^2+z^2}}\right) = \arccos\left(\frac{z}{r}\right) \qquad (2)$$

$$\varphi = \arctan\left(\frac{y}{x}\right) \qquad (3)$$

The Cartesian coordinate (x, y, z) can be converted to Spherical coordinate of a point in the ISO convention (radius r, inclination θ, azimuth φ). azimuth angle φ and inclination or polar angle θ are basically the same as *latitude* and *longitude* values.
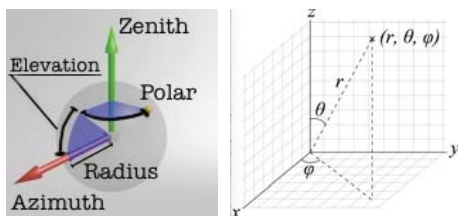

Fig. 9. Spherical coordinate (radius r, polar angle θ, azimuth angle φ).

The latitude and longitude values are used to retrieve both weather and location information. In addition, we also provide calendar for our users to select a specific day for starting a garden. Figure 10 shows the location selection scene and calendar provided by Little Botany.

Fig. 10.   Location Selection scene and Calendar game object

After users have selected their location and a date from the calendar, our game will bring users to their garden. Users are able to grow plants and vegetables by selecting a specific tile in this scene. We have designed user's garden using 2-Dimensional Tile-map. The tile-map is structured in rows and columns or (X, Y) Axis. Figure 11 shows how Little Botany stores positions in the tile-map system.

Fig. 11.   (5 x 2) Tile Map Structure

Figure 12 shows the user who has selected tomato at (0,0) position on the tile. Users start growing their plants and vegetable by selecting gardening tools. After sowing the tomato seed to the soil, users can track the tomato plant's development, user's activity logs, and learn about the structure of tomato plant. Little Botany displays a detailed description for each plant which includes health condition, water amount, plant state, and plant type.
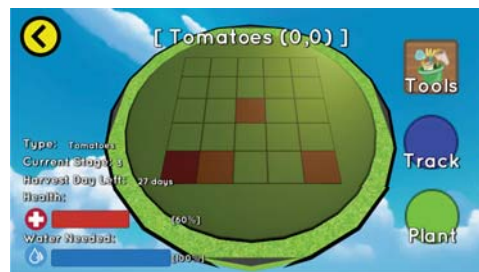

Fig. 12.   Garden with Tile Map Structure

B. User Engagement

The gardening tools are important components for plant maintenance. In Little Botany, we divide gardening tools to three categories (i.e. Starter, Daily, and Finalize). We describe the roles and functionalities of each category in the following sections.

Fig. 13.   Gardening Tools

1) Starter: sowing seeds phase. Users will start digging the soil by performing the swipe gesture; after that, users will start sowing plant seeds by selecting their favorite plant they would like to grow.

TABLE I.   STARTER: SOWING SEEDS PHASE

Starter Phase	
	Shovel: Users will interact with the game by swiping their fingers. Each swipe will play the diging animation and being counted. Users need to swipe maximum nine at a time.
	Seed Can: Users will select a specific seed from the store, and start sowing the seed by holding the button until the progress bar has filled.

In Little Botany, we have selected plants and vegetables that are considered as the most common plants. We provide three vegetables including tomatoes, carrots, and onions in Beta version of Little Botany. We plan to provide approximately twenty common plants and vegetables in the near future. Table II shows the list of most common plants and vegetables that users can grow on Little Botany in the near future.

TABLE II.   PLANTS AND VEGETABLES SELECTION

Plants and Vegetables Selection			
Apples	Tomatoes	Celery	Strawberries
Onions	Asparagus	Avocado	Cabbage
Potato	Blueberries	Egg plant	Kale
Spinach	Grapes	Watermelon	Kiwi
Peaches	Lettuce	Peppers	Pine apple

2) Daily: plant maintenance phase. Little Botany requires users to water and spray pesticide to their plants and vegetables. Tomatoes are susceptible to insect pests, especially tomato hornworms and whiteflies. Users will attach to the game by maintain their plants on a daily basis. If some weather events have occurred, the maintenance activity will be adjusted accordingly. For example, if it rains on a specific day, users do not need water plants in their gardens.

TABLE III.   DAILY PLANT MAINTENANCE PHASE

Daily Phase	
	Watering: Users hold on the watering button until watering gauge reach the required amount. In some cases, plant will display a message if it still needs more water.
	Pesticide Spray: Users can interact with the game by destroying harmful insects. Users will click on a specific insect. It will spray pesticide to the insect, and the insect will be eliminated.

3) Finalize: achievement phase. When a plant reaches its final growing season, users can harvest the vegetable or fruit from the plant. Harvest time for tomatoes will occur at the end of its growing season, once the tomatoes are at their mature green stage. Users will start picking about 60-85 days after planting seedlings in the garden.

TABLE IV.   FINALIZE PHASE

Finalize Phase	
	Harvest: Users can use picking gesture as an input. Users pick a specific fruit and put it into a basket. Users will earn more money by selling those fruits they picked.

Playing with Little Botany, users can learn how to grow their plants and vegetables. Moreover, users can learn to take care of their garden in different seasons and locations. After harvest, users can sell the fruit for money, and then buy seeds for a new plant.

4) Simulate plant growth.   The principal environmental requirements for plant growth include adequate space for root and canopy development, sufficient light, water, oxygen, carbon dioxide, and mineral elements, and temperature suitable

for essential physiologic processes. An adequate amount of water is essential for plant growth. To simulate plant growth and development, we use Growing Degree-Day (GDD) formula (see Eq. 4) to calculate a plant's development rate based upon real-time weather data. For tomato plant, GDD formula is defined as follows:

$$GDD = \frac{Tmax + Tmin}{2} - Tbase \qquad (4)$$

Tmax = Maximum Temperature
Tmin = Minimum Temperature
Tbase = usually equal to 50 °F

Each plant in the garden has a timestamp, which records the plant's starting date. The game automatically calculates how long the plant has been growing based upon the timestamp. Then, the game calculates how much water each plant is required so that users can provide an adequate growing environment for the plant. Figure 14 illustrates five models of tomatoes, each model represented as one development stage.
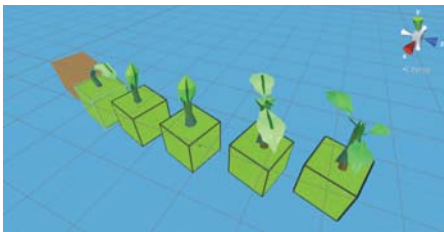

Fig. 14.   Five development stages of tomatoes

5) Track plant growth. Every day users perform an activity to take care the plants in their garden. Activities such as watering and spraying pesticide will be stored in the activity log. Users are able to keep track all plant development since the day the plant has been placed. In order to track a specific plant, Little Botany uses the scroll bar. For example, a user started growing his tomato on Jan. 11, 2010. When the user login Little Botany on Jan. 15, 2010, he can drag the scroll bar within five days sequentially. Fig. 15 illustrates the tracking plant growth scene.
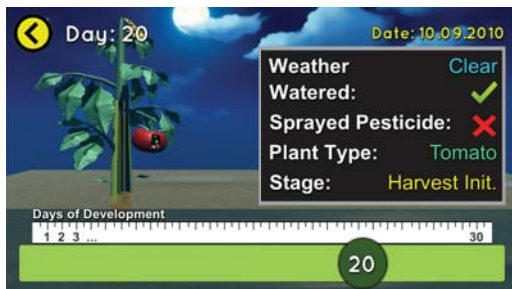

Fig. 15.   Tracking plant scene

Little Botany uses activity logs to keep tracking of users' activities and plant development. Activity data including watering, spraying pesticides, and plant health data is recorded in the activity logs. Therefore, when a user drags the scroll bar, Little Botany displays all the activities the use has performed in his garden.

C.   Education Module

In addition to tracking plants development, Little Botany can also teach users about the structure of each plant. Plant structure is divided to two parts: external structure and internal structure. External parts consist of root, stem, leaf, flower, fruit, and seed. Internal parts consist of plant cell and plant tissue. When a user touches on a specific part of the plant, a detailed description of the functions for the touched part will be displayed to the user. Using tomato plant as an example, Fig. 16 illustrates the modules selection scene where users can select different topics such as plant cell anatomy, tomato plant anatomy, and flower structures. Fig. 17 illustrate in depth of tomato plant anatomy. This scene provides a free rotation of objects. Thus, users can interact with the plant in a 360-degree view. Moreover, users can learn a specific part of anatomy by touching on an individual part.
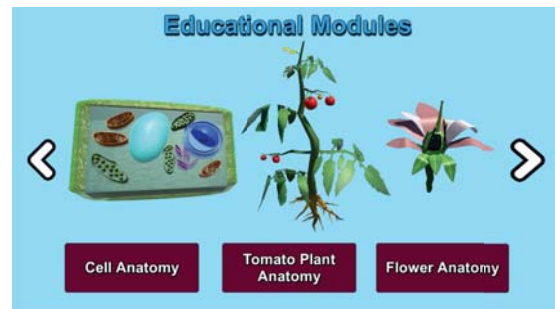

Fig. 16.   Select educational modules

Fig. 17.   Learning of tomato plant structures

V.   Conclusion

Games are important for learning development. In this paper, we present a mobile educational game for gardening to enhance plant science learning and improve student content retention. Using Little Botany, users can create their dream garden in any places in the world. More importantly, Little Botany is using real-time weather data for the garden location (e.g. South America) to simulate how the weather affects plants growth. Weather plays a major role in the healthy growth and development of plants. To engage users, Little Botany has plant daily maintenance component which requires users' daily involvement with the game. With this game, users can discover where our food comes from and learn how to tend and harvest crops, learn about insects and pollinators. The current virtual

garden in Little Botany is simulated based upon soil gardening, but we plan to add indoor Hydroponic system to our game in the near future. Hydroponic [11] gardening uses considerably less water than soil gardening, because of the constant reuse the nutrient solutions. Mobile devices are rapidly becoming the new medium of educational and social life for young people, and hence mobile educational games are a key topic for learning.

VI. REFERENCE

[1]   Unity3D Game Engine url: https://unity3d.com/

[2]   Autodesk Maya url: http://www.autodesk.com/products/maya/overview-dts?s_tnt=69290:1:0

[3]   Kii Cloud url: https://en.kii.com/

[4]   Weather Underground API: http://www.wunderground.com/

[5]   Google Geocode API url: https://developers.google.com/maps/documentation/geocoding/intro

[6]   Top 10 Weather API url: http://www.programmableweb.com/news/top-10-weather-apis/analysis/2014/11/13

[7]   Mobile Backend as a Service (MbaaS) url: https://en.wikipedia.org/wiki/Mobile_backend_as_a_service

[8]   Best MbaaS url: http://forum.unity3d.com/threads/best-mbaas-solutions.252863/

[9]   R. N. Amundsen, "Urban farming: Victory gardens for sustainable communities," *Energy and Sustainability Conference (IESC), 2013*, Farmingdale, NY, 2013, pp. 1-3. doi: 10.1109/IESC.2013.6777068

[10] Environmental Working Group's (EWG) 2015 Shopper's Guide to Pesticides in Produce url: http://www.ewg.org/foodnews/

[11] Hydroponics: https://en.wikipedia.org/wiki/Hydroponics

E-learning User Interface For Visual and Hearing Impaired Students

Wejdan Farhan and Kalpdrum Passi

Department of Mathematics & Computer Science, Laurentian University, Sudbury, Canada

Abstract – *This paper discusses an e-learning system through the design and development of an e-learning user interface for students with visual- and hearing impairment. In this paper the tools and features in the user interface required for making the learning process easy and effective for students with such disabilities have been presented. The tools and features added to the user interface were tested with visually and hearing impaired students from Laurentian University's population. After collecting and analyzing the data, the results from different usability factors such as effectiveness, ease of use, and accessibility showed that the participants were not completely satisfied with the existing D2L e-learning system, but were satisfied with the proposed new user interface. Based on the new interface, the results showed also that the tools and features proposed for students with visual and hearing impairment can be integrated into the existing D2L e-learning system.*

Keywords: E-learning; visually and hearing impaired; D2L user interface.

1   Introduction

The rapid development in the e-learning technology has enabled special needs students to overcome their learning barriers and make progress in their learning endeavors. Educational technology has the potential to facilitate the inclusion of special needs students in classrooms of higher learning. When pursuing this subject, a diverse range of special needs students' issues, both technical and non-technical, needs to be considered. Some studies [1, 3, 11, 15] show that most of the technical issues with e-learning systems reported by the special needs students remain unresolved. Accordingly, educational organizations at all levels also invest large amounts of time and resources in educational technology, with the goal of enhancing the educational effectiveness of the learning environment [17]. In the educational technology context, it has been found that there is a high success rate from an e-learning approach among learners of all ages [10, 20]. This resulted in a sense of increased confidence, pride among learners and increased educational options available to them. In addition to that, surveyed participants demonstrated an increase in personal skills; namely, time management, computer literacy, independence and work ethic [20, 24]. Also, e-learning provides students with access to qualified and specialized instructors. If instructors were technologically literate, the rate of student success would only increase [24].

This paper proposes the integration of the available technology for special needs students with the existing e-learning environment by developing an e-learning user interface of the integration development environment (IDE) that will enable students with special needs to use the same Learning Management System (LMS) as normal students. The special tools in the user interface will enable students with visual and hearing impairment to interact within the environment of e-learning system as their peers do who do not have disabilities.

2   Related Work

Current literature explores e-learning systems from normal student's perspective with little focus on students who required special needs technology that is used in these systems.

Visual Impairement

According to the Royal National Institute for the Blind "The internet is one of the most significant communication developments since the invention of Braille. For the first time ever, many blind and partially sighted people have access to the same wealth of information as sighted people and on the same terms" [21]. Firstly, in the research literature, of all the different special needs scenarios, blind users show the most complications when performing a task [5, 9, 13, 21]. Secondly, the growing use of LMS in all aspects of teaching and learning process by increasing presence of adaptive e-learning systems in Canadian universities. Thirdly, increase in the use of computer-based evaluating methods, testing materials, and grading systems. Finally, the vital role that is produced from these technologies is facilitating their life on one side and the increasing compatibility of e-learning with general-use information technologies on the other side. The frustrations of blind and low vision people can be minimized by following good design principles, such as the guidelines and protocols of the Web Accessibility Initiative (WAI) that support the evolution of the World Wide Web (www) and ensure its interoperability which works with universities to develop strategies, procedures, and resources to help make web accessible to students with disabilities [7]. However, regardless of significant research focus in this field, interacting with a virtual learning environment and using e-learning objects is still hard for a blind student who cannot see the screen and is unable to use a mouse [3]. Furthermore, interaction requires a new innovation that aids the smart

technology and decreases another degree of software complexity.

All blind or low vision barriers should be considered when designing e-learning applications and courses management systems.

Hearing Impairement

In the case of e-learning systems environment for deaf learners, it is not easy for developers to agree on if deaf students are deteriorating their normal academic activities because of incapability to deal with the audio/ video sound content issue. In addition, because of language and literacy capabilities there are obstacles to accessing commands in text-rich e-learning systems. As well as, most of the literature shows that no information is presented on how many deaf education programs offer e-learning systems, nor what course management systems or LMS is available to deaf students via e-learning. There is a need to offer e-learning education opportunities for deaf students by preparing future teachers [2]. Parton [18] found within several studies that deaf students were keen about e-learning systems that assisted their academic life. They enthusiastically attempted reading activities by using their language on information technology, which supported the notion of e-learning layout. Richardson et al. [21] in their study mention that communication was easier in e-learning than in a traditional classroom setting. With an increasing focus on e-learning systems, research is needed to examine whether LMS is fully reachable to deaf students and whether this technology needs further development as some recent literature shows that deaf students are enthused by e-learning [12].

3   Prototype Design for E-Learning User Interface

In designing an e-learning user interface, we need to collect information about the capabilities of the e-learning system and the needs of the students. Microsoft developers [16] suggested good principles for designing the layout of the user interface. The following are some principles that should be followed:

Colour: designers should consider the UI colour carefully, because colours get a user's attention and many individuals perceive colours differently and so designers should not rely on colours to communicate information. In addition colour contrast is also important because designers should ensure there is enough contrast between foreground and background colours.

Typography: is another important feature to consider in designing the UI. The Microsoft developers recommended "Font size, font weight, and the spacing between letters, words, and paragraphs are also important. We should avoid sizes that are too large or too small. It is often helpful to make the font size of a text field slightly larger than the surrounding text, but

we need to take into consideration the size of the page and avoid forcing the user to scroll down if possible".

Balance and Symmetry: this is related to the distribution of visual weight and whether it is symmetrical or asymmetrical. Symmetry is appropriate for a traditional audience because it can communicate stability and/or strength. Asymmetry is appropriate for a modern audience or an entertainment website because it has a more informal balance.

Consistency means the page layout, colour, and typography throughout the UI should be consistent with each other. Designers should be mindful of UI control choices to ensure consistency across all applications.

Simplicity is the simple and logical layout of the UI that lets users executes important features and/or tasks. This is achieved by limiting the number of animations, special effects, colors, gradients, fonts, and other design options.

The user interface design should show a suitable level of consistency and the commands and menus should have the same format based on their level of impairment. For example, for visually and hearing impaired students we should care about the typography such as typeface, interlinear space, word spacing, and colour. So any typeface on user interface design can be used if we use it large enough. The standard of the Royal National Institute for the Blind (RNIB) "Recommends a minimum font size of 14 point for readers who are likely to be blind or partially sighted." For headings, use a font size at least two points bigger than the body text. Leave reasonable space between lines of type. RNIB suggests interlinear space should be at least +2pt for type sizes between 14pt and 20pt. Always use even word spacing: In some documents for the visually impaired, it has been the tradition to use double word spacing. This has not been fully researched. While it may help some readers, others may find double word spacing actually hinders reading. There are also multiple types of colour blindness; more common cases are an inability to recognize blue/yellow or red/green. "[1] However, the new e-learning user interface follows these standards by considering the fluctuation in student ability; for example one student preferred the white background and black text but others did not. The new user interface gives them the choice to select the colour based on their needs.

Choose alternatives

After interviewing visually and hearing impaired students two alternative e-learning user interfaces were designed. Before starting to implement the design, another interview was conducted with the participants to make sure that the suggested design covered all the tasks that they preferred to see in the e-learning user interface. They were asked to choose the best alternative that would give them ease of use, ease of movement, and ease of choice functions. However, both alternatives have the following commands and each command has some tasks: My Home, Course Home, Contents, Drop box, and Grades. For example visually and hearing impaired students can use a mouse or tap the bottom of the keyboard to

---

[1] http://www.reading.ac.uk/web/FILES/simplification/lucidmarkbarratt.pdf

choose one of the above commands. The system reads the command and gives them the sign language for each one to help hearing and deaf students understand the command; for the visually impaired it will also read aloud each command. Nevertheless, the participants chose the alternative design as this design was closer to the e-learning user interface they used in D2L in terms of the order of the tasks and the format.

4 Implemantation of the E-Learning User Interface

This section describes in detail the design and implementation of the proposed e-learning user interface prototype that has been implemented and developed based on Laurentian University special needs students' requirements. An experimental method is described that was selected to compare the design of a new e-learning user interface prototype with the D2L user interface prototype.

User Interface for People with Visual and Hearing Impairments

We can't overlook that there are many studies that are interesting and that discuss the principles of design of user interface for people who have vision and hearing impairment [6]. As well, Darejeh and Singh [6] recommended designing UI for visually and hearing impaired users based on their preferences and by giving them some options for choosing and controlling some commands such as font and colour [14]. Furthermore, some scholars expand that by giving them also a number of keys such as controlling the zoom in the user interface, enhancing and putting speech recognition to make the user interface more interactive, rather than customize the font size and colour [4, 25]. In [26] the study focuses on interface for people with different levels of visual and hearing impairment, suggested making UI accessible, and that the designers should use a "combination of features such as speech input and output, gestures, haptic feedback and a zoom-able graphical interface". That means that the e-learning designers and developers should always have the user's preferences when designing an e-learning user interface. Because of this, the literature focused on design principles in term of user preferences like "suitability for task, self-descriptiveness, controllability, conformity with user expectations, error tolerance, suitability for individualization, and suitability for learning". The literature also confirms that user preferences may have differing relative importance in given specific situations [23]. Taking user preferences in designing an e-learning system for students with disabilities by getting those commands could lead to the elimination of unnecessary stress and frustration that can make impact on UI usability for e-learning system [8].

D2L E-learning System

Listening to the perceptions of visually and hearing impaired students about the D2L (see figure 1) e-learning system at the Laurentian University [12] provided the understanding of the barriers faced by them while using D2L

without any help from assistive technology. The following is an example of the opinion of a visually impaired student who was interviewed. *She said that the most important obstacle that she had encountered when using D2L at Laurentian university was the lack of commands that help visually impaired students, such as zooming the texts. She could not use any computer at Laurentian University to access the e-learning system (D2L), but she brought her Laptop because it contains an assistive software named (a magnification program) zoom text. She noted that if anything happened to her laptop (broken or lost) she could not view nor do her assignments.* In addition, this student is not the only one facing this barrier; others who had glasses faced difficulties reading their grades for assignments or could not view course content and so on.
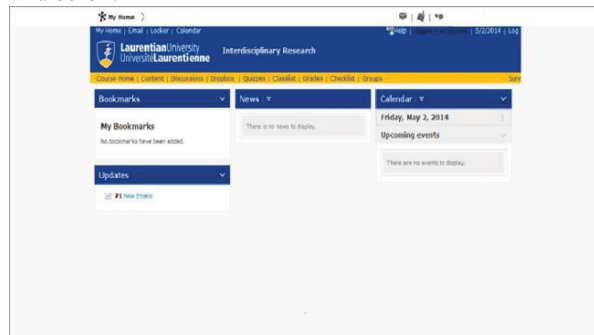

Figure 1. D2L E-learning user interface at Laurentian University

Implementing the proposed design of the user interface:

Figure 2 shows the user interface design for the e-learning system that was selected by visually and hearing impaired students through the interviews and questionnaires. Internet websites application languages were used to implement the e-learning user interface.
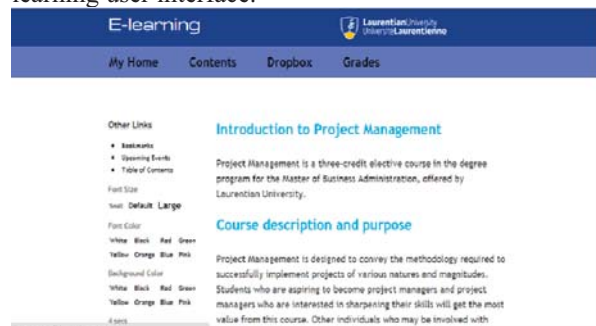

Figure 2. Proposed E-Learning user interface

The e-learning user interface has multiple tasks in an effort to help visually and hearing impaired students when they use the e-learning user interface. Multiple tasks include button voice, tab voice, voice reading for web page, sign language for commands and uploading video and audio with sign language on the user interface, zoom texts, and control of colour of font and background. These multiple tasks that are implemented in the design of the proposed user interface are explained below. **Task1**:The tool bar was built to enable students to choose one of the available commands by a mouse click for hearing

impaired students and by moving within a tap through the keyboard for visually impaired. They can also view sign language that explains what this word is and listen to loud sounds to read the same word (see figure 3).

Figure 3. Use of sign language to read words in tool bar

Task 2 : From the left side of the following screen, the student can control his/her font size preferences by zoom text (small, large, and default); this feature is on all pages in the user interface with voice read (see figure 4).

Figure 4. Control of text zooming

Task 3 : Students can also control their font colour or background colour based on their preferences. This option was developed for students who have color blindness or other students who prefer a special colour (see figure 5).
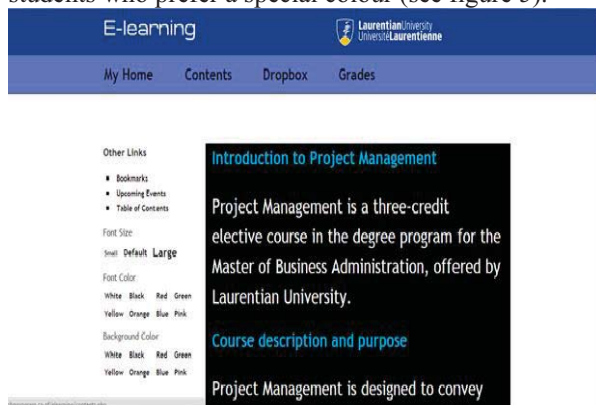

Figure 5. Control of Font and background color

Task 4: This task gives students the opportunity to understand a graph by reading it by voice and by having it explained by sign language (see figure 6).
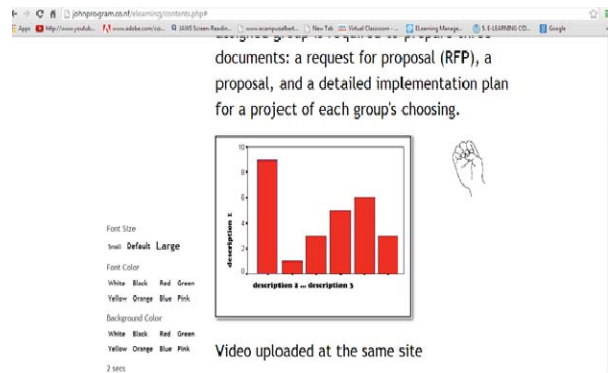

Figure 6. Explain graph by sign language and voice

Task 5: Streaming media: visually and hearing impaired students can also view a complete video and audio with added sign language (See figure 7).
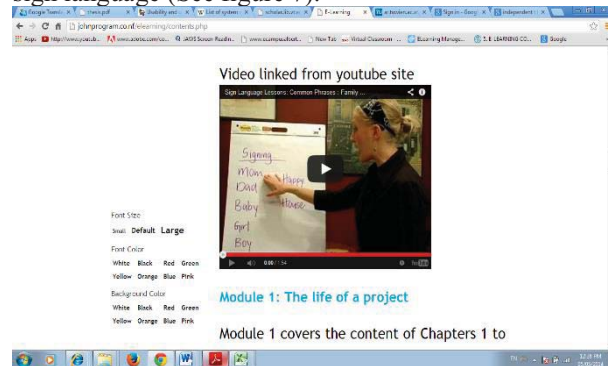

Figure 7. Streaming media of lecture with translation in sign language

5   Data Analysis and Findings

The methods that have been applied to evaluate the usability testing of e-learning interface are: quantitative, qualitative and experimental. In the qualitative part, the data collection included semi-structured interviews and open-ended questions to visual and hearing impaired students at Laurentian university. After designing an e-learning user interface based on their requirements, a quantitative method was followed by asking them to fill out two surveys that ask the same questions to compare between the existing D2L e-learning system at Laurentian University and the proposed design that was developed. The survey questions asked the participants to rate many factors such as accessibility, ease of use, usefulness and so on. Their relative satisfaction with the usability of the e-learning user interface was also rated by using an experimental method which allows participants to experiment with multiple tasks such as button voice, Tab voice, and voice reading for web page, sign language for commands and uploading video and audio with sign language on the user interface. These commands were tested and compared with the commands on D2L interface by the participants. As well, this survey includes questions regarding the usability factors related with the integration of the tools in the D2L e-learning system. The survey had ten questions that have been ranked

on a 5-point Likert scale, ranging from 'Strongly Disagree' to 'Strongly Agree'. The collected data was analyzed.
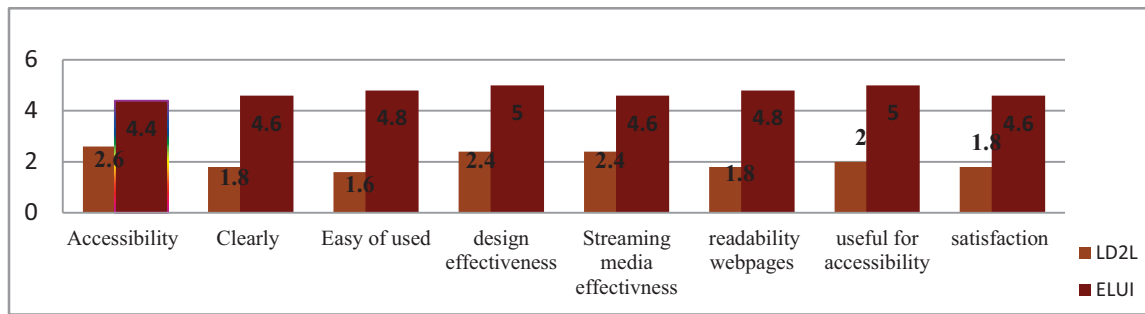

Figure 8: Differences between factors when using D2L e-learning user interface and proposed e-learning user interface

The main goal of this study is to integrate the tools for visually and hearing impaired students in an existing e-learning system like D2L without using any assistive software technology to help them to use and understand the tasks in the e-learning system. In addition to answer the question "Does D2L at Laurentian University meet the needs of visually and hearing impaired students?" we test the following null hypothesis (H0) to try to prove our claim and question:

H0: There is no difference in the mean satisfaction of visually and hearing impaired students between D2L user interface and the proposed e-learning user interface.

To test the above hypothesis, descriptive statistics have been used to label and describe some of the results from both questionnaires: D2L user interface questionnaires (LD2L) and suggested e-learning user interface (ELUI) for visually and hearing impaired students at Laurentian University to see the differences between both systems. The factors are summarized in the both surveys as follows: accessibility for user interface, clarity of commands, ease of use of the interface, design and streaming media effectiveness, readability of texts and webpages, useful for special needs students and satisfaction of user interface. From Figure 8, it can be seen there is a big difference in the participant satisfaction between the proposed user interface and the D2L user interface for students with visual and hearing impairments by looking at the averages of all the participants' answers for each factor that describes the extent of participant satisfaction.

Paired samples T-test

In addition, to answer the second question "Does the measure of usability testing (Factors) based on the existing e-learning system differ with the suggested e-learning system user interface?" this study used Paired samples T-test, a feasible test with a small sample size (N=5). The test was for each usability factor as one sample experiment is on two user interfaces. Compared to the usability testing factors, the hypothesis tends to predict the statistical power of comparing the mean scores between LD2L and ELUI for visually and hearing impaired students. The usability factors tested in this study are at the satisfaction level of both user interfaces, ease of use for both user interfaces by visually and hearing

impaired students, clarity of commands and accessibility for user interfaces. The paired sample statistical analysis showed that there are statistically significant differences between the mean of the factors (satisfation level, ease of use of UI, clarity of commands in the UI, accessibility for user interface, time of task completion) in the D2L interface and the new interface (ELUI) for visually and hearing impaired students. Figure 9 shows that the participants found the ease of use and greater speed in completing tasks on the proposed user interface as compared to D2L for visual and hearing impaired students.
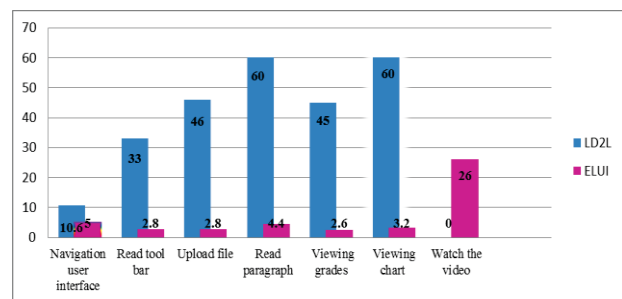

Figure 9: Bar chart showing the average time (in seconds) to accomplish tasks.

6   Conclusions

The new e-learning user interface has many features and tools that enable the students with visual and hearing impairment to use the e-learning system without the use of any assistive technology. Some of these tools are expected to contribute and help those students to use e-learning system. For example, the features involved are: commands to read with voice, Tab voice, voice reading for web page, sign language for commands and uploading video and audio with sign language on the user interface, zoom texts, and control of colour of font and background. All these features have been implemented and tested in the new user interface. From statistical analysis we infer that there are big differences in the usability testing factors between the D2L user interface and the new user interface for participants tested at Laurentian University. In addition, the paired sample T- Test showed that the hearing and visually impaired students are not satisfied with the existing D2L e-learning system and satisfied with the new designed user interface for participants of this study. The proposed user interface can be integrated with the D2L system and allow those Students to use the same environment as other

students, which achieved the main goal of this study. Finally, the time accuracy method to measure the usability testing also found that the proposed user interface is easy to use, and is speedy in completing tasks. We can conclude that visually-and hearing-impaired students who participated in this study have been completely satisfied with this new user interface design.

7 References

[1] Almond, P., Winter, P., Cameto, R., Russell, M., Sato, E., Clarke-Midura, J. & Lazarus, S. (2010). Technology-enabled and universally designed assessment: Considering access in measuring the achievement of students with disabilities—A foundation for research. The Journal of Technology, Learning and Assessment, 10(5).

[2] Antia, S.,Johnson, H.,Lenihan, S., & Benedict, K. (2009, March). Doctoral preparation in education of DHH students: Needs, concerns, and the way ahead. Presentation at the conference of the Association of College Educators of the Deaf and Hard of Hearing, New Orleans, LA.

[3] Buzzi, M. C., Buzzi, M., & Leporini, B. (2009). Accessing e-Learning Systems via Screen Reader: An Example. In Human-Computer Interaction. Interacting in Various Application Domains (pp. 21-30). Springer Berlin Heidelberg.

[4] Chiang, M.F., R.G. Cole, S. Gupta, G.E. Kaiser and J.B. Starren, 2005. Computer and World Wide Web accessibility by visually disabled patients: Problems and solutions. Survey Ophthalmol., 50: 394-405. DOI: 10.1016/j.survophthal.2005.04.004.

[5] Craven, J. & Brophy, P. (2003). Non-visual access to the digital library: the use of digital library interfaces by blind and visually impaired people. In: Technical report, Manchester: Centre for Research in Library and Information Management - CERLIM, 08.03.2011, http://www.cerlim.ac.uk/pubs/index.php.

[6] Darejeh, A., & Singh, D.(2013). A review on user interface design principles to increase software usability for users with less computer literacy. Journal of Computer Science, 9(11), 1443.

[7] Evans, S., & Douglas, G. (2008). E-learning and blindness: A comparative study of the quality of an E-learning experience.Journal of Visual Impairment & Blindness, 102(2), 77-88. Retrieved from http://search.proquest.com/docview/222044681?accountid=12005.

[8] Fryia, G. D., Wachowiak-Smolikova, R., & Wachowiak, M. P. (2009, November). Human-computer interface design in an e-Learning system for individuals with cognitive and learning disabilities. In Digital Information Management, 2009. ICDIM 2009. Fourth International Conference on (pp. 1-6). IEEE.

[9] Ivory, M. Y., Yu, S. & Gronemyer, K. (2004). Search result exploration: a preliminary study of blind and sighted users' decision making and performance. Proceedings of Extended abstracts of CHI 2004, pp. 453-1456, ISBN:1-58113-703-6, Vienna, Austria, April 24-29 2004.

[10] Kawalilak, C., Wells, N., Connell, L., & Beamer, K. (2012). E-learning access, opportunities, and challenges for aboriginal adult learners located in rural communities. College Quarterly, 15(2), 1. Retrieved from http://search.proquest.com/docview /1041025822? accountid= 12005.

[11] Lambe, J. (2007). Student teachers, special educational needs and inclusion education: reviewing the potential for problem-based, e-learning pedagogy to support practice. Journal of Education for Teaching, 33(3), 359-377.

[12] Laurentian University website, D2L, https://d2l.laurentian.ca.

[13] Leporini, B. & Buzzi, M. (2007). Learning by e-Learning: Breaking Down Barriers and Creating Opportunities for the Visually-Impaired. Proceedings of UAHCI'07, International Conference on Universal Access in Human-Computer Interaction: applications and services, pp. 687-696, ISBN: 978-3-540-73282-2, Beijing, China, July 22-27, 2007.

[14] Madiah, M. and S. Hisham, 2010. User-interface design: a case study of partially sighted children in Malaysia. Prcoeedings of the International Conference on User Science and Engineering, Dec. 13-15, IEEE Xplore Press, Shah Alam, pp: 168-173. DOI: 10.1109/IUSER.2010.5716745.

[15] Matheson, C., & Matheson, D. (2009). Access and accessibility in e-learning.Applied e-learning and e-teaching in higher education.

[16] Microsoft developer network website (accessed, June 13, 2014). http://msdn.microsoft.com/en-us/library/

[17] Moseley, W. L. (2010). Student and faculty perceptions of technology's usefulness in community college general education courses. The University of Nebraska - Lincoln). ProQuest Dissertations and Theses, 152.

[18] Parton, B. S. (2005). Distance education brings deaf students, instructors, and interpreters closer together: A review of prevailing practices, projects, and perceptions. International Journal of Instructional Technology & Distance Learning, 2(1), 65- 75.

[19] Petrie, H., Hamilton, F. & King, N. (2004). Tension, what tension?: Website accessibility and visual design. Proceedings of the International Cross-disciplinary Workshop on Web Accessibility (W4A), No. 76, pp. 13 – 18.

[20] Philpott, D., Sharpe, D., & Neville, R. (2009). The effectiveness of web-delivered learning with Aboriginal students: Findings from a study in coastal Labrador. Canadian Journal of Learning and Technology, 35(3).Available from http://www.cjlt.ca/index.php/cjlt/article/view/545.

[21] Richardson, J. T. E., Long, G. L., & Foster, S. B. (2004). Academic engagement in students with a hearing loss in distance education. Journal of Deaf Studies and Deaf Education, 9(1), 68-85.

[22] Royal National Institute for the Blind, Communicating with blind and partially sighted people. Peterborough (2004).

[23] Rutgersson, S., & Arvola, M. (2007). User interfaces for persons with deafblindness. In Universal Access in Ambient Intelligence Environments (pp. 317-334). Springer Berlin Heidelberg.

[24] Sisco, A. (2010). Optimizing the effectiveness of e-learning for First Nations: Report 2010. Available from http://www.conferenceboard.ca/temp/dbd8e1a8-edd8-48fa-8bc8-4e96368c1047/10-255_OptimizingEffectivenessE-learning_WEB.pdf.

[25] Stephanidis, C., D. Akoumianakis, M. Sfyrakis and A. Paramythis, 1998. Universal accessibility in HCI: Process-oriented design guidelines and tool requirements. Institute of Computer Science, Greece.

[26] Turunen, M., H. Soronen, S. Pakarinen, J. Hella and T. Laivo et al., 2010. Accessible multimodal media center application for blind and partially sighted people. Comput. Entertain. DOI: 10.1145/1902593.1902595.

A Study of Learning Effectiveness for PBL-flipped and PBL-online in a Digital Information Literacy Curriculum

Naicheng Chang[1], Hsuanyu Hsu[2]
[1]General Education Center, Tatung University, Taipei, Taiwan
[2]Department of Information Management, Tatung University, Taipei, Taiwan
*[1]ncchang@ttu.edu.tw, [2]hyhsu@ttu.edu.tw

Abstract - *This study integrates PBL and innovative teaching, flipped classroom and blended e-learning environments using the digital materials, "Information Literacy and Ethics", to explore motivation for learning and learning outcomes. The study uses the ARCS motivation model as the quantitative indicator in an online questionnaire and in-depth interviews for qualitative analysis. The results show that the ARCS model is valid for both methods and that each method has its own advantages and disadvantages, in terms of learning outcomes. Based on the results, this study proposes four key elements for the promotion of PBL teaching and initiates a new and innovative teaching model - blended flipped online instruction - which produces the best learning outcomes.*

Keywords: Problem-based learning, Innovative teaching, Flipped classroom, Blended learning, Information literacy.

1 Introduction

As information technology grows rapidly, educational technology has a crucial role in reforming teaching and learning models. Educational technology is widely used to facilitate learning and improve performance by creating, using and managing appropriate technological processes and resources [1]. The NMC Horizon Report noted that education paradigms were shifting to the integration of online learning, blended learning and cooperative learning and that this would be the fastest area of growth in educational technology for Higher Education [2]. Flipped learning is often referred to as an "inverted classroom", where students watch recorded video lectures at home and do their homework exercises in school. Studies have shown that there is a lack of sufficient discussion digital learning platforms [3]. Datig and Ruswick found that an information literacy (IL) course that used the flipped classroom model allowed a more efficient and beneficial use of class time [4]. Mutula et al. found that IL was delivered online more frequently in higher education and that students preferred the medium of technology for library instruction to face-to-face instruction [5].

Problem based learning (PBL) is strengthened by the Constructivist approach. It is an instructional strategy that is organized around the study and resolution of problems [6]. PBL was introduced at McMaster University (Canada) in the 1960s. Originally, it was used particularly for traditional medical education [7]. However, the importance and the effect on students' learning performance using PBL and learning via problem solving in technology-mediated PBL or using PBL in online environments have been the subject of many higher education studies worldwide in recent years [8]. PBL encourages collaboration and reinforces real world skills and it is believed that PBL enhances learning motivation and promotes the achievement of satisfactory learning performance. Students are confronted with a real or simulated problem that is a catalyst for the learning process. Students are transformed into active role players with responsibilities to develop skills in problem solving, so learning becomes reflective and involves a deep understanding of the materials. The challenges that are associated with integrating PBL and innovative teaching are manifold and are poorly documented. This study validates the ARCS model for motivation in the flipped classroom and online learning environment, analyses the learning outcomes for the two innovative teaching methods, proposes the key factors for a good PBL in an innovative teaching environment and proposes a new PBL model that produces the best learning outcomes.

2 The Five-step PBL model

The IL course for this study consisted of 3 PBL coursework in the Decision-making of Information Ethics, the Evaluation and Verification of Network Information and Internet Addiction. The coursework followed the 5-step PBL model. Within the PBL environment, the problem is a catalyst that initiates the learning process: 1. Students are introduced to an ill-structured problem that is related to their lives to increase interest and motivation; 2. Students analyze the problem to determine what they know about the problem and conduct independent investigation of the information needed to address the problem; 3. Students analyze the problem and identify action steps through collaboration; 4. Students generate possible solutions to the problem; 5. Students consider the consequences of each solution and select the most viable solution through metacognition.
The PBL process is supported by continuous reflection on the content and the process. This is improved on an ongoing basis by inputs from multiple sources and perspectives of assessment. The instructor acts as a facilitator and introduces the problem that is related to students' lives, in order to increase interest and motivation. The instructor groups students and provides resources to promote teamwork. The instructor observes the PBL process and supports the group leaders to strengthen their leadership and stimulate effective

collaborative learning. The instructor also promotes self-regulated learning, in order to stimulate critical reasoning and elaboration on the topics. The instructor assesses the progress and designs the multiple evaluation scheme.

3   The ARCS model for motivation

The ARCS (Attention, Reference, Confidence, Satisfaction) model is created by generating a large list of motivational strategy statements, which are derived from research findings and real world practices[9]. The strategy statements are then sorted into four requisite categories. Each category has three subcomponents. Attention is a prerequisite for learning. Attention refers to gaining and sustaining attention to the instruction by stimulating curiosity and interest. Relevance represents the importance and the value of learning. Confidence refers to building learners' confidence in their ability to succeed in the learning task. Satisfaction refers to the potential for learning satisfaction. The ARCS model has been widely validated as a method for the systematic improvement of learner motivation and performance in e-learning settings [10]. The IL course for this study used an ARCS-based motivational course design for teaching and learning.

4   Research design

A total of 95 students (49 flipped and 46 online) were evaluated in the general education Information Literacy and Ethics digital materials for higher education module that is a product of the Ministry of Education in Taiwan. An ARCS-based online questionnaire used the first author's previous research to measure students' perception of their motivation [11]. In-depth interviews with group leaders and group members were used to gather qualitative evidence, in order to evaluate the PBL learning process. The questionnaire consisted of 20 items, which were derived from the four constructs of the ARCS model. Each construct is operationalized with five items, based on the subcomponents of ARCS model. The questionnaire items are measured using a 5-point Likert-type scale, ranging from 1 (strongly disagree) to 5 (strongly agree). A total of eight items (two in each construct) were removed because they exhibited cross-loading for different factors. Based on the first author's previous research, the following hypotheses are proposed:

H1: Attention has a positive direct effect on relevance.
H2: Attention has a positive direct effect on confidence.
H3: Attention has a positive direct effect on satisfaction.
H4: Relevance has a positive direct effect on confidence.
H5: Relevance has a positive direct effect on satisfaction.
H6:Confidence has a positive direct effect on satisfaction.

5   Results and discussion

5.1   Validating the ARCS model

Regression analyses were performed to test the hypothesized relationships. As shown in Table 1, the factor

loading for items meets the recommended threshold values of 0.60 (0.60~0.83). A reliability coefficient was computed for each factor, in order to estimate the reliability for each scale. All factors with a reliability coefficient of more than 0.8 (0.83~0.91) were considered to be acceptable in this study.

Table 1. Item factor analysis and reliability.

Construct and item	Loading	Cronbach's α
Attention		
A1 The content captured my interest and stimulated my curiosity.	0.72	
A2 The multimedia motivated me and aroused my attention.	0.83	0.91
A3 The variability of instructional strategies helped keep my attention.	0.78	
Relevance		
R1 The content meets my personal needs and goals.	0.61	
R2 The content uses concrete examples to illustrate the use of IL knowledge.	0.60	0.85
R3 It is clear to me how the content is related to things that I already know.	0.71	
Confidence		
C1 I could control the success of learning outcomes.	0.82	
C2 The good organization of the content gave me confidence that I would master this material.	0.68	0.85
C3 I can establish the direction of self-learning after learning.	0.61	
Satisfaction		
S1 Completing the course gave me a satisfying feeling of accomplishment.	0.80	
S2 I believe that the course is worthwhile, in terms of study and daily life.	0.63	0.83
S3 I had a useful learning experience from the course tasks.	0.67	

The R^2 value shown in Figure 1 indicates that the coefficients in the ARCS model are generally statistically significant. The model explains a substantial proportion (flipped 61% and online 55%) of the variance in relevance. The respective variances for confidence and satisfaction are: flipped: 64%, online: 69% and flipped: 76%, online: 80%. The paths in the ARCS model, that is, Attention—>Relevance—>Confident—>Satisfaction, are all statistically significant (p-values between 0.001 and 0.01).
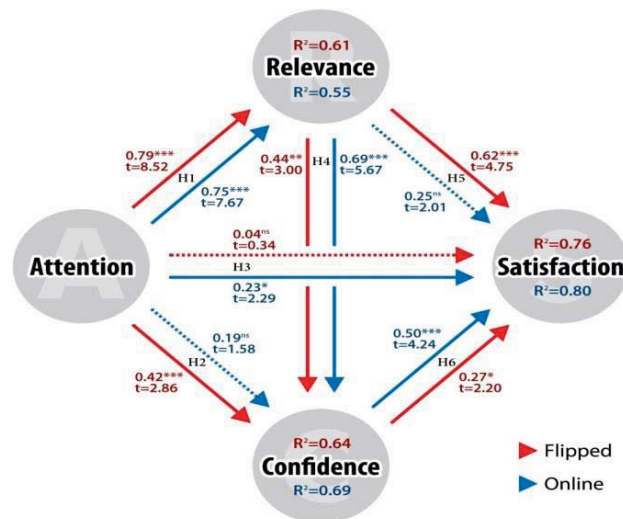
Figure 1. A summary of the path modeling and the statistical results

(Statistical significance is indicated by asterisks: ns: not significant; t>1.96 (*p*<0.05); t>2.58 (*p* <0.01); t>3.96 (*p* <0.001)

Figure 1 also demonstrates that for the flipped model, while attention is significantly related to relevance (H1), it also has a significant influence on confidence (H2), and while satisfaction is influenced by confidence (H6) in the model, there is a significant relationship between relevance and satisfaction (H5). Students may believe that they achieve a desirable level of success when they value the digital materials in a personally meaningful way and when those materials are relevant to their needs and goals. This increases confidence and sustains attention for learning. When students believe that the courses meet their expectations, positive quality perceptions are also generated and satisfaction is boosted.

Figure 1 also shows that for the online model, while satisfaction is significantly related to confidence (H6), it also is influenced by attention (H3). Students may achieve feelings of satisfaction as a result of interactive digital materials that attract their attention.

5.2   Learning outcomes

5.2.1   Class participation

The results show that the online group exhibits better engagement in the class and better performance than the flipped group, in terms of entering digital classroom times (flipped 426; online 815), reading hours (flipped 74:22:19; online 180:37:40), reading pages (flipped 974; online 1811) and average scores in the online exam (flipped 83.1; online

90.1). However, the flipped group exhibits higher average scores for the term than the online group (flipped 81.7; online 78.5). The online group also performs better than the flipped group in terms of self-regulated learning and collaborative learning that is required for PBL.

5.2.2   The PBL learning process

Parts of the in-depth interviews with group leaders and group members and feedback from the questionnaire are detailed herewith.

"We were all senior students and were busy planning our future careers. We created a FB club to make use of PBL, but the level of group engagement was low." (flipped_groupLeader1)

"We were from different departments and were unfamiliar with each other. I asked group members to watch video lectures before PBL. I was satisfied with the PBL quality." (flipped_groupLeader2)

"We were all from business school. We used PBL in class and on the Line social platform outside class. We had insufficient PBL engagement." (flipped_groupLeader3)

"Based on my previous online learning experience, I thought that online PBL was more efficient than flipped PBL because students could do coursework at their own learning pace." (flipped_groupLeader6)

"Based on my previous online learning experience, I suggested mixing the two models, because each model had its advantages and disadvantages." (flipped_groupLeader7)

"We were all from design school. We used PBL entirely on the FB platform. I was happy that group members participated fully." (online_groupLeader2)

"I hated PBL because our leader exhibited poor personal time management and often forgot the due date. I always had to complete the coursework at the last minute. I think that it was unfair that group members contributed little but still got marks!" (online_groupMember1)

"I made a concerted effort using PBL and the group members all worked hard to achieve our common goal, which was to achieve excellent grades." (online_groupMember8)

The study shows that the online group gained more benefit than the flipped group and found that challenges were easier to overcome than did the flipped group. The two groups all gave negative feedback in the questionnaire on the theme of the ill-coordination of collaborative learning, using terms such as free-rider or irresponsible group leader. Overall, the study demonstrates that both models are viable for PBL IL courses.

6   Discussion and Conclusions

The IL courses in this study provide a student-centered, inquiry-learning environment, which promotes a more general and pervasive extrinsic orientation by allowing opportunities for self-direction and the acknowledgement of feelings about learning. This contrasts with the traditional, instructor-centered learning environment. Students who exhibit goal-oriented extrinsic motivation have a good chance of success if

they have a strong belief in their capabilities and make an effort, which in turn increases the intrinsic motivation that is derived from motivational instruction. Based on the results, four critical elements that increase the effectiveness of PBL are proposed:

1. Leadership: the study shows that good leadership allows a group to continuously produce excellent coursework. A good group leader creates a positive social climate and sense of community, encourages communication and leads the members to achieve common goals, participates in collaborative learning and increases confidence, which improves performance;

2. Self-regulated learning: this allows students to generate positive attitude towards responsible and active learning. This also depends on motivation and self-discipline, students who remain motivated and excited in the face of difficulties can persevere and experience increased feelings of self-efficacy when they use PBL;

3. In terms of the application of ARCS to teaching and learning, the IL digital materials are effective in capturing students' interest and in stimulating a curiosity to learn and when the materials meet the students' needs/goals, a positive attitude is generated. Instructors can increase students' confidence by encouraging them to master the materials and control their individual success. The instructor reinforces accomplishment with internal/external rewards to increase the students' satisfaction with the learning experience;

4. A proper learning environment: students in the general education curricula are from different grades and departments and not necessarily familiar with each other, so a well-planned learning environment that provides course assessment and a smooth network environment are all important factors that directly affect the efficiency of learning.

This study proposes that PBL should take account of institutional requirements, course objectives, learning context and the characteristics of learners. The study proposes a new innovative teaching mode by integrating both methods in a scheme that is termed, "blended flipped online instruction". This provides a workable model that produces the best learning outcomes. The instructor starts with flipped PBL, in order to establish leadership in the group leaders and to encourage self-regulated learning by group members. The instructor also supports the PBL process by providing a proper learning environment that stimulates student engagement. The instructor monitors group communication and provides timely feedback whenever it is required. Students then continue to use PBL coursework with collaborative learning in an online community at an individual learning pace, which increases the effectiveness of learning. This innovative blended teaching mode retains the benefits of flipped PBL and online PBL and addresses the difficulties that each method presents.

8. References

[1] Margaret Roblyer, Jack Edwards. "Integrating Educational Technology into Teaching". 2nd ed., Upper Saddle River, N.J: Merrill, 2000.

[2] Larry Johnson, Samantha Adams Becker, Victoria Estrada, Alex Freeman. "NMC Horizon Report: 2014 Higher Education Edition". Austin, TX: The New Media Consortium, 2014.

[3] Jonathan Bergmann, Aaron Sams. "Flip Your Classroom: Reach Every Student in Every Class Every Day". Eugene, OR: International Society for Technology in Education, 2012.

[4] Ilka Datig, Claire Ruswick."Four Quick Flips: Activities for the Information Literacy Classroom". College & Research Libraries News, Vol.74, Issue 5, 249-257, 2013.

[5] Stephen Mutula, Trywell Kalusopa, Kgomotso Moahi, Justus Wamukoya. "Design and Implementation of an Online Information Literacy Module: Experience of the Department of Library and Information Studies, University of Botswana." Online Information Review, Vol. 30, Issue 2, 168-187, 2006.

[6] Linda Torp, Sara Sage. "Problems as Possibilities: Problem-based Learning for k-16 Education". 2nd ed., Alexandria, VA: Association for Supervision and Curriculum Development, 2002.

[7] Howard Barrows. "A Taxonomy of Problem-based Learning Methods". Medical Education, 20, 481-486,1986.

[8] Maggi Savin-Baden, Kay Wilkie (Eds.). "Problem-based Learning Online" . Maidenhead, United Kingdom: SRHE/Open University Press, 2006.

[9] John Keller. "Development and Use of the ARCS Model of Instructional Design". Journal of Instructional Development, Vol.10, Issue 3, 2-10,1987.

[10] John Keller, Katsuaki Suzuki. "Learner Motivation and e-Learning Design: A Motivationally Validated Process". Journal of Educational Media, Vol.29, Issue 3, 229-239, 2004.

[11] Naicheng Chang, Hueihuang Chen." A Motivational Analysis of the ARCS Model for Information Literacy Courses in a Blended Learning Environment". Libri: International Journal of Libraries and Information Services, Vol.65, Issue 2, 129-142, 2015.

The Effectiveness of Website Design in Higher Education Recruitment

Fatemeh Bordbar, Ellen Treanor
Marketing Communication Office
Southern Utah University, Cedar City, UT, USA

Abstract - This paper explores the effectiveness of visual elements and aesthetics in university websites for recruiting prospective students. College and university websites are the gateway to an educational institution and the public face for both academics and athletics. According to Ruffalo Noel Levitz's study on consumer behavior, websites play an important role in providing information for prospective students (both new and transfer), current students, parents, and alumni [9]. Universities' recruiters constantly strive to maximize the utility and depth of information on their websites while offering pleasing and powerful aesthetics to attract potential students and donors. Entirely qualitative in content, this study examines the role of aesthetics in the three key categories: web design, website functionality, and universities' online recruitment strategies. The website functionality key category divides further into subcategories including website usability, accessibility and credibility.

Keywords: web design, aesthetics, online education, e-learning, website functionality, higher education recruitment

Introduction

Universities have started to create marketing and communication strategies which directly involve the website content and especially the redesign of their home page [6]. These strategies help convey various rhetorical messages for visitors. Both the textual treatment and graphic design/photography by designers play large roles in creating a site that gains aesthetic interest and continues to provide better information to the targeted audience.

Students appear to trust a professionally designed website more and find it more credible for accessing information [18]. The credibility of a website affects a user's interest in the site's content and, consequently, users tend to spend longer sessions on the site and access more information. Aesthetics and the use of enhanced visual elements (i.e. color, graphics, texture, text formatting, lines, icons) increases the credibility of a website. "Recent studies have shown that judgments on website credibility are 75% based on a website's overall aesthetics" [2]. This effect is made truly significant when observing that web users tend to value the professional appeal of a website when deciding which site to select for the same information and services. According to Fogg, Soohoo, Danielson, Marable, Standord, & Tauber [4],

people have reported that professionally designed websites win credibility points.

As most public higher education institutes including, Southern Utah University, generally continue to get budget cut from federal and state funding, marketing and admissions departments feel tremendous pressure to increase enrollment, often with limited resources. In the past five years, freshman enrollment at Southern Utah University has suffered a decline, which resulted in cuts in state funding that was directly related to the university's growth by number. At the source, in this case, lies the prospective student population, which can help the institution decide on effective recruiting methods in order to make better use of their budget and human resources.

Literature Review

High school students, undeniably, are already using the Web in the college selection process. With 79 % of high school students using the Internet for playing games, staying in touch with friends through social media, and completing assignments [12], researchers are finding that the Internet is also becoming a powerful resource in the college selection process. Strauss [13] studied the use of the Web in the college selection process of students who were admitted at Ohio State University and found that the majority of students had access to and also utilized the Web somehow during their college search process. The focus of admissions professionals should be on a simple way to communicate the college benefits like financial aid to the most appropriate audiences for effective recruitment. Online communication is relatively an easy way to send the message to the majority of potential students.

Current and prospective students are looking for easy-to-find information and anything else is simply annoying. The results from Poock suggest that information on the homepage should be easy to follow and organized in one place that doesn't require unnecessary scrolling. "Homepages that do require scrolling down either have too much information or are not well organized " [11]. Designers should be well aware of structuring a layout that does not need much scrolling and effort by the user in order to find the information they need.

Online education in higher education institutions is rapidly growing throughout the United States. Online student enrollment has been growing at a rate that exceeds that of the total higher education student population. "The 17 percent growth rate for online enrollments far exceeds the 1.2 percent growth of the overall higher education student population" [1]. Studies show that the demand for both face-to-face and online courses in higher education institutions is growing. In all cases, the demand for online offerings is greater than that of the equivalent face-to-face offerings. Universities and colleges need to prepare for this growth by utilizing their websites and online services in a way that effectively surpasses the demand.

The importance of using the Internet for marketing and promotional purposes by universities and colleges becomes more and more apparent as technology moves forward in a rapid pace. As universities are targeting potential students through the use of technology and the Web, high school students are also searching the Web for the right college, as they are getting closer to graduation. "Much of the research on the use of the Web for marketing purposes has focused on the business sector. However, there is clearly a benefit to colleges and universities in understanding the fundamentals of an effective promotional web design" [10]. Despite a clear need for colleges and universities to understand how prospective students use the Web for accessing information and navigating through sites, the literature indicates that limited data exists in this area.

There are some informational websites, like Google, that pay more attention to functionality than aesthetics. As Thorlacius mentions in his article, this is typically the case where the primary focus is to provide information for users. "The term functionality in this context covers the user friendly aspects of interfaces and Human Computer Interaction (HCI), where the main objective is to create effective websites where the user quickly and efficiently can obtain the desired pieces of information without being delayed by long downloading times or blind alleys when navigating on the site" [15]. He also argues that aesthetics and functionality should work together in order to create an effective website. Paying attention to the crucial role of aesthetic effects in web design helps the functionality of the site tremendously.

The functionality of a website is defined by usability, accessibility and credibility of the site. Research shows that educators in the area of web design are trying to teach students the importance of web usability and accessibility as well as aesthetics. "Faculty need to balance teaching students the basic building blocks, such as HTML and CSS, with teaching students visual design and design best practices, particularly usability and accessibility" [18]. A website is fully functional when it is easy to find information by all users including users with disabilities and it is more credible and trustworthy when it is professionally designed with accurate information.

Usability, or user-friendliness, is crucial. If information is hard to find, users will leave the site immediately [18]. In addition, poor usability has been proven to damage a site's overall credibility, which results in the loss of user trust on that website's content. As Youngblood points out usability is about the development process that focuses on making an interface easier to use [18]. Creating a user-friendly navigation system and organizing the information into a meaningful hierarchy are important components of designing an easy-to-use website. The best way to create a hierarchy in design is by categorizing the information based on the content priorities.

Accessibility, at its core, involves ease of use of a site by users with disabilities including vision, hearing, cognition, and motor skill impairments. A website should be easily and equally accessible for users with disabilities. When a website lacks these considerations in its design, it becomes difficult to use and thus undesirable for this population of web users [18]. "The power of the Web is in its universality. Access by everyone is an essential aspect" [17]. The World Wide Web Consortium (W3C) announced the launch of the International Program Office (IPO) for the Web Accessibility Initiative (WAI) to promote and achieve web functionality for people with disabilities.

Visual design has a direct impact on the credibility of a site regardless of the quality of the site's content. To design a highly credible website, a designer should pay careful attention to the look of a site. According to Fogg, Soohoo, Danielson, Marable, Standord, & Tauber, [4], almost 50% of comments about web credibility included something about the design look of the site, either in general ("looks professional") or in specifics (the layout, the colors, and so on). "Experiments have shown that users can judge a website's credibility in as little as 3.42 seconds merely on the basis of its aesthetic appeal" [2]. Visual elements and aesthetics used in web design have an important role in first impressions of credibility.

Based on the findings in literature and a lack of sufficient research in the effectiveness of visual elements in attracting prospective students through university websites, this study will explore the following question:

RQ-What is the role of aesthetics in designing a recruitment website for higher education institutions?

Method

Entirely qualitative in content, this study will use Grounded theory since there is no existing theory with an adequate framework for exploring the role of aesthetics in the following three key categories resulting from literature review: web design, website functionality, and universities' online recruitment strategies. The website functionality key category divides further into subcategories including website usability, accessibility and credibility. University of Chicago and Southern Utah University websites will be used as examples for comparison and in-depth analysis. University of Chicago was ranked second out of thirty universities and won two high-profile Webby awards: " In May 2013 the site was honored with two high-profile Webby Awards, winning in the overall School/University Webby Award category as well as picking up the Webby People's Voice Award" [14]. Southern Utah University's website was recently redesigned in order to attract and bring focus to prospective students for recruiting purposes. The new website has a very different look and feel compared to its predecessor, and the results from analytics collected by the web development team at Southern Utah University indicate vast improvement in site traffic compared to the older version.

Discussion/analysis

The Role of Aesthetics in Website Design:

A recent trend in web design for both desktop and mobile interfaces is an emphasis on incorporating attractive and eye-catching graphics as background, or as the top banner of a page. It is important to maintain a reasonable balance over the elements of the design so that none of them overpower the message. I believe the University of Chicago has done a tremendous job of keeping the balance between the use of eye-catching imagery, navigation system and the hierarchy of information placement on its homepage (Figure 1).
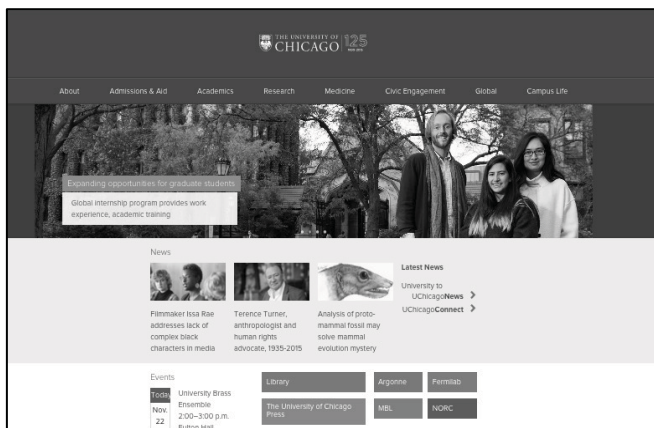

Figure 1 - *University of Chicago Home page*

A large high-resolution photo is used in the top banner, which is very attractive and aesthetically pleasing. They layered two text boxes on the photo to explain it in greater detail. It is important to mention that the contrasting color of each text box is carefully selected so that the information in front of the image can be easily read. At the same time, there is a clear horizontal navigation system at the top of the banner, which helps users find information easily. Design for websites requires certain skills for appropriate use of design elements. Colors and fonts play varying roles when used for web content and should be chosen properly. Certain fonts can become nearly illegible on screen and saturated bright colors may irritate the eyes when viewed on a monitor. While incorporating images in a design [5], it is important to pay attention to the context in which they appear, knowing that it might change the meaning associated with each image. For example, the color scheme chosen for the university of Chicago homepage, including both the dark maroon color used in the very top banner and the color combination on the boxes (Figure 1), communicates their school color (Figure 2).
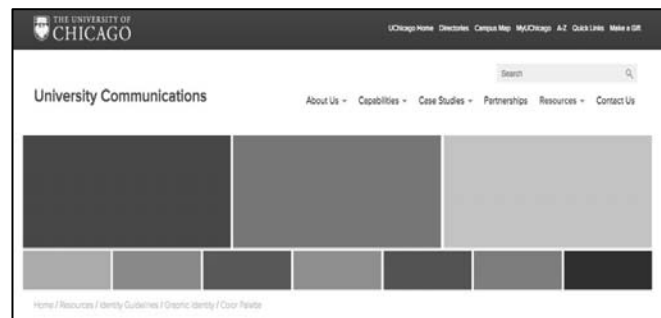

Figure 2- *University of Chicago Color Palette*

Designers always face the challenge of crafting a page's design without cluttering it with too much information or irrelevant visuals. A web designer needs to be very direct, simple and clear in order to accurately convey a message and emphasize this message in a very visually crowded page. One of the skills that assist a web designer in overcoming cluttering issues is to keep the content and information well-organized. The University of Chicago stands once again as a great example of an effective hierarchy method for organizing the information and content of a page. The title and logo of the university dominate the space through their size and position at the very top. Secondary information such as news is set against a gray-colored background in a smaller font size below the top banner, demonstrating a wise choice of placement, color and font to organize content.

The Role of Aesthetics in Website Functionality:

The functionality of a website boils down to its usability, accessibility and overall credibility. To date there

remains an erroneous assumption that this functionality is unaffected by the usage of visual elements and aesthetics in a site's design.

In order to explore the role of aesthetics in the functionality of a website in finer detail, I'll discuss this topic within website functionality subcategories including usability, accessibility and credibility. These three subcategories are interconnected and support one another in practice. When a site is usable – easy to use – it is often, as a result, more accessible for users with disabilities; consequently, users are then also more likely to trust the site's content and treat it as a credible source of information.

Website Usability:

Usability of a website corresponds to how easy it is to find information and navigate the many pages of the site. It is a web designer's primary responsibility, for the sake of user retention, to create a design that makes it easy for users to find information through a clean and simple navigation system and well-organized content. University of Chicago's website clearly showcases how clever design facilitates ease of use. The clean, elegant and straightforward navigation system of the site empowers a visitor to rapidly and directly access the desired information (Figure 3). I tested the navigation of the site with a prospective student's mindset by immediately following the Admissions & Aid link. As is demonstrated on the image below, a very clear and precise drop-down menu appeared from the top horizontal navigation bar and provided me a list of choices that were very easy to follow.

Figure 3- *University of Chicago Horizontal Navigation System*

It is worth mentioning that the clean look and design of the navigation system here is absolutely crucial to efficient site navigation. The overall simplicity of the design and clever choice of color eliminate any distraction from the important and relevant content (Figure 1). This is an excellent example of how usability and aesthetics work in unison to synthesize an effective, efficient website.

Website Accessibility:

As it is defined by W3C, website accessibility is the usability of a site for users with disabilities related to vision, hearing, cognition, and motor skills, among others. When designing for accessibility, designers need to create a layout

that is adaptable to a variety of disabilities, including those related to vision, hearing, mobility, speech, cognition and learning [16].

Designers should refer to the W3C rules and make sure that their design complies with accessibility standards, especially when designing websites for a governmental organization (universities sites included); otherwise, the organizations may face lawsuits related to lack of access.

Educators in the area of web design often encourage design students to adopt universal design so that a wide variety of audiences can access their content regardless of the technology used [18]. One example of such a design is the inclusion of alternative text for images as a solution for sighted users when the images themselves are not available as a result of the device being used. In addition, the ALT attributes make sites more accessible when users turn off web images to conserve bandwidth and/or loading speed in areas without broadband and on mobile devices.

A website can be simultaneously accessible and aesthetically pleasing for the user; the two concepts are not necessarily separate. Again the University of Chicago is an outstanding example of such a design, as the screenshot of their style sheet coding demonstrates (figure 4).

Figure 4- *University of Chicago CSS Coding*

In this style sheet of their home page, the yellow highlighted **alt** tag, as explained above, is clear evidence of careful consideration toward accessibility rules. The alt tags are used in web design to include information about image so that if users, for any reason, turned the images off or couldn't load or see them, they can easily get a depiction of these images in text format. As you can see in the figure bellow, each *alt tag* is assigned to a certain image and followed with related information.

Website Credibility:

The role of aesthetics in the credibility of a website is examined in Alsudani and Casey's study based on user judgment. Participants in this study commented on the overall unity of design for website credibility. Unity in web design can be achieved by a close relationship between harmony, balance, contrast/dominance and color of all the content. "Making 'Unity' in home page design affects users' judgments on web credibility, as home pages that achieve 'Unity' in their design are considered to be more credible than

others that lack 'Unity' in their design" [2]. Users tend to trust the credibility of a website that is designed more professionally in comparison to one that shows no indication of clean and professional design.

A solid example of a credible website which is designed professionally is the University of Chicago. The overall look and feel of the design shows signs of all components of unity based on design principles. The wise choice of complementary colors like red and green, blue and orange in their color scheme is a clear indication of well-formed contrast. There is also a great balance between the use of images and text to create unity throughout the page (Figure 5).
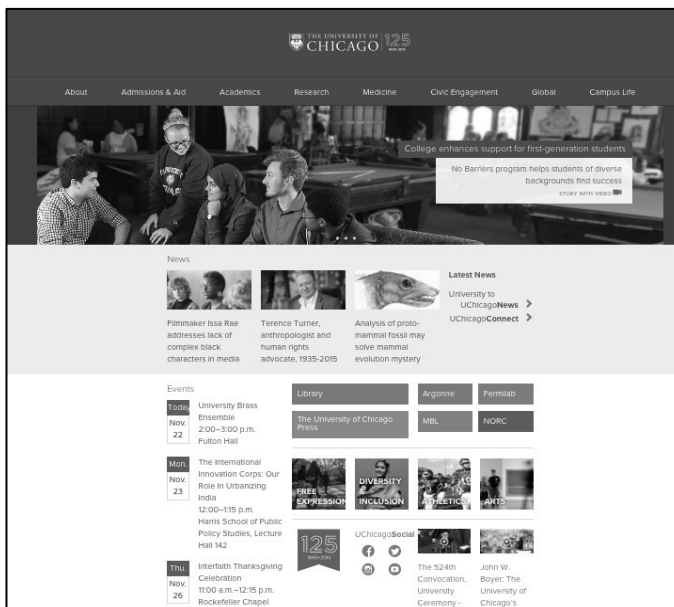

Figure 5- *University of Chicago Overall Feel & Look*

The Role of Aesthetics in Universities' Online Recruitment Strategies:

Universities usually search for prospective students by developing products like courses, distributing them by announcements and promoting them by publishing brochures and view books. This concept has been widely used as an educational tool in both the business and academic fields [8]. Some higher education institutions are still recruiting via traditional methods like sending out letters and brochures or through phone calls. It is commonly recommended to use a mixed method when recruiting future students. Traditional forms of communication, such as phone calls and printed materials, should be used in combination with technological tools, such as email and social media [8]. Poock and Lefond [10] studied college and high school students and found that almost all of them relied on the Web when applying to colleges or universities.

Clearly the Web plays an integral role in the college choice process for undergraduates. More recently, research on the college choice process of graduate students has produced similar findings to those focusing on undergraduate students. For example, in a series of focus groups and surveys done by Poock, participants suggested that the information on a web page should be visually clear to make reading easy [11]. In the same study, graphics were perceived as an important visual guide for the user so that they knew they were on the university's web pages, although such graphics should not dominate the page.

Knowing how to reach and ultimately connect with prospective students is a primary responsibility of marketing and admissions departments at all institutions of higher education [8]. Admissions offices are challenged to evaluate their recruitment practices under the increased use of online communication and social media. The rapid growth of technology and easy access to online resources for many students and parents has dramatically reduced dependence on traditional forms of media, yielding a demand for change in the recruitment process.

College and university websites play a vital role in this process. A university home page is a gateway to information that can regularly assist future/current students and their parents. Meticulous attention to detail in the content arrangement and aesthetics of the home page is therefore crucial [6]. It is widely popular in university website creation to use oversized photographic banners and minimalistic design. In fact, most of these home pages are designed specifically for the targeted students and their parents. For example, Southern Utah University's home page has undergone a major redesign in order to make the page more recruitment-oriented with useful information for prospective students. Previous versions were designed with faculty, staff and current students in mind. Information in the older design was organized through two vertical and horizontal navigation systems, which were crafted for internal use (Figure 6). The overall look and feel of the page wasn't aesthetically pleasing because of lacking eye catching and large visual elements.

Figure 6- *Southern Utah University-Old Website Design*

The new website, by contrast, has a completely different look and feel with a large, attractive photo/ video placed directly below the main navigation system to attract prospective students. The organization structure for information strictly uses horizontal navigation, keeping the

needs of future students in mind. The hierarchy of information presentation is also carefully planned to prioritize the prospective student's needs. For example, the most important links to information that is essential for future students – Apply, Visit, College life, Majors, Scholarships and Success Stories – are placed at the top of the page using bold font in the main red top navigation bar. Secondary links to information for the use of faculty and staff (internal use) are organized below the top bar in a gray color with smaller font size (Figure 7).

Figure 7- *Southern Utah University- New Website Design*

Conclusion

In designing for the Web, choosing suitable visuals provides the dual benefit of conveying the right message to the audience as well as creating a strong and emotional connection with viewers. Incorporating interesting, bold and attractive images/photos into a web page attracts and engages viewers and builds a powerful emotional connection with one's audience.

Because of a large number of URLs presently existing on the Internet, web designers need to work tirelessly in order to grab attention and stand out among their competition. The first impression of visual appeal seems to be consistent over time [7]. At the same time, designers need to know how to maintain a proper balance between the use of aesthetics and other components involved in web design (like navigation systems) so that they support the functionality of the site.

Strong evidence in research has proven that the functionality of a website is heavily linked with the use of aesthetics. A website is fully functional when the user can easily use the site, find information through a well-organized navigation system and, in result, find the site credible. "Design and aesthetics have a profound impact on how users perceive information, learn, judge credibility and usability, and ultimately assign value to a product. To dismiss design as merely visual is to make a fundamental mistake. Style does not replace substance, but style and substance in balance work much better" [3].

Using large photographic/video banners has become the new trend in designing for the Web. Many universities are changing their websites under this new and popular design method for recruitment purposes and have already moved away from the traditional approach towards prospective students. In addition to recruitment and marketing, universities are working on online education and improving their e-learning environment. One the best ways to keep the e-learning experience at its best is to design online educational websites so that they are clean, easy to use and attractive to students. "At least one aesthetic concern is currently beyond the control of most individual educators or even individual schools or systems: the aesthetic of the e-learning platform. The main criterion for using and choosing e-learning platforms has been usability and tool options. The aesthetic qualities and sensory considerations have been in many cases absent" [3]. According to David and Glore, results from a survey done by course administrators show that 47% of the participants feel the e-learning platform offers only limited possibility of customization while 82% feel that design and layout are critical for user engagement.

It is important to mention that no matter how visually attractive and eye-catching a university website seems, the overuse of graphics and scattered information can easily confuse potential students and will result in a loss of interest. To attract prospective students and to bolster recruitment efforts, it is therefore necessary to keep the design simple with the appropriate use of images and related information that is well-organized and easy to find, along with a user-friendly navigation system.

References:

[1]   Allen, E. & Seaman, J. (2010). *Learning on Demand: Online education in the United States, 2009.* Retrieved from: http://files.eric.ed.gov/fulltext/ED529931.pdf

[2]   Alsudani, F., & Casey, M. (2009). *The effect of aesthetics on web credibility*. Retrieved from http://www.bcs.org/upload/pdf/ewic_hci09_paper66.pdf

[3]   David, A., & Glore, P. (2010). The impact of design and aesthetics on usability, credibility, and learning in an online environment. Retrieved from https://www.westga.edu/~distance/ojdla/winter134/david_glore134.html

[4]   Fogg, B., Soohoo, C., Danielson, D., Marable, L., Standord, J., & Tauber, E. (2003). *How do users evaluate the credibility of Web sites? A study with over 2,500 participants*. Retrieved from http://htlab.psy.unipd.it/uploads/Pdf/lectures/captology/p1-fogg.pdf

[5]   Grancea, I. (2014). *Visual rhetoric and framing strategies in advertising word-based product categories*. Retrieved from http://www.fssp.uaic.ro/argumentum/Numarul%2012%20issue%201/09_Grancea_tehno.pdf

[6] Halvorsen, T. (2014). *Breaking the Mold.edu.* Retrieved from https://www.fastspot.com/blog/breaking-the-edu-mold/

[7] Josephson, S., Barnes, B. & Lipton, M. (n.d.). *Visualizing the Web.* Retrieved from http://www.newbooksservices.de/MediaFiles/Texts/7/9781433111457_Intro_006.pdf

[8] Keller, A. (2012). *Marketing techniques and recruiting effectiveness at a public community college*. Retrieved from http://www.nwmissouri.edu/library/fieldstudies/2012/Keller,%20Andrea.pdf

[9] Levitz, R. (2014). *7 things we learned this year about college students and higher education enrollment management*. Retrieved from http://blog.noellevitz.com/2014/12/11/2014-noel-levitz-research-highlights-7-things-learned-year-college-students-higher-education-enrollment-management/

[10] Poock, M. C., & Lefond, D. (2001). How college-bound prospects perceive university web sites: Findings, implications, and turning browsers into applicants. College & University, 77(1), 15–21.

[11] Poock, M. C. (2006). Characteristics of an effective web site in educational leadership. College Student Journal, 40(4), 785-790.

[12] Richter, D. (2008). *The Role of the Internet in Students' College Selection Process and Admissions Recruitment Strategies.* Retrieved from https://steinhardt.nyu.edu/scmsAdmin/uploads/001/352/JoSA2008 _RichterOnline.pdf

[13] Strauss, D. (1998). *The use of the world wide web as a source of information during the search and choice stages of the college selection process.* (Electronic Thesis or Dissertation). Retrieved from https://etd.ohiolink.edu/ap/10?0::NO:10:P10_ACCESSION_NUM:osu1242848622#abstract-files

[14] The 30 Best Designed U.S. College Websites. (2014, October 03). Retrieved from http://www.webdesigndegreecenter.org/best-designed-college-websites/

[15] Thorlacius, L. (2007). The Role of Aesthetics in Web Design. *NORDICOM Review*, *28*(1), 63-76.

[16] W3C (2008). *Web Content Accessibility Guidelines (WCAG) 2.0*. Retrieved from http://www.w3.org/TR/WCAG

[17] W3C (1997). *World Wide Web Consortium Launches International Program Office for Web Accessibility Initiative*. Retrieved from http://www.w3.org/Press/IPO-announce

[18] Youngblood, N. E. (2013). Integrating usability and accessibility into the interactive media and communication curriculum. *Global Media Journal: American Edition*, 1-37.

Japanese Junior High School Students' Perception toward English and Soft CLIL
A Case Study at Shoto Junior High School in Tokyo

Chiharu NAKANISHI[1] and Hodaka NAKANISHI[2]
[1]Department of Music, Kunitachi College of Music
5-5-1 Kashiwa-cho, Tachikawa-shi, Tokyo190-8520, Japan
[2]Technology Transfer Center, Teikyo University
2-11-1 Kaga, Itabashi-ku, Tokyo173-8605, Japan

Abstract - *The Japanese Society, which is faced to change from a monolingual community of Japanese to a global multilingual society, has been struggling to find an effective way to learn / teach English. Increasing multilingualism is most salient in big cities like Tokyo. A Metropolitan Junior High School in the center of Tokyo adopts Soft CLIL as a method to teach English as a foreign language. The object of this study is to investigate how the Japanese students and teachers think about learning / teaching subjects in English, in the form of Soft CLIL (Language-driven). The participants (n = 174) were 1st, 2nd, 3rd year students of Junior High School, the subject teachers of native Japanese speakers (n=3) and assistant language teachers of native speakers of English (n=4). For the students it was the first to third year to study subjects such as Music, PE and Art in English, in the form of Soft CLIL. The results show that attitudes towards learning / teaching subjects in English are positive among overall students and the teachers. Generally students like learning English / very much in English class and like learning in Soft CLIL / very much. All of the students and teachers think Soft CLIL is an effective way to learn / teach English, whereas they are worried about their understanding level of content subjects might decrease. The Japanese school and teachers who would like to implement Soft CLIL have to learn from situation of Shoto and be aware of students' preference and anxiety toward Soft CLIL.*

Keywords: Japanese junior high school, Soft CLIL, preference, perception

1. Introduction

The Japanese Society, which is faced to change from a monolingual community of Japanese to a global multilingual society, has been struggling to find an effective and efficient way to learn / teach English. From this social pressure, education of English language is one of the most emphasized aspects in Japanese Ministry of Education, Culture, Sports, Science and Technology (Hereafter MEXT). However, for Japanese junior high school students, English is a favorite subject in the eighth in 9 subjects (Benesse, 2009) [1]. In the 2015 survey of MEXT, the junior high school students who answer "I do not like English" is 43.2% (Yomiuri Press, 2016) [2]. Being asked the time when they start to feel poor at English, the students' answer is from the first half of Year

1 to the second half of Year 2 (Benesse, 2014) [3]. In the former research of English as second language, motivation has been considered an influential factor in language learning (Gardner, Tremblay & Masgoret, 1997) [4]. Many studies have pointed out that motivation has a direct influence on second language achievement and proficiency (Gardner et al., 1997 [4]; Tremblay & Gardner, 1995 [5]; Yamashiro & McLaughlin, 2001 [6]). It can be said to increase the number of lover of English is one of the ways to improve English proficiency.

Under such circumstances, there is a public junior high school, Shoto Junior High School, in which students' favorite rate of English keeps high percentage until the end of Year 3. In this paper we would introduce the method of Shoto Junior High School, and then we would focus on teaching subjects in English, Soft-CLIL and explore how students and teachers think about Soft CLIL.

2. Shoto Method: "Partial Immersion"

2. 1. From the information on the HP of Shoto Junior High School

Shoto Junior High School, located in the center of Tokyo, emphasizes education of English and understanding intercultural communication. On the homepage of Shoto Junior High School, they call their characteristics of education as "Partial Immersion". First we would like to see HP and examine what is written.

SHOTO Junior High School

Shoto Junior High School is located in the most exclusive residential district in Tokyo, and has been known as a prestigious public school providing a high level education since its foundation in 1949.The school aims to provide the most unique education, with all the students being offered the stimuli to attain high general academic achievement and English communicative competence whilst maintaining a Japanese identity.
English-oriented School 2004
The English-oriented school aims at developing the student's capacity to cope with "globalization".
To achieve the aim:
1)   English classes have only a small number of students and will be organized according to levels of achievement

---

2) Classes for other subjects, such as, music, art, PE, etc. will be partly delivered in English.
3) A sequence of short lessons in English is delivered every morning.
4) Communication in English is encouraged on as many occasions and opportunities as possible.
5) Extra activities in cooperation with English speaking schools and students will be promoted.
6) Japanese or foreign students from overseas will always be welcome.
7) Education of Japanese language, tradition and culture remains highly valued.

[https://www.shinko-keirin.co.jp/keirinkan/j-kaikaku/0404/index2.htm, Retrieved Feb. 28, 2016]

The detailed explanation follows in Japanese:

Goals of Shoto Junior High School

➢ Fostering students who are globally competent and internationally minded
➢ Fostering communicative competence of English
➢ Training students to speak daily basic issues in English
➢ Fostering attitudes to pay respect to Japanese tradition and culture

✧ Method of Shoto Junior High School: Partial Immersion (Teaching subjects in English)
➢ [PE] PE teacher of Japanese teaches PE in English.
➢ [Music and Art] Japanese subject teachers and Assistant language teachers team-teach these subjects.
➢ The class is conducted by "Annual Teaching Plan" which are based on "Course of Study" and textbook made by Japanese subject teachers.
➢ Either Japanese subject teacher or Assistant language teacher teach mainly by unit.

[https://www.shinko-keirin.co.jp/keirinkan/j-kaikaku/0404/index.htm, Retrieved Feb. 28, 2016]

Table 1: Class Schedule of Year 1 at Shoto Junior High School
[https://www.shinko-keirin.co.jp/keirinkan/j-kaikaku/0404/index.htm, Retrieved Feb. 28, 2016]

	Mon	Tue	Wed	Thu	Fri
Morning Activity 15 min.					
Special Activity 15 min.					
1 50 min.	Moral Study	Math	Social study	Japanese	Math
2 50 min.	Social study	English	Japanese	Domestic Art	Japanese
3 50 min.	Music	Science	English	Elective	English
4 50 min.	Integrated Study	Japanese	PE	Science	Science
5 50 min.	Art	Social study	Domestic Art	Math	PE
6 50 min.	Short HR	Short HR	Short HR	PE	Long HR
				Short HR	Short HR

The gray and black colored parts are partly conducted in English.

2.2 Is Shoto Program "Partial immersion"?

Shoto Junior High School self-proclaimed their school "Partial Immersion" as shown on HP. Shoto's "Partial Immersion" is not the same as Partial Immersion in the context of the United States. According to Arakawa (2004) [7] to teach only one subject in English can be called "Partial immersion" in the context of Japan. We would like to see Shoto programme from three viewpoints of American context to understand the situation more.

Viewpoint 1: Length of immersed time
Lenker et al. (2007, p.1) defines partial immersion in the United States that "Programs in which approximately 50% of instruction is provided in the target language" [8]. The calculation shows that the students at Shoto might be immersed in English about 560 min. per week (Table 2). As total school length is 1500 min. per

week, the percent that the students might be exposed to English is at most (37.3%) in a week (Table 2).

Table 2: English Immersed class length at Shoto Junior High School

	Partially English immersed length (min)	Total school length (min)
Class (50 min)		50 x 6 x 5 days=1500
English (50 min)	50 x 3 times = 150.	
Subjects partially taught in English (50 min)	50 x 4 times = 200	
Morning Activity (15 min)	15 x 5 times = 75	
Special Activity (15 min)	15 x 4 times = 60	
Short Home Room (15 min)	15 x 5 times = 75	
Total	560	1500

Viewpoint 2: Rate of Immigrants

The number of foreign residents in Japan has steadily increased, and the number of foreign residents were more than 2 million people in 2015. It was 1.5% of Japan's population. The students at Shoto Junior High School were mostly Japanese and it didn't have immigrants. Lenker et al. (2007, p.1) explain in immersion program about "one third to two thirds of the students in each class are native speakers of English; the remainder are native speakers of the other language, most often Spanish" in the context of the United States [8]. It does not apply to Japanese situation.

Viewpoint 3: Object of proficiency level

According to the HP of Shoto, the goal of English proficiency is to achieve A2 level of CEFR until the graduation. Lasagabaster and Sierra (2009) point out the goal of immersion programs is to reach an L2 proficiency similar to that of native speakers [9], whereas Shoto's goal is not as high as native speakers.

From these three viewpoints, Shoto's English program does not accord to the definition of partial immersion in the context of the United States. We can explain Shoto is a school which emphasizes learning of English language with teaching subjects such as Music, Arts, and PE in both Japanese and English. The subject teachers of Japanese and Assistant Language Teachers team teach and try to improve knowledge of content subjects and proficiency of English. These characteristics might be easier to be explained as Soft CLIL.

2.3 Shoto Program As Soft CLIL

The definition of CLIL is as follows:

> "Content and Language Integrated Learning" (CLIL) is a dual-focused educational approach in which an additional language is used for the learning and teaching of both content and language. That is, in the teaching and learning process, there is a focus not only on content, and not only on language. Each is interwoven, even if the emphasis is greater on one or the other in a given time (Coyle et al., 2010, p.1) [10]

In CLIL there are many types of programs and modules depending on the situation, context, and aim.

> According to Ball (2008) there is a basic division of the CLIL approach into two camps: one in which the teaching and learning is focused primarily on language, and the other in which the teaching and learning is focused primarily on the subject content. The former is referred to as language-driven, and is called "Soft CLIL" or "Light CLIL". The latter is called content-driven, and is often called "Hard CLIL" or "Heavy CLIL". Ball explains that the content-driven approach means that the subject content is given primary focus and subject concepts and skills as its learning objective, whereas a language-driven approach has as its basic objective language learning [11].

As Shoto's subject teaching in English is a language-driven, we would define Shoto's subject teaching as Soft CLIL. It seems that Soft CLIL plays an important role in the language education of Shoto, we would investigate how students and teachers think about its implementation.

3. The Present Study

3.1 Research Questions

1）How do Japanese Junior High School students think about learning English and effect of learning subjects such as Music, Arts, and PE in English?

2）How do Subject Teachers of Japanese (STU) and Assistant Language Teachers of native speakers of English (ALT) think about students' perception?

3.2 Method

Participants

The participants were totally 174 students and 7 teachers at Shoto junior high school in Tokyo Metropolis. The number of students in each grade was as follows: Year 1: 57, Year 2: 56, and Year 3: 61. For the students it was the third to fifth year to study English in a formal education setting. For them to learn subjects such as Music, PE and Art in English was first to third year according to their grade.

Among the teachers of seven, there were three subject teachers of Japanese (hereafter JST) whose specialties were Music, PE and Art. All of them were supposed to team teach with assistant language teachers. The other four teachers were assistant language teachers (hereafter ALT) who were native speakers of English.

Their specialties were Music, PE and Art.

Instruments

The students were requested to respond to each statement in about 10 minutes. The questionnaire consisted of a question of preference of learning English in English class and learning subjects in English, and four questions of effect of Soft CLIL with a 5-point Likert scale, 5:Strongly agree, 4:Agree, 3:Neither agree nor disagree, 2:Disagree, and 1: Strongly disagree (Table 3).

Table 3: Questionnaire for students

Items		Questions
Preference of studying English in English class		I like studying English in English class very much.
Preference of studying subjects in English		I like studying subjects in English very much.
Effect of Soft-CLIL	English proficiency	Studying subjects in English improves my English proficiency very much.
	Understanding content	Studying subjects in English improves my understanding of the content very much.
	Thinking skills	Studying subjects in English improves my thinking skills very much.
	World	Studying subjects in English opens my door to the world.

The teachers were also asked to fill out a questionnaire of which were consisted of seven questions with a 5-point Likert scale. One was about students' preference of learning English in English class and learning subjects in English, five questions were about effect of Soft CLIL, one was about negative effect of Soft-CLIL and one was about the parents' preference toward Soft CLIL (Table 4).

Table 4: Questionnaire for teachers

Items		Questions
Preference of studying English in English class		Students like studying English in English class very much.
Preference of studying subjects in English		Students like studying subjects in English very much.
Effect of Soft-CLIL	English proficiency	Studying subjects in English improves students' English proficiency very much.
	Understanding content	Studying subjects in English improves student's English proficiency student's English proficiency understanding of the content very much.
	Thinking skills	Studying subjects in English improves student's thinking skills very much.
	World	Studying subjects in English opens my door to the world.
	Drop out	Studying subjects in English produce drop out.
General preference of parents toward Soft CLIL		Parents think their children like studying subjects in English very much.

4. Results

All answers to the questions of the students and teachers were calculated.

4.1 Students' Perception

4.1.1. Preference of Learning English in English Class and Learning Soft CLIL

The descriptive statistics for the students' preference of learning English in English class and Soft CLIL are presented in Table 5 and 6. Generally students like learning English / very much in English class ($n = 94$, 54.0%) and like learning in Soft CLIL / very much ($n = 98$, 56.3%). On the other hand, the number of students who don't like English / very much ($n = 24$, 13.8%) and Soft CLIL ($n = 28$, 16.1%) is few. Table 5 shows the difference of preference of learning English in English class among the students of Year 1, Year 2, and Year 3. The students of Year 2 show the most positive preference toward learning English in English class. 39 students (69.7%) like learning English in English class. On the other hand, the number of students in Year 2 who don't like English is only 4 (7.2%). Table 6 shows the preference of CLIL by the students of three grades.

Table 5: Students' preference of learning English in English class by year

Preference of Learning English in English Class	Year 1 (n=57)	Year 2 (n=56)	Year 3 (n=60)	Total (n=174)
5. Like English very much	12 (21.1%)	17 (30.4%)	14 (23.3%)	43 (24.7%)
4. Like English	12 (21.1%)	22 (39.3%)	17 (28.3 %)	51 (29.3%)
3. Undecided	19 (33.3%)	13 (23.2%)	23 (38.3%)	55 (31.6%)
2. Don't like English	12 (21.1%)	3 (5.4%)	5 (8.3%)	20 (11.5%%)
1. Don't like English very much	2 (3.5%)	1 (1.8%)	1 (1.7%)	4 (2.3%)

Table 6: Students' preference of learning Soft CLIL by year

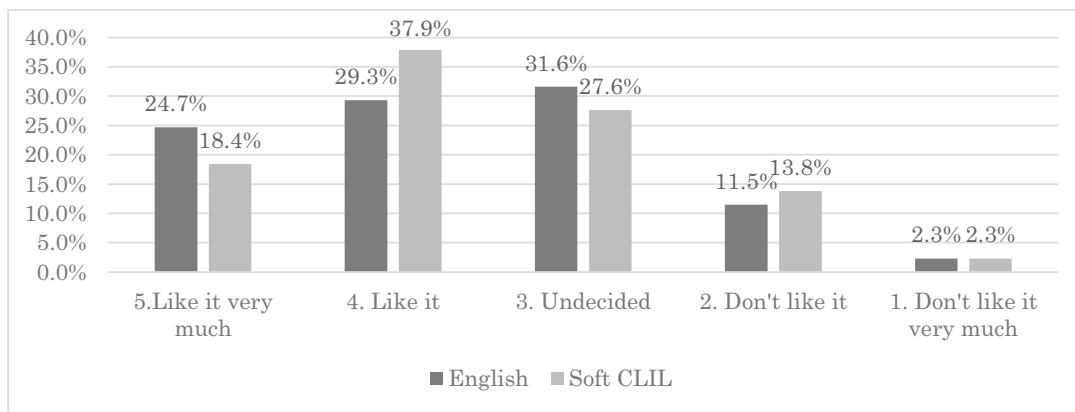| Preference of Learning in CLIL	Year 1 (n=57)	Year 2 (n=56)	Year 3 (n=60)	Total (n=174)
5. Like CLIL very much	9 (15.8%)	12 (21.4%)	11 (18.3%)	32 (18.4%)
4. Like CLIL	18 (31.6%)	24 (42.9%)	24 (37.9%)	66 (37.9%)
3. Undecided	15 (26.3%)	16 (28.6%)	17 (28.3%)	48 (27.6%)
2. Don't like CLIL	14 (24.6%)	3 (5.4%)	7 (11.7%)	24 (13.8%)
1. Don't like CLIL very much	1 (1.8%)	1 (1.8%)	2 (3.3%)	4 (2.3%)

Figure 1: Students' preference toward English and Soft CLIL

4.1.2 Students' Perception toward effect of Soft CLIL

Table 7 shows students' perception toward the effect of Soft CLIL. The students perceive effect of Soft CLIL positively in improving English proficiency (3.70), opening the door to the world (3.48), and improving thinking skills (3.33). When to see the number of students, 108 students (62.4%) think Soft CLIL improves English proficiency, whereas 22 students (12.7%) don't think Soft CLIL improves their proficiency of English. Moreover, 60 students (34.7%) don't think learning in Soft CLIL improves content knowledge whereas the 49 students (28.3%) think Soft CLIL improves content knowledge. It seems that they think Soft CLIL is an effective way to improve their English proficiency, though Soft CLIL might not enhance their understanding of content knowledge.

Table 7: Students' Perception toward effect of Soft CLIL

	Items	Average Points (SD)			
		Year 1 n=57	Year 2 n=56	Year 3 n=60	Average n=173
Effect of Soft CLIL	English proficiency	3.68 (0.98)	3.80 (0.97)	3.61 (1.09)	3.70 (1.01)
	Understanding content	2.77 (0.96)	3.13 (1.05)	2.97 (1.13)	2.95 (1.05)
	Thinking skills	3.27 (0.94)	3.57 (1.07)	3.16 (1.24)	3.33 (1.08)
	World	3.52 (1.12)	3.55 (0.88)	3.35 (1.07)	3.48 (1.02)

4.2 Teachers' Perception

4.2.1. Teacher's Perception toward students' preference and perception toward effect of Soft CLIL

7 teachers perceive that the students generally like learning English in English class (3.83) and Soft CLIL (3.71). The point of ALT is higher than JST both in preference of English and Soft CLIL (Figure 2). ALT seem to think that the students like learning English in English class and Soft CLIL more than JST.

Figure 2 also shows the teachers' perception of how students think about effect of Soft CLIL. ALT give higher points in improving English proficiency, content

and thinking skills than JST. ALT seem to think effect of Soft CLIL more positively than JST. The biggest difference between perception of ALT and JST is how they think about drop out in Soft CLIL. ALT do not think Soft CLIL produce drop out (1.25), whereas JST think Soft CLIL may produce drop out (3.67). Both ALT and JST think parents like Soft CLIL as their children's learning way of English.
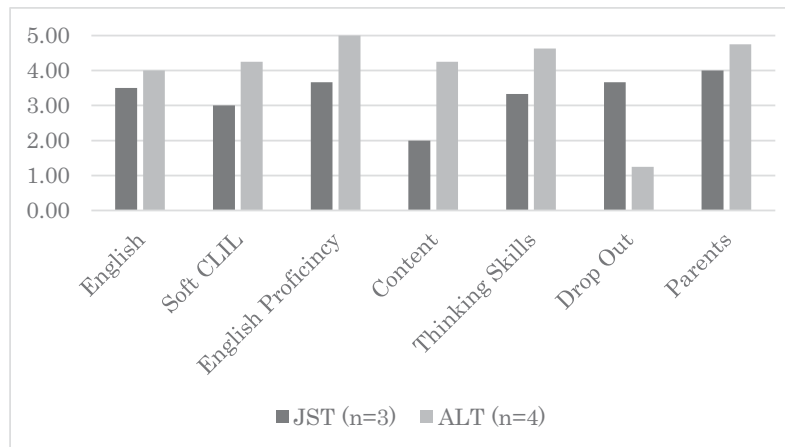

Figure 2: Teacher's perception toward students' preference and perception of Soft CLIL

4.2.2. Teacher's Description

According to the description of the teachers, both JST and ALT think that Soft CLIL is a good method to teach / learn English. Both of them point out that the students can learn and experience English in natural setting. They think the students can build vocabulary in subject context which they will not learn in English textbook. One of JST mentions that the students can listen to English that will make students feel easy to approach English and other foreign languages. One of ALT explains "Soft CLIL provides students with the advantage of learning another skill in both English and Japanese and they are unknowingly learning English without a strict translation focus".

JST and ALT also point out the disadvantages of Soft CLIL. Both JST and ALT worry about the understanding of content. However, between the viewpoint of JST and ALT, there is a difference. All of JST worry that they cannot follow Japanese "Courses of Study" which are determined by MEXT, Ministry of Education, Culture, Sports, Science and Technology. It means that JST think that Soft CLIL hinders the students' understanding of subjects which are on the "Courses of Study". They think it takes more time or twice as much to learn / teach in Soft CLIL. JST think to share the class time with ALT shortens their own time of teaching. Because of this, they are frustrated that they cannot teach what they want following "Courses of Study". On the other hand, ALT, who do not need to think about "Courses of Study" by MEXT, has narrower viewpoint. A music teacher of ALT says that when the students are not interested in the subject taught, they don't learn much. A PE teacher of ALT says "For PE it is sometimes difficult to explain precise body movements to children in a language that is not theirs. We deal with this by using gestures as we explain."

About a way of learning / teaching a foreign language, there is difference between JST and ALT. JST think to understand subject matters, the students need word by word translation. One of JST comments that the students cannot understand the subject matters without complete translation. On the other hand, one of ALT mentions that the good point of Soft CLIL is that the students do not depend on word by word translation to understand English.

Thirdly, JST comments on the minimum essential of English proficiency. One of the JST mentions that JST are required to have English proficiency when to teach in Soft CLIL. However, when they were hired as subject teachers, English proficiency was not essential skill. JST worry about their working requirement may change by implementing Soft CLIL.

5. Conclusion

In Shoto Junior High School, the number of students who don't like English is very few (13.9%). The survey of junior high school students' preference of English by MEXT indicates that 43.2% of the junior high school students say "I do not like English" [2]. The survey by Benesse (2014) shows that students start to dislike English between the latter part of Year 1 and Year 2. When to see Shoto students' preference of English and Soft CLIL (Table 5 & 6), Year 2 and Year 3 students do not dislike English. In Year 2, only 7.2% of the students show negative preference toward English and Soft CLIL. In Year 3, 10% of students show negative preference toward English and 15% of them show negative preference toward Soft CLIL.

There is a big difference between Shoto Junior High School and the Benesse's survey. Why don't the students of Shoto Junior High School dislike English? Three reasons can be possible.

First it might be a reason that the length of learning time. In ordinary junior high school, they learn English only in English class. That is 150 min per week and it is 10 % in total class length. At Shoto the students can be exposed to English is as long as 560 min (37.3%) at most. The length of exposure may make the students feel they are close to English or they like English.

Secondly in Soft CLIL classroom, language of English is used as vehicle. Learners learn English as vehicle which is some characteristics of CLIL. It means that learners can learn English with natural context such as subject content. The students at Shoto may learn English without being conscious of learning English.

Thirdly at Shoto the students have more chances to listen and talk with native sparkers of English teachers. The students are encouraged to communicate in English and are expected to talk with native teachers. This may enhance the necessity of learning English. As Benesse shows that students who have chances to speak in English are more motivated to learn English, Shoto's case may be this case.

Now in Japan Soft CLIL is getting popular as a method of teaching English. The present study reveals how students and teachers think about Soft CLIL. Both the majority of students and teachers think Soft CLIL improves proficiency of English but they do not think teaching / learning subjects in English improves content knowledge. The Japanese subject teachers are worried that they cannot cover "Course of Study" by MEXT in Soft CLIL. CLIL has an advantage to be a dual-focused educational approach, however we should know overlook the perception of students and teachers' anxiety of not understanding content.

6. References

[1] Benesse Educational Research and Development Center, "First Basic Survey of English at Junior High School, Survey of Studetns", (Daiikkai chugakko eigo ni kansuru kihon chosa, seito chosa), in Japanese, 2009 [http://berd.benesse.jp/up_images/research/data_00_(3)] (Retrieved on March 2, 2016)

[2] Yomiuri Press, "Survey of English proficiency test by MEXT", (Monkasho chosa eigoryokuchosa), In Japanese, Feb. 3, 2016

[3] Benesse Educational Research and Development Center, "Teenagers English Learning Survey 2014, (Sokuhoban, chukousei no eigo gakushu ni kansuru jittaihosa, 2014), in Japanese, 2014 [http://berd.benesse.jp/global/research/detail1.php?id=43 56] (Retrieved on March 2, 2016)

[4] Gardner, R. C., Tremblay, R F., & Masgoret, A. M. (1997) Towards a full model of second language learning: An empirical investigation. Modern Language Journal, 81, 344-362.

[5] Tremblay, P.F., & Gardner, R.C. (1995). Expanding the motivation construct in language Learning. Modern Language Journal, 79, pp. 505-518.

[6] Yamashiro, A.D., & McLaughlin, J. (2001). Relationships among attitudes, motivation, Anxiety, and English language proficiency in Japanese college students. In P. Robinson, M. Sawyer, & S. Ross (Eds.), Second language acquisition research in Japan, pp. 113-127., Tokyo: Japan Association for Language Teaching

[7] Arakawa, Y., "On English Immersion Programs in Japan", Tokyo University of Foreign Studies, Japanese Language Center for International Students, 30, pp.105-122,

2004

[8] Lenker, A., Rhodes, Intern & Rhodes, N. (2007). Foreign Language Immersion Programs:Features and Trends Over Thirty-Five Years, ACIE Newsletter The Bridge [http://carla.umn.edu/immersion/acie/vol10/BridgeFeb07 .pdf#search=%27definition+partial+immersion%27] (Retrieved Feb. 28, 2016)

[9] Lasagabaster, D. & Sierra, J. M. Immersion and CLIL in English: more differences than similarities, ELT journal Volume 64/4 October 2010, [https://www.researchgate.net/publication/228815979_I mmersion_and_CLIL_in_English_More_differences_tha n_similarities] (Retrieved on Feb.25, 2016)

[10] Coyle, D., Hood, P., & Marsh, D. (2010). Content and Language Integrated Learning, Cambridge: Cambridge University Press.

[11] Ball, P. (2008). How do you know if you' practising CLIL? [http://www.onestopenglish.com/clil/methodology/article s/article-how-do-you-know-if-youre-practising-clil/500614.article], (Retrieved Feb. 5, 2016)

Acknowledgements

Evaluating the Impact of an Interactive Classroom Application on Student Learning Outcomes

M. Beránek, G. Feuerlicht, V. Kovář, L. Petkovová, V. Vacek
Information Technology Department, Unicorn College, Prague, Czech Republic

Abstract – *Interactive learning environments are becoming an integral part of university education and there is increasing evidence that interactive learning has the potential to improve learning outcomes. Recently we have introduced the Nearpod interactive learning platform into several of our courses. While our experience with using an interactive learning platform is still relatively short, it is evident that interactive classroom environment can make the learning experience more rewarding for the students and at the same time lead to improved learning outcomes. Our results indicate that the effectiveness of using an interactive learning platform varies depending on the type of course and on depends on attendance pattern.*

Keywords: Interactive Learning, Interactive Classroom, Learning Outcomes, Nearpod

1   Introduction

The impact of Information technology (IT) on teaching and learning at all levels of the education systems has been profound. The emergence of Learning Management Systems (LMS), Course Management Systems (CMS), Interactive Whiteboards (e.g. SMART Board, e-Beam, Smart Pen) and mobile devices (e.g. iPads, etc.) have transformed the way we teach and learn [1, 2]. Using electronic media enables frequent updates of educational materials with new versions instantly available to students, making printed books effectively obsolete. Interactive delivery of rich multimedia course content that includes audio and video using e-learning platforms is becoming an integral part of university education [3, 4].

Numerous publications deal with problems related to quality of the educational process and new approaches that aim to improve the effectiveness of higher education [5, 6, 7, 8]. At the same time governments are continuously reforming higher education attempting to manage rising costs and improve the accessibility of university education to a wider range of the population. As the new generation of Internet savvy students enters the higher education system, they often find traditional methods of delivery of courses using lectures with a heavy assignment load difficult to adjust to, resulting in poor educational outcomes and high attrition rates. Furthermore, there is evidence that while students are spending increasing amounts of time online, they are devoting less time to university related activities.

A recently published survey of more than 1,200 students at technical universities followed over a period of ten years (2005 to 2015) indicates that the average time students spent online each day increased from 2 hours in 2005 to 5 hours in 2015, with a corresponding reduction of time spent on university related activities, from 7 hours to 4 hours per day [5] (table 1).

Table 1: Breakdown of student activities: 2005 and 2015

Activity	2005	2015
Sleep, rest, travel	9,5	9
Meals	2	2
Personal interests and sports	2,5	2
Part time jobs	1	2
Online: web, chats, etc.	2	5
University related activities	7	4

As illustrated in Figure 1, there was a steady increase in the time students spent online and a steady decrease in the time devoted to university related activities.
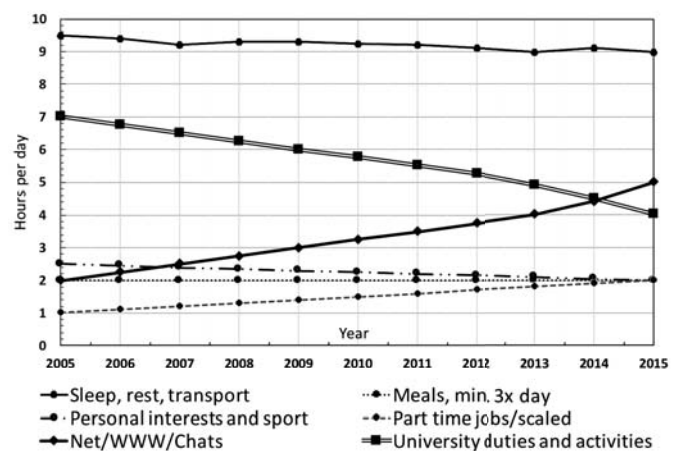

Figure 1: Change in students' daily activities over a 10-year period: 2005 to 2015

It can be argued that as more student activities take place online, university education must follow this trend to remain attractive and relevant.

Unicorn College (UC) is a leading private university based in Prague, Czech Republic that offers Information Technology (IT) and Business Administration courses to local and international students. Most of our students (60%) are employed in the IT industry and study part-time, and find balancing of university and work commitments challenging. Over the past two years we have been focusing our efforts on reducing failure rates, in particular during the first year of study. We have incorporated lecture podcasts, industry case studies, and interactive learning applications into our courses with the objective of increasing student engagement in the courses and improving our ability to identify potential situation that could lead to students dropping out of the course. We have been experimenting with using various types of learning platforms, including podcasts and interactive learning tools for several years in our college [5]. More recently we have been using the Nearpod learning platform to provide rapid feedback and the ability to evaluate students' understanding of the material that is being presented during lecture and tutorial sessions. We have reported preliminary results of our efforts to support student learning using Interactive Textbooks, Podcasts, and Nearpod in our courses [5]. We have modified our courses and our teaching methods to take better advantage of these modern technologies.

In this paper we report on the impact of implementing interactive classroom on learning outcomes, and on students' perception of the benefits of using an interactive learning platform. In the following section (section 2) we review related literature. In section 3 we discuss the implementation of an interactive classroom application in our college, and in section 4 we present the results of the student survey. In section 5 we present our conclusions.

2   Related Work

Improving learning outcomes using Information Technology to provide instant feedback and to facilitate more interactive learning environment has been an active area of research for more than a decade. In early work Anderson et al. [9] use a PC-based tablet system that facilitates active and collaborative learning in the classroom. The system was piloted in eight Computer Science courses at the University of Washington, and the authors report that the students have responded very positively to the system and that using the system increased student engagement. The inclusion of student artifacts improved the classroom discussion of possible solutions. Beuckman et al. [10] have developed and deployed a Web-based classroom interaction system in introductory physics lectures to facilitate real-time two-way student interaction with the instructor using PDAs (Personal Digital Assistants) and demonstrated learning gains. Blodgett [11] evaluated an interactive student response system implemented in a traditional college algebra class and used attitude surveys to show that the students thought that they were learning more, but that the empirical evidence on academic achievement did not support this opinion.

In a more recent work Jonsdottir and Stefansson [6] describe a system for web-assisted education that is used to deliver on-line drill questions suited to individual students. As system focuses on learning rather than evaluation, the students are allowed to continue requesting drill items until the system reports a grade that is satisfactory to the student. The authors provide experimental results to show that the students improve their knowledge while using the system. Jamwal [12] evaluated the impact of using interactive learning modules with classroom lectures compared to traditional methods of teaching and found that interactive learning modules were preferred by students over alternative methods of learning, and that students reported that quiz activities were helpful in learning the material and in correcting their mistakes. Baepler et al. [8] examined the effect of reducing the "seat time" of a large lecture chemistry class by two-thirds and conducting the class in an active learning classroom. The authors demonstrated experimentally that student-teacher contact could be reduced by two-thirds with students achieving learning outcomes comparable with the traditional classroom approach. Other researchers have used commercial platforms (Nearpod) to study the effect of interactive classroom applications on student learning outcomes [13, 14].

3   Introducing Interactive Classroom Applications in Unicorn College

In the Fall Semester 2015 we have conducted a pilot project using the Nearpod interactive classroom application (www.nearpod.com) for students in the first year courses: Business Economics (BE), Introduction to Accounting (IA) and Programming 1 (P1).

We have selected Nearpod for our teaching because of a number of features designed to support interactive sharing of content with student and effective control of the learning process including continuous feedback to students about their level of knowledge of the subject matter. Nearpod is a software tool which enhances student engagement with interactive content, enables the collection and sharing of student responses and tracking student understanding of the material in real time. During the session students can interact with the lecturer and submit responses through a range of mobile devices (e.g. iPads, iPhones, etc.) or using a computer. Lectures can create interactive presentations that contain different types of content including overhead slides, audio, video, and live Twitter streams. Learning activities include open-ended questions, polls and quizzes. Lectures can monitor and measure student responses on an individual or aggregate basis. Importantly, Nearpod enables import of teaching materials from existing PDF and PowerPoint slides avoiding the need to develop new teaching materials.

3.1   Using Nearpod in our Courses

Unicorn College has participated in the 1:1 iPad program [15] since 2012 ensuring that all students have iPads and can use Nearpod during lessons. During the pilot project Nearpod was used by a total of 168 students (72 part-time and 96 full-

time students). The average age of full-time students was 22.5 years and the average age of part-time students was 30.4 years.

We used different approaches for introducing Nearpod in different courses. In business courses (i.e. Business Economics and Introduction to Accounting) the lecturers used Nearpod at the beginning of the lecture to present lecture slides, and then at the end of the lecture for quizzes and open ended questions, and to provide feedback to students about their level of understanding of the presented material. Instant feedback and discussion of common mistakes motivated students to prepare for the lectures and to review previously learned topics. In the technical course (Programming 1), lecturers used Nearpod continuously during the lecture, running short quizzes and asking open-ended questions with the aim to maintain student engagement during the lecture and providing instant feedback. Students in the selected courses were divided into study groups and each group was given different quiz questions to avoid sharing the questions between groups.

3.2   Impact of Implementing Interactive Classroom on Learning Outcomes

Following the introduction of interactive learning using the Nearpod application into our courses in the Fall Semester 2015, we have investigated the impact of interactive learning by comparing the learning outcomes with results attained during previous periods (2012-2014) that did not involve interactive learning. We used two separate metrics:

i)   percentage of students who successfully completed the courses (Figure 2, 3 and 4) and

ii) distribution of grades attained by the students (Figure 5, 6, 7 and 8)
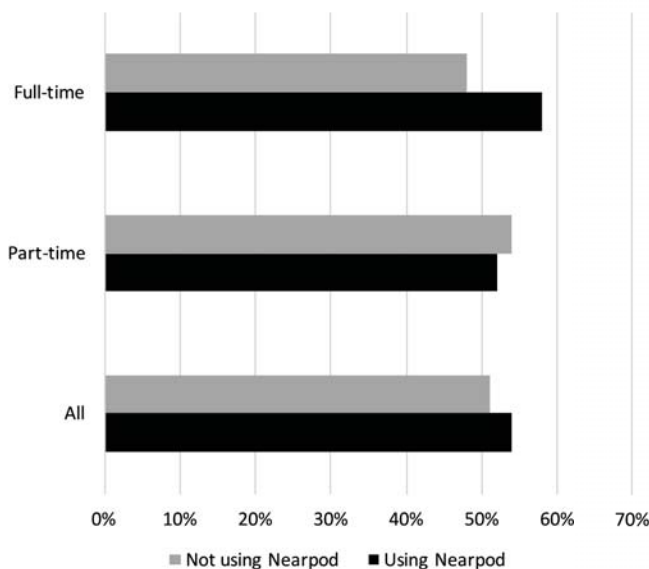
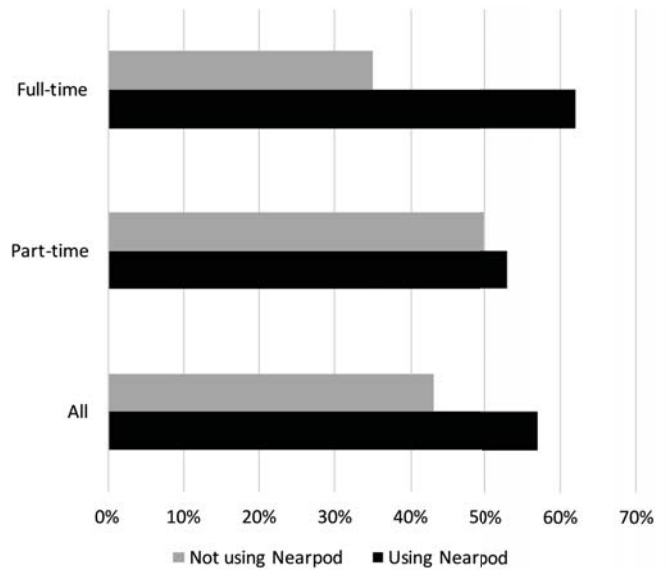Figure 2: Comparison of success rates for the BE course

Figure 3: Comparison of success rates for the IA course

Figure 2 shows relatively small increase in the successful completion rates for students in the Business Economics course, mainly for the full-time students.
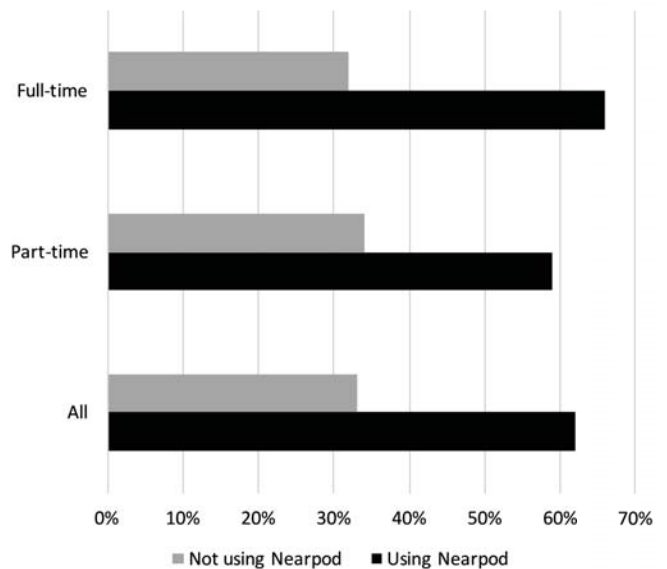
Figure 4: Comparison of success rates for the P1 course

More significant impact on successful completion rates is evident for the Introduction to Accounting course (Figure 3), and for the Programming 1 course (Figure 4). This can be to some extent explained by differences in the use of the Nearpod application in these courses as noted in section 3.1, and by related changes to teaching materials made in connection with the introduction of interactive learning.

As an alternative measure of the impact on student learning outcomes we have used the grades that students

obtained in the selected courses. Figure 5 shows a box plot illustrating a positive shift in student grades for aggregated results across all three courses (i.e. Business Economics, Introduction to Accounting and Programming 1).
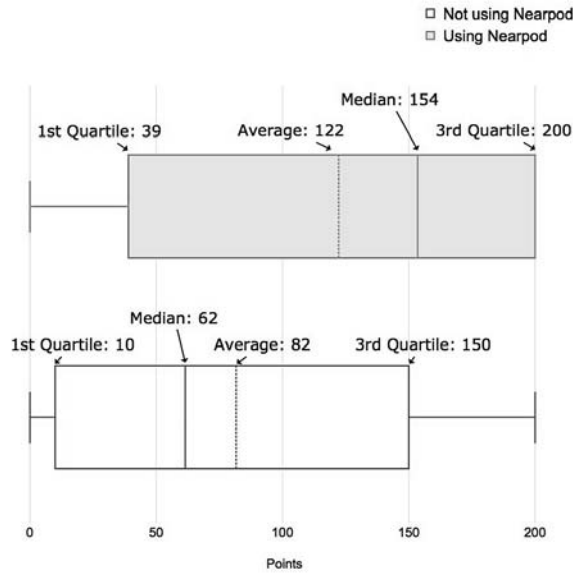

Figure 5: Comparison of the distribution of aggregated student grades

Table 2: Grading of results

Grade	Scores (%)
Excellent	88-100
Good	75-87
Pass	60-74
Failed	0-59

Figure 6 shows a more detail analysis of aggregated grades for all students in the three courses (we use the grading indicated in Table 2 to convert scores to grades). The use of interactive learning had a major impact on learning outcomes with the percentage of students who failed decreasing by 13% (from 56% to 43%) and the percentage of students who achieved the highest grade (excellent) increasing by 19% (from 7% to 26%). As illustrated in Figure 7 the reduction in the percentage of students who failed is most evident for full-time students where failures decreased by 23% (from 61% to 38%). For part-time students (Figure 8) the failure rate decreased by 6% (from 52% to 46%), and there was a significant increase in the percentage of students with excellent grades (from 8% to 29%). These results indicate that both full-time and part-time students have benefitted from the introduction of interactive learning using the Nearpod platform, with full-time students significantly reducing their failure rate, and part-time students reaching higher grades.
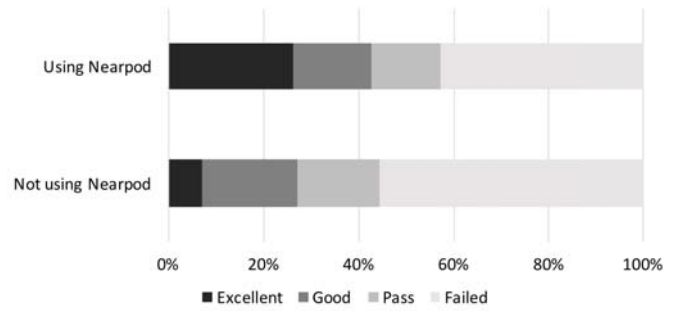

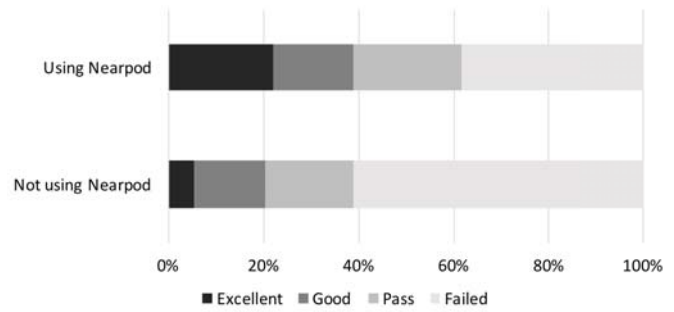Figure 6: Comparison of aggregated student grades for all students

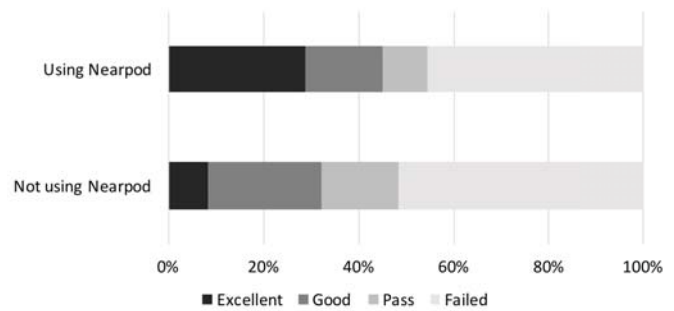Figure 7: Comparison of aggregated student grades for full-time students

Figure 8: Comparison of aggregated student grades for part-time students

4   Student Survey

In addition to objective measures of the impact of introducing the Nearpod interactive classroom application into our courses (i.e. success rates and grades) discussed in the previous section, we have evaluated the effect of interactive learning as perceived by the students using an online survey. The survey was implemented using Google Forms (apps.google.com) and included 23 questions divided into three parts. The first part included questions about the student (gender, age, educational background, field of study, and form of study). The second part included questions about the platform and devices that the students use to access the Internet (i.e. desktop computers, laptops, tablets, and smartphones), and the third part included questions about their experiences with using the Nearpod application.

We have received 57 responses (61% from part-time students and 39% from full-time students) with 71% of the students enrolled in all three courses (i.e. Business Economics, Introduction to Accounting and Programming 1). A majority of the survey participants were male (86%), and the median age of the students was 21 and 29 years for full-time and part-time students, respectively. The average amount of time the students spent online each day was 6 hours for full-time students and 5 hours for part-time students. As illustrated in Figure 9 full-time students made more extensive use of mobile devices (i.e. tablets); this could be the result of full-time students being younger and more ready to use mobile devices [16].
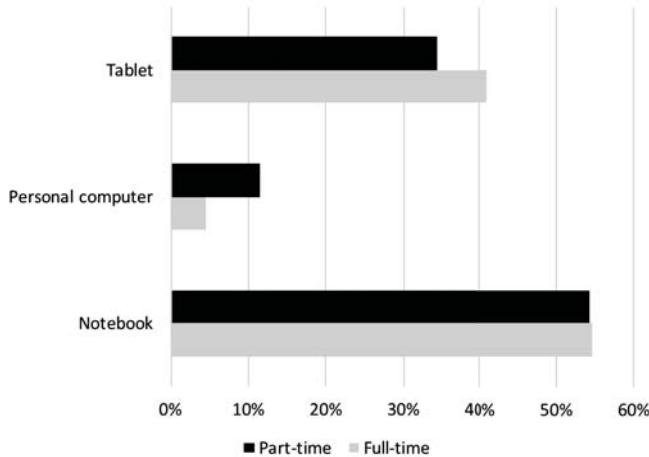

Figure 9: Platforms used by students to study

Majority of full-time students (86%) and part-time students (94%) reported that using Nearpod resulted in a more enjoyable learning experience (Figure 10).

The instant feedback provided by the Nearpod application was rated positively by 90% of the students, 84% of the students found that the use of Nearpod helped them to remain active participants in the class, and 77% of the students felt that the use of Nearpod helped to identify problem areas that required additional study.
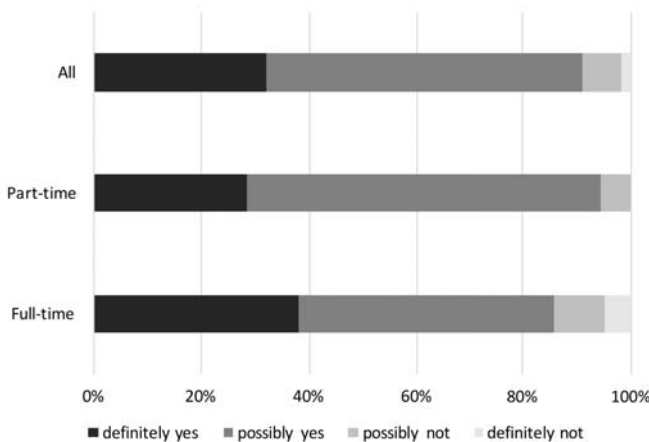

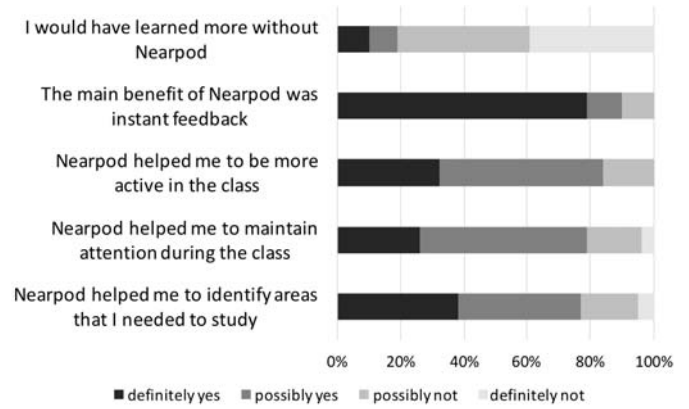Figure 10: Nearpod helped me to enjoy the course

Figure 11: Students responses to survey questions.

Figure 12 shows the responses to a question regarding the effectiveness of the feedback provided by the lecturer using Nearpod, with 88% of students agreeing that the lecturers used Nearpod effectively for providing feedback. Only 9% of full-time students and 14% of part-time disagreed with this assertion.
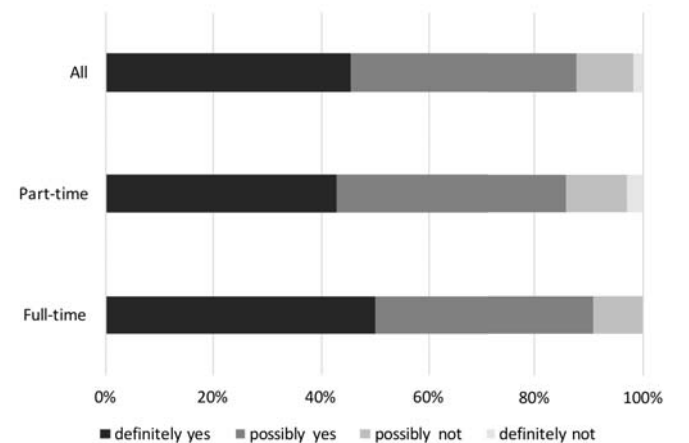
Figure 12: Lecturer gave feedback effectively by Nearpod

5   Conclusions

While our experience with using an interactive learning platform is still relatively short, it is evident that interactive classroom environment can make the learning experience more rewarding for the students and at the same time lead to improved learning outcomes. Our results indicate that the effectiveness of using an interactive learning platform varies depending on the type of course and on the attendance pattern (i.e. full-time vs. part-time). We have found that the use of Nearpod platform has resulted in significantly improved learning outcomes in the programming course (Programming 1) and in the Introduction to Accounting course, but only minor improvements in the Business Economics course. This could be, at least partially, explained by differences in the style of use of the Nearpod platform in different courses. A more extensive study is needed to establish how interactive learning can be introduced into different types of courses to achieve

the greatest impact. We have also found that full-time students tend to benefit from interactive learning, with significantly reduced failure rates (of more than 20%). Part-time students are typically more experienced, more motivated and have better ability to time-manage their university activities, so that the impact of interactive learning is limited when compared with full-time students that benefit from a more structured learning environment.

On the negative side, there is some evidence that better attendance of classes resulted from the improved ability of lecturers to monitor student participation; 59% of students reported that they used the Nearpod application mainly to receive attendance credits. Additionally, a small fraction of the survey respondents felt that they would have learned more without the Nearpod application.

Our plan is to expand the use of Nearpod interactive learning across other courses in our college and at the same time evaluate the effectiveness of interactive learning in individual courses.

6   References

[1]   M. U. Bokhari, S. Ahmad, S. Alam, F. Masoodi, "Modern tools and technologies for interactive learning", Proceedings of the 5th National Conference, INDIACom-2011, Bharati Vidyapeeth's Institute of Computer Applications and Management, New Delhi, pp. 1-4, Mar 2011.

[2]   Apple, "iPad in education". [Online]. Available: https://www.apple.com/education/ipad/in-the-classroom/

[3]   A. R. Khan, A. Ahmed, S. Ahmed. "Collaborative web based cloud services for e-learning and educational ERP", Proceedings of 2014 RAECS UIET, Panjab University Chandigarh, pp. 1-4, Mar 2014.

[4]   M. Beránek, "Disertation thesis Prospects of education process virtualization at an IT university", University of Hradec Králove, 2011.

[5]   M. Beránek, P. Bory, V. Vacek, "Platform for Supporting Student Learning at Unicorn College", International *Journal of Education and Learning Systems*, vol. 1, pp. 61-67, 2016.

[6]   A. H. Jonsdottir, G. Stefansson, "From evaluation to learning: Some aspects of designing a cyber-university", *Computers & Education*, vol. 78, pp. 344-351, 2014.

[7]   K. Weinerth, V. Koenig, M. Brunner, R. Martin, "Concept maps: A useful and usable tool for computer-based knowledge assessment? A literature review with a focus on usability", *Computers & Education*, vol. 78, pp. 201-209, 2014.

[8]   P. Baepler, J. D. Walker, M. Driessen, "Blending, flipping, and efficiency in active learning classrooms", *Computers & Education*, vol. 78, pp. 227-236, 2014.

[9]   R. Anderson, et al. "Classroom Presenter: a classroom interaction system for active and collaborative learning." *The Impact of Tablet PCs and Pen-based Technology on Education* (2006).

[10] J. Beuckman, N. S. Rebello, and D. Zollman, "Impact of a classroom interaction system on student learning." *2006 Physics Education Research Conference*. Vol. 883. 2007.

[11] D. L. Blodgett, *The effects of implementing an interactive student response system in a college algebra classroom.* Diss. The University of Maine, 2006.

[12] G. Jamwal, "Effective use of Interactive Learning Modules in Classroom Study for Computer Science Education." (2012).

[13] L.-W. Peng and L. Cheun-Yeong, "Maximizing Online Engagement and Learning through Nearpod and Skype." *Society for Information Technology & Teacher Education International Conference*. Vol. 2013. No. 1. 2013.

[14] S. Delacruz, "Using Nearpod in elementary guided reading groups."*TechTrends* 58.5 (2014): 62-69.

[15] St. Matthew's Parish School, "Teaching in a 1:1 Environment". [Online]. Available: http://www.ipadbootcampforteachers.com/11-teaching.html

[16] E. Rosenfeld, D. V. Loertsher, "*Toward a 21st-Century School Library Media Program.*" Scarecrow Press, 2007.

Can You Read What I'm Saying?

Closed Captions added to Molly Open Source Online Lecture System

Ronald P. Vullo, Ph.D., Gaurav Kumar, M.S.I.S.T., Catherine I. (Irving) Beaton, M.I.T.E. and Natallia Ivaniuk, M.S.I.T.
Department of Information Sciences and Technologies
Golisano College of Computing and Information Sciences
Rochester Institute of Technology
Rochester, New York 14623

Abstract - *In offering online educational video lectures it is essential to provide captions for accessibility by Deaf/Hard of Hearing students. The Rochester Institute of Technology (RIT), being unique as the home of the National Technical Institute for the Deaf (NTID), has a significant percentage of Deaf/Hard of Hearing students and faculty. As such, we understand the need to support this population in everything we do. The tools described here, a recent addition to the Molly Online Lecture system, makes the addition of such captions an easy, WYSIWYG experience for video lecture authors. The system is entirely web-based and uses the W3C standard for closed captions via the HTML5 video tag.*

Keywords: Online Lecture, Online Learning, Closed Captions, Accessibility, Molly, Distance Learning

1   Introduction

The Rochester Institute of Technology (RIT) is unique in many ways, among them being the home of the National Technical Institute for the Deaf (NTID). Because RIT is the home of NTID we have a significantly higher percentage of Deaf and hard of hearing students and faculty than most other universities. As such, we need to address the needs of this population in everything we do. All videos used in teaching at RIT are required to be captioned. In the past, videos used in the Molly Online Lecture System (aka 'MollyPoint') have been open captioned, with the captions embedded directly in the video. There are several issues with this approach, including the difficulty of the captioning process for faculty, the inability of hearing students to turn the captions off, and the need to recreate the videos to correct even minor errors in the captions.

With the introduction of the W3C standard for closed captions and its adoption by the major browser manufacturers, it was decided to add dynamically generated closed captions and an authoring tool for those captions to the Molly online lecture system.

The MollyPoint system has two key components: a presentation interface and an authoring/management interface. The presentation interface is designed for the viewing audience (students), while the authoring/management interface is for faculty to create their lecture slides and captions.

2   System Overview

The Molly online lecture system's design attempts to capture and simulate to a certain extent an in-class environment with face-to-face communication. Professors record video lectures and combine them in MollyPoint with slides that are linked to their time-coded place in the lecture. Slides are created by the faculty in a WYSIWYG editing environment with access to the underlying HTML code. Slide order can be easily changed via drag and drop of slide thumbnails. When a video is uploaded for the lecture, a timeline is automatically created and the author can play the video and drag the slides to the appropriate spot marked by a play-head icon on the timeline as the video plays.

In the presentation mode, the student plays the video and the appropriate slides are displayed as the lecture progresses. Additionally, the presentation is interactive. A menu of all of the slides in the lecture are listed below the video, with the current slide highlighted. If the student clicks on any of the slides, that slide is displayed and the video queues up or continues playing (depending on whether it was paused or playing at the time) from that point in the lecture. Likewise, the video has a normal progress slider and moving that slider to change the video's play position automatically displays the appropriate slide.
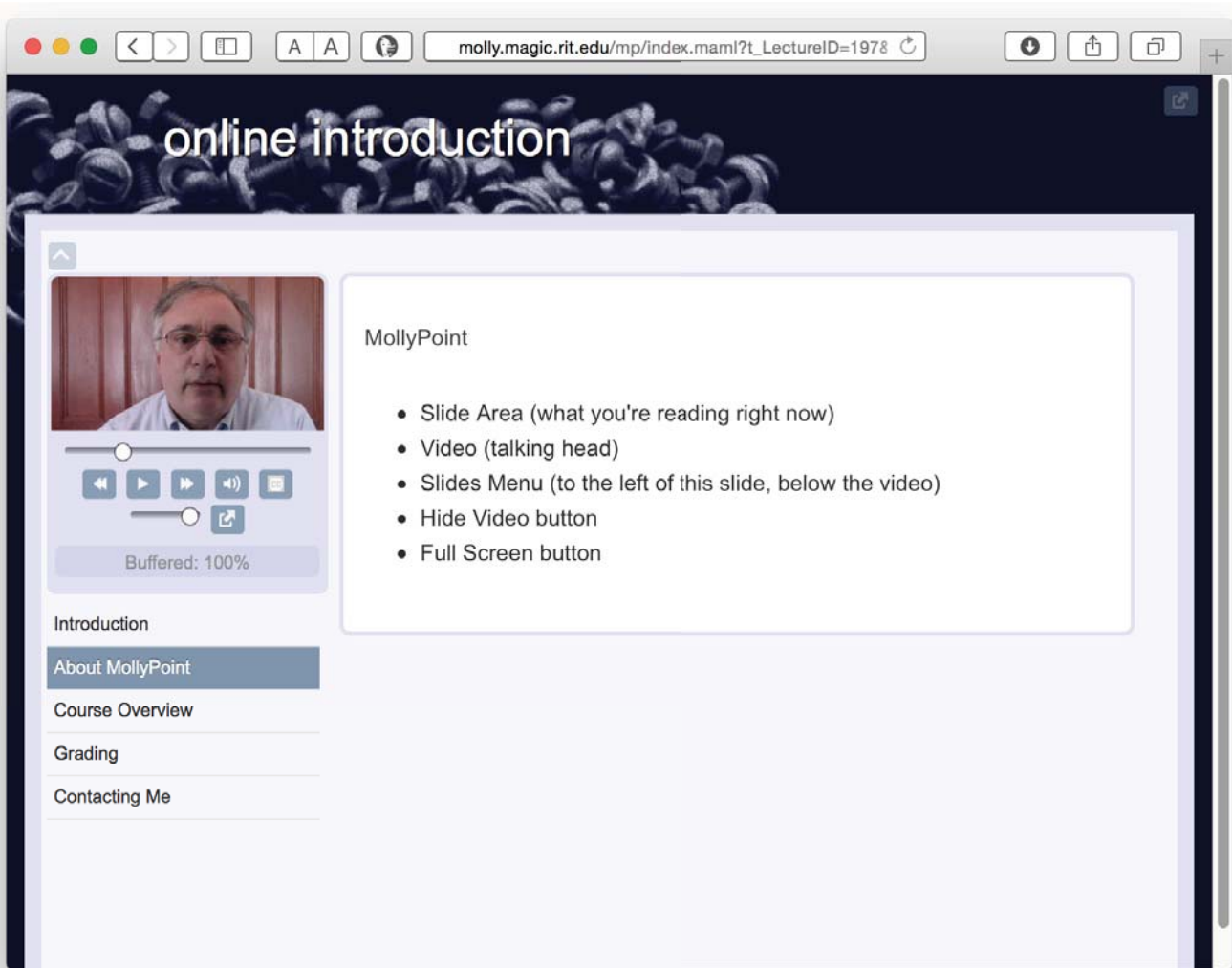
3   Application Architecture

The system was developed using a basic three-tier architecture, providing benefits such as reusability, flexibility, maintainability, and scalability.

3.1   Presentation Layer

The Graphical User Interface uses current web client-side technology: HTML5, CSS3, JavaScript and AJAX. The system is designed to be compatible with the most common current browsers: Chrome, Safari, Firefox, IE, and Edge.

3.2   Business Server Layer

This layer encapsulates the main business rules and services. This layer enforces required parameter validation, data dependencies and data integrity. The service layer was built with the Molly middleware system (molly.rit.edu) using Molly Active Markup Language (MAML). Molly is built in the PHP server-side scripting language.

3.3   Data Layer

The data layer resides in the MySQL database management system, however Molly uses a database abstraction layer allowing other databases such as Oracle and PostgreSQL to be used if desired. Molly's user login management system (used for authoring permission control) can use a built-in user database, be tied into an existing user database, or as it is currently configured at RIT using the institute's Active Directory (LDAP) system.
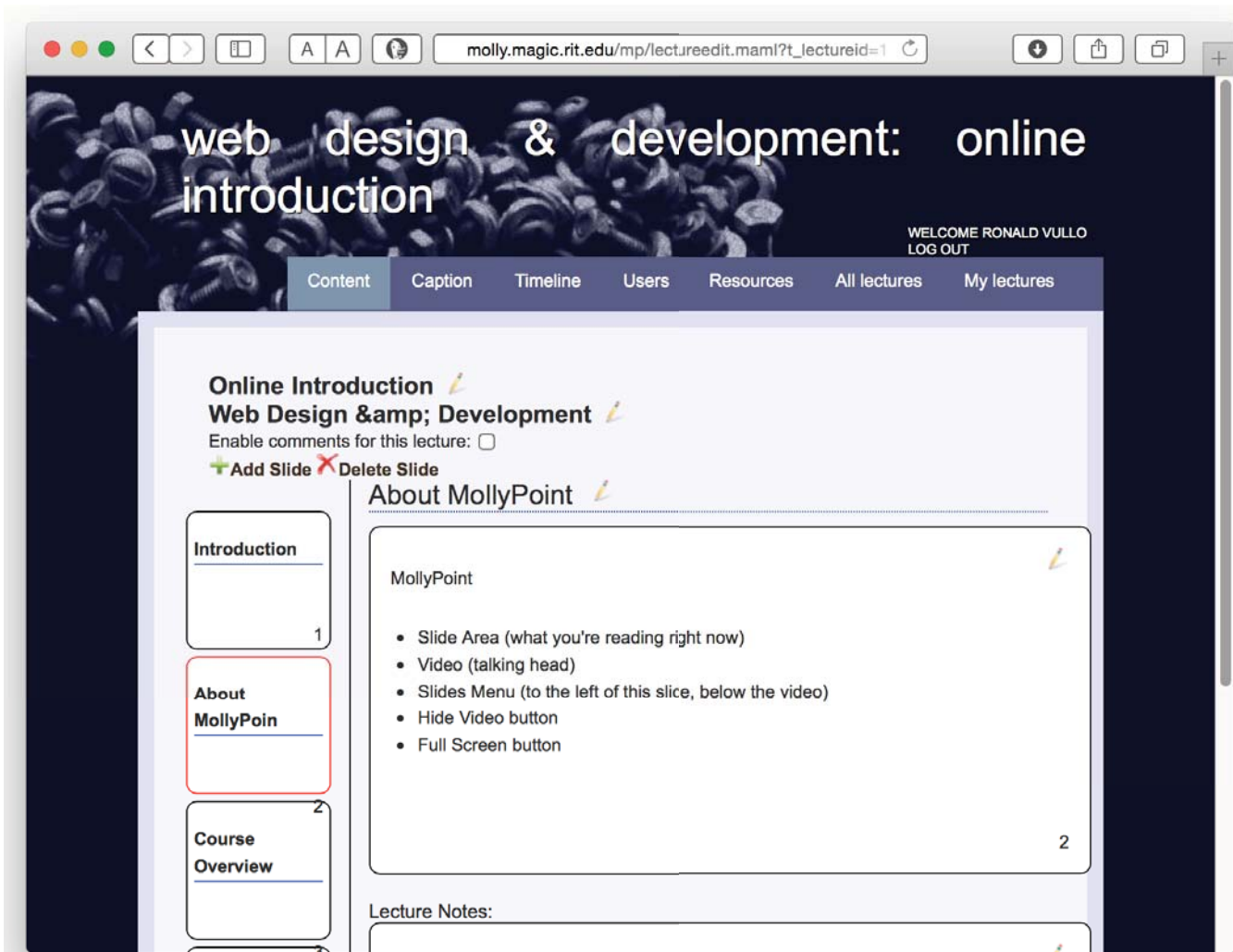
4 Technologies and Tools

4.1 HTML5

HTML5 is a new version of HyperText Markup Language (HTML) that has rapidly penetrated the Web market.

First presented in 2004 by the Web Hypertext Application Technology Working Group, the first working draft of the specification was published in 2008. Since then, many browsers have started incorporating HTML5 features. HTML5 was the driving reason for the redesign of the MollyPoint system because it provides APIs for embedding and controlling audio and video content.

4.2 CSS

Cascading Style Sheets (CSS) are a set of rules that define how HTML elements are displayed and positioned on a web page. CSS styles can be defined in-line with HTML elements or imported from a separate style sheet. We used separate additional CSS files for this system, in addition to Molly's built in dynamically generated CSS, to simplify changing and configuring layout and styles of the page. The current version of CSS, CSS3, offers very powerful features to give web developers more sophisticated control over the interface, including rounded corners, multi-column layouts, styling of videos, etc. CSS also permitted us to have slides formatted for printing automatically.

Cross-browser incompatibility in supporting different CSS styles, which leads to display differences, was a challenge for our design and implementation. In some cases, different attributes were used to support different browsers.

4.3   JavaScript

JavaScript is a lightweight, client-side scripting language. It is incorporated into web browsers in order to provide enhanced user interfaces and dynamic web pages. JavaScript uses objects and classes to allow dynamic manipulation of a web page's HTML and CSS via the Document Object Model (DOM). It also allows web developers to respond to user events such as mouse clicks, form input and page navigation.

4.4   AJAX

The acronym AJAX stands for Asynchronous JavaScript and XML, though its definition has broadened over the years to incorporate technologies such as JSON, etc. It represents a set of techniques and an API used to create dynamic web pages by enabling asynchronous communication between the client and server. Using AJAX, the client makes asynchronous calls to the server to send and/or retrieve data without refreshing the whole web page. It can often significantly reduces the users' wait time and allow for a richer range of possibilities for user interactions.

4.5   PHP

PHP (PHP Hypertext Preprocessor) is an open source server-side scripting language used to develop rich web applications. PHP code can be embedded directly into the HTML page. It runs on every common web server platform, including Linux, Windows and Mac OS. Usually PHP is deployed as an Apache module (written in C, so it executes quickly) and makes efficient use of system resources. PHP provides a rich set of libraries and APIs for graphics, database management, XML support, and much more. Because PHP is open source software, there are many sample solutions and considerable documentation available online. Its community provides reliable and quick support.

4.6   MAML

MAML (Molly Active Markup Language) is an XML markup language, developed by students of the Rochester Institute of Technology under the lead and guidance of Professor Vullo. The idea behind MAML is to create a generic library of controls to help abstract complex server-side logic, including database access, so that developers can deploy sophisticated web applications using HTML-like markup in lieu of writing PHP (or other programming language) code.

Molly's XML tags are incorporated into HTML markup, then upon page load, the Molly system parses the included tags and replaces them with the results of functionality written in PHP and SQL.

4.7   JQuery Library

JQuery is an open source JavaScript library developed by John Resig (a former student of Dr. Vullo's) that provides simpler interaction between HTML and JavaScript by abstracting existing DOM APIs and providing cross-browser commonality. JQuery was first released at the beginning of 2006. Today, the leading web development companies, such as Google, Amazon, IBM, and Microsoft, are all using JQuery for developing web applications. According toBuildWith.com, more than 50% of the top web sites are using jQuery libraries. JQuery has a rich library of methods for AJAX development, which were used in developing our system. This library significantly simplified drag and drop functionality for slide reordering. JQuery is available in a minimized version that helps reduce its impact on the pages' load times.

4.8   KineticJS Library

KineticJS is used for slide and video synchronization. KineticJS is a relatively new HTML5 library. It has good documentation and support, quickly gained popularity with the development community. The library is less than 70kb.

4.9   TinyMCE Library

TinyMCE is an open source JavaScript/HTML editor. It provides ability to convert HTML elements including text areas to editor instances. This editor offers a set of built in core HTML formatting tools, such as different font styles and decorations, formatted ordered and unordered lists, style alignments, etc. TinyMCE is integrated into Molly and so was a natural choice for providing authors WYSIWYG slide editing.

5   Caption Authoring System

Once a lecture video has been uploaded for a set of slides, two tabs are added to the authoring/management interface while editing that lecture: Caption and Timeline.

5.1   Caption Tab

Once the Caption tab is displayed for the lecture it can be clicked to access the page which allows the user to: Add captions, delete captions, or reorder captions.

The captions for the video can be added in two ways: one caption at a time, or the entire video's captions (i.e. if a script is available) at once. When adding the entire caption content at once, the author can specify an appropriate delimiter option for dividing the text into the individual captions that will display on the screen as the video plays. There are three delimiter options available to the author: CRLF, Custom caption length (i.e. 50 characters), or Custom Delimiter. When adding captions in bulk like this, the system prompts the author asking whether to overwrite or to append the captions being uploaded to the existing captions. Initially, to start with the time intervals for captions are automatically assigned based on their count and distributed over the length of the video.

5.2   Timeline Tab

The timeline tool allows the author to position both the lecture's slides and the captions along a timeline of the video.

There are two sub-tabs to this tool, Slide Timeline and Caption Timeline, which work in the same way for their respective content. As the video, displayed above the timeline, plays (or is adjusted manually) an indicator moves along the timeline to mark the current position within the video. When the video reaches the appropriate place in the lecture the author can pause the video and move the appropriate slide or caption thumbnail to the position indicated on the timeline. Each line of the captions has a record in the database which is automatically updated by this procedure via AJAX with the correct start and end time code. When the lecture is viewed by the student, the system dynamically generates a .vtt caption file per the W3C specifications for captioning via the HTML5 video tag. These captions can then be turned on or off by the student as they wish.

6   About the Authors

Dr. Vullo is Associate Professor, Department of Information Sciences and Technologies, creator and director of the Minor in Web Design and Development for non-computing Majors, and MAGIC Center faculty affiliate. Dr. Vullo is currently in the process of putting his minor online using the system described in this paper.

Gaurav Kumar and Natallia Ivaniuk are graduates of the master's degree program of the Department of Information Sciences and Technologies.

Ms. Beaton is Associate Professor, Department of Information Sciences and Technologies.

7 References

B. Means, Y. Toyama, R. Mupphy, M. Bakia, K. Jones "Evaluation of Evidence-Based Practices in Online Learning: A Meta Analysis and Review of Online Learning Studies".

Ed.gov. US. Department of Education. 2010. Web. 1 Sep 2012. http://www2.ed.gov/rschstat/eval/tech/evidencebased-practices/finalreport.pdf

http://www.w3schools.com/html/html5_video.asp

Vullo, Ronald P., Ph.D.; Molly: Simplifying Development of Complex Web Apps, invited presentation to the Rochester Joint Chapters of the IEEE Computer and Computational Intelligence Society, Rochester, New York (June, 2012)

Vullo, Ronald P., Ph.D., Sean Boyle, M.S.I.T.; Building Interactive Online Lectures with the Open Source Molly System. Polytechnic Summit 2014, Boston, MA (June, 2014).

Vullo, Ronald P., Ph.D., Natallia Ivaniuk, M.S.I.T., and Sean Boyle, M.S.I.T.; Molly Open Source Online Lecture System. EEE'13 - The 2013 International Conference on e-Learning, e-Business, Enterprise Information Systems, and e-Government, Las Vegas, NV (July, 2013).

Vullo, Ronald P., Ph.D., Bogaard, Daniel S.; Better than HTML Web: XML for Program-ming-Free Dynamically Generated Web sites, WWW@10 (2004)

Vullo, Ronald P., Ph.D., Christopher A. Egert, Ph.D., Daniel S. Bogaard; Molly: Bringing Back Simplicity to Web Site Development and Web Research. White Paper, 2006

Vullo, R.P., et al. (October, 2000). Telemedicine initiatives in International Outreach at St. Jude Children's Research Hospital. Presentation at the American and European Associations for Cancer Education Joint Meeting.

Supporting Hands-on Networking Lab Exercise for On-Line Students

James T. Yu

DePaul University

Chicago, Illinois USA

jyu@cdm.depaul.edu

Abstract - This paper presents an integrated lab environment to support networking education for on-line students. Hands-on lab exercises are essential for networking education. Through hands-on lab exercises, students could see network in action and observe it dynamic behavior from which students gain deeper understanding of network theories. In the past, students need to be *physically* at a network lab and put *hands* on devices to do lab work. Recently, there is a growing demand to support *on-line* students to conduct hands-on exercises. This paper presents three different approaches, physical labs, emulation, and simulation, to address the needs of support hands-on lab exercises for on-line students, along with their pros and cons. Each approach plays an important role in our networking curriculum.

KEY WORDS: Remote Labs, On-Line Learning, Networking Education, Emulation, Simulation.

1. Introduction

The growing demand of On-line Learning (OL) is evident in today's higher education as many students are pursuing undergraduate and graduate degrees while they cannot be physically at the campus due to various reasons. There are many challenges to support an On-Line environment for distance learning, such as group projects and discussion forum between faculty and students. There are also many publications to address some of those issues [1]. The provision of a networking lab for hands-on exercises was recognized as an integral part of networking curriculum in the early days of computing networks [2]. Over the years, the advancement of networking technology requires continual enhancement and improvement of the lab environment to support OL learning in network curriculum [3][4][5].

A classical perspective on network is to divide it into *telecommunications* network and *data* network, but there is no longer a clear distinction between one and the other. We may consider telecommunications standards are mostly from International Telecommunication Union (ITU-T) and data networking standards are mostly IP-based and are from Internet Engineering Task Force (IETF) and IEEE. In this paper, networks include both telecommunication networks and data networks.

In general, *hands-on* exercises require students to be physically at networking labs and put their *hands on* network devices for provisioning, configuration and trouble shooting. However, OL students cannot be physically at the campus, and it becomes a challenge to offer them hands-on exercises.

2. Objectives of Networking Education

The networking curriculum teaches students to understand the complexity of today's networks, and to build their expertise to design and manage these networks. From the theoretical perspective, students need to understand and appreciate communication protocols. From the practicum perspective, students need to design and manage the networks. Combining both, students need to predict (or estimate), measure, and evaluate network performance. These three learning objectives are further expanded in the following subsections.

2.1 Protocol Analysis

Standards are the foundation of computer networks, and the Open System Interconnect (OSI) 7-layer model is usually introduced in the introductory networking course. Network protocol are specified in the standard documents and are mostly from ITU-T, IETF, and IEEE. Protocols define the *rules* of communication, and the rules are about the the *syntax* and *semantics* of data being communicated. In addition to reading textbooks about protocol specifications, students would appreciate the purposes and functions of a protocol by *observing* the traffic. Therefore, hands-on exercises are important for students to *generate* and *capture* the traffic of the protocol under study. The availability of wireshark (www.wireshark.org) is a blessing for network education because it is not only a traffic capturing tool but also a protocol analyzer. The challenge, however, is to generate the traffic to be captured by wireshark.

2.2 Network Design and Configuration.

Network Design includes the physical design and logical design. The physical design includes (a) selection of network devices, and (b) physical connection between network devices. The logical design includes (a) logical connection between devices, (b) Virtual LAN (VLAN), (c) IP subnets, (d) static IP address

assignments, (e) dynamic IP address schemes, and (f) communication protocols between devices. Students are sometimes not sure about the distinction between a *physical* network diagram where all connections are physical cables versus a *logical* network diagram where a logical link could be a layer-2 or layer-3 connection.

2.3 Performance Analysis

As any *engineering* discipline, the use of data (i.e., numbers in the context of networking) is essential in network application. Students are required to use *numbers* to size the network, and to describe the quality, performance, and limitations of the network under construction.

Before building the networking, students are required to estimate the network performance. After building the network, students are required to measure the network performance and to compare with its original estimates. In many cases, the measured performance does not conform to the original estimate. As a result, students need to determine the cause of difference (i.e., causes of variations). Students may need to reevaluate their understanding of the theory (i.e., protocols), to redo the lab work and verify the device configuration, to study the results which may be due to random variation (also known as measurement errors), or any combination of the above.

In our networking curriculum we follow the RFC2544 recommendations for the following four measurements:

1. *Delay and Round Trip Time (RTT).* In practice, it is extremely difficult to measure one-way delay as it requires perfect clock synchronization, so we can measure RTT only. Fortunately, almost all our network design is symmetric, and we teach students to avoid congestion when doing RTT measurement. With that, one-way delay is half of RTT.

2. *Throughput.* The measurement includes both bit throughput (bps) and packet throughput (pps). One challenge of the throughput measurement is the implementation of *flow control*. This is not an issue for TCP as the protocol supports flow control. However, students are not sure how to measure the UDP or ICMP throughput unless there is a clear lab instruction for doing it.

3. *Jitter.* It measures the variation of the delay, and this measurement is important for delay sensitive application, such as VoIP and media streaming services. It should be noted that the definition and measurement of jitter is different between optical transmission, Optical Carrier (OC-x), and packet transmission which is defined in the Real Time Protocol (RTP), RFC-3550.

4. *Packet loss.* In a physical lab environment, the bit error rate (BER) is extremely low, usually less than 10^{-9}. In a simulation or emulation environment, BER is zero. Therefore, it is unlikely to observe packet loss in *normal* cases. In order to observe packet loss, students need to create scenario of packet loss. Students are usually surprised to learn that UDP is extremely reliable when there is no network congestion. On the other hand, TCP is not very reliable when the network is congested, and established connection is lost due to timeout. Also, it is challenging for students to create different scenarios of network congestion, measure packet loss, and observe the traffic behavior under these scenarios.

In summary, hands-on exercises are essential for students to study the protocols, design and manage the network, and measure the network performance to understand its dynamic behavior. Without hands-on lab exercises, student learning would be constrained to abstract concepts with limited practical application.

3. Physical Labs with On-line Capability

The physical lab is the ideal environment for hands-on lab exercises because students are working on real network devices [5]. The major disadvantage is the cost of building the physical labs. A challenge of the physical lab is the technical support for on-line (OL) students who cannot remotely put their hands on network devices. This section presents our experience of building the physical lab with remote access capability for OL students.

3.1 Lab Environment

Our network lab environment has several network pods, and each pod has a standard physical configuration. The physical design of each pod is illustrated in Figure 1 and the physical connection of each pod is illustrated in Figure 2. There are more than 20 pods in the physical lab, and eight of them are designated for OL students. We also reserved several pods for testing and backup. The pods for OL students are referenced as DLPOD[1], and they have fixed physical connections and their access is strictly under the control of the DLPOD scheduling program. Non-DLPODs are available to students who come to the lab on the first-come-first-serve basis.

---

[1] The on-line program was originally designed to support distance learning (DL). However, many local students are taking on-line courses so the name was changed to OL. For the lab, we still call it DLPOD to distinguish it from POD used *locally* at the networking lab.
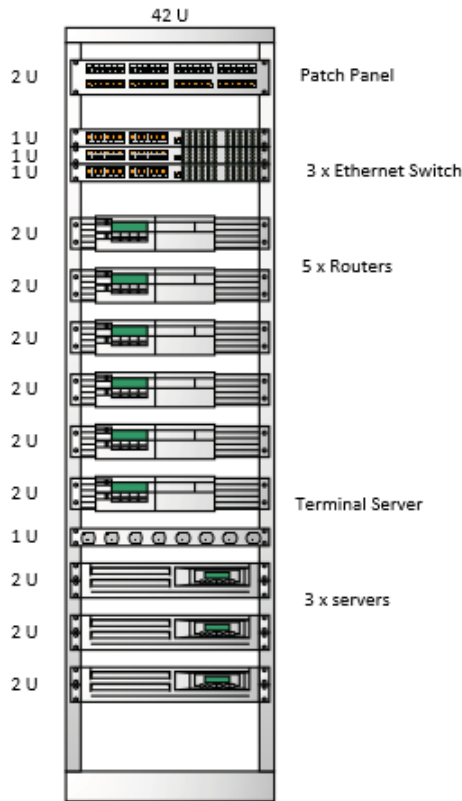
Figure 1. Physical Rack Diagram of Network POD

For the OL students, they use a Virtual Private Network (VPN) software (Cisco AnyConnect) to connect to a lab VPN gateway. After the VPN connection, students use **telnet** to access the console port of individual network devices via the terminal server as illustrated in Figure 2. The VPN software can be launched from any web browser, and students can access the lab over the Internet from anywhere in the world.
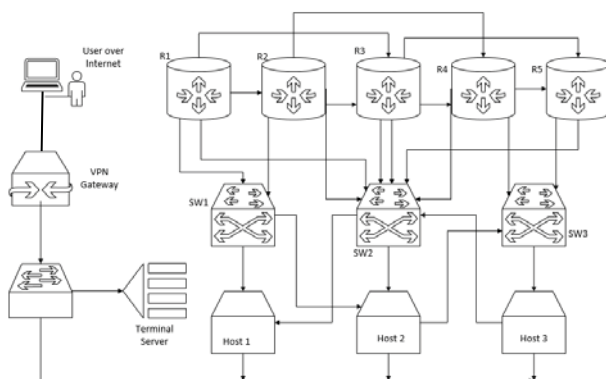

Figure 2. Phyiscal Connection of Network POD

3.2 Lab Scheduling Tool

The physical lab is accessible to students with 24×7 availability. A major challenge of building physical labs with on-line (remote access) capability is the

management of shared resources. A network device dedicated to one student cannot be used by another student. To prevent students from interfering with each other's work, a scheduling tool is required. We already had a policy-based scheduling tool for our old lab environment [6], and we enhanced its capability to support DLPOD with the flexibility to add and remove individual DLPODs. The lab scheduling process and policy are described as follows:

1. The instructor sets an environment for each lab session. The instructor also specifies the requirements of individual network devices for the lab, along with the duration for each lab session.
2. Student logins to the scheduling tool and reserve a lab session. When a lab session is reserved, a slot of DLPOD is also reserved for the session. The physical DLPOD is not allocated.
3. At the scheduled time, the student logins to the DLPOD environment and activates his/her lab session. A DLPOD is then allocated to this lab session. Only the student with the reservation can activate the reserved lab session.
4. During the activation of a lab session, all hosts and network devices on the designated DLPOD are rebooted.
5. After the lab activation, the student starts a Virtual Private Network (VPN) connection to the designated DLPOD.
6. After the VPN setup, the student creates a telnet session to the console port of individual network device via the terminal server.
7. For Linux hosts, the student uses an SSH client software.
8. For Windows machines, the student uses Remote Desktop application to access the host.
9. A student can reserve only one lab session at a time. After completing one lab session, the student may reserve another lab session.
10. If a student completes the lab work earlier, he/she can relieve the lab resource which would be available to other students.

The lab scheduling tool also collects the log data of each lab session. The log data is useful for instructors and lab support to investigate any potential lab problems.

3.3 Pros and Cons of Physical Labs

The physical lab environment is useful for *mini* experiment design from which students can test various network protocols, analyze the traffic, and measure the performance. We also developed several private tools for traffic monitoring, performance analysis, and fail-over time measurement. Students also learn to develop or install their own tools for network management. Some of the unique benefit of physical labs are given as follows:

1. *Protocol Analysis*. Students learn to generate the traffic, capture the traffic, and use a protocol analyzer to observe the captured traffic. For example, students first learn to capture the *default* traffic of Spanning Tree Protocol (STP). They then modify the STP timers and study the Bridge PDU to see the content being changed. Another more challenging example is to create a scenario to observe some not-to-common traffic, such 802.3x (flow control). From our experience, students would have much deeper understanding of a protocol after they see the protocol in action. There is no better way to *see* the protocol except generating the real traffic.

2. *Performance Measurement*. The physical environment provides the most realistic measurement for traffic analysis. Students are often excited to observe a near perfect linear relation between round trip time (RTT) and packet size, and they are also surprised to observe that throughput is not negatively affected by the number of routers on the route; throughput of one router is almost identical to the throughput of five routers.

However, there are four major disadvantages of building a physical lab for networking education:

1. *Cost*. The cost of building a single POD is more than $20,000, and the budget would limit the number of PODs for network education.

2. *Maintenance*. The lab is available to the students 24×7, but we cannot afford to have staff available for 24×7 support. Currently, we recruit students as lab assistants to monitor the lab environment. When a lab assistant detects and confirms a problem, the DLPOD at fault will be removed from the service. The lab administrator will then investigate and resolve the problem off-line.

3. *Vendor-specific*. Networking education should not be tied to a specific vendor's product; however, network devices are from a specific vendor. In order to configure devices, students need to learn vendor-specific commands and operations for device configuration. However, the majority of students consider this constraint to be an advantage because it allows them to build practical experience and expertise to manage network products from a major vendor.

4. *Scalability*. This is probably the most critical issue of the physical lab because any network configuration is limited to only five routers and three switches in our lab. For example, it is not possible to design a three-layer switched network (access,

distribution, and core layers) and test the cascading effect of the spanning-tree protocol. A few students incorrectly assume that the STP fail-over time is always 30 seconds because that is always the case on DLPOD.

4. Network Emulation

A network emulation environment is a software tool to emulate network devices from a specific vendor, and the purpose is to test *real* applications on a virtual network. Examples of network emulators are Cisco PacketTracer, GNS3 (www.gns3.com), and Juniper Junos. This paper uses PacketTracer as an example to illustrate the use of emulator to support networking education, and the discussion is applicable to any network emulator. From the education perspective, it is effective and efficient to build, design, configure, and test a network with various network devices on the student's personal computing environment. Students can easily install the software on their own computing environment, such as Windows or Linux, and they can perform the *hands-on* exercises on their local computing environment.

4.1 Device Connectivity and Configuration

The immediate benefit of an emulation tool is to build a network and see it in action. We find the tool is most useful in introductory courses. After learning the basic networking concepts and interconnecting devices, students can put all these together and build a simple network to see the traffic in action. During the process, students also learns the basics of network cablings, such as straight through UTP cables, cross-over UTP cables, serial cables, and optical cables as illustrated in Figure 3.
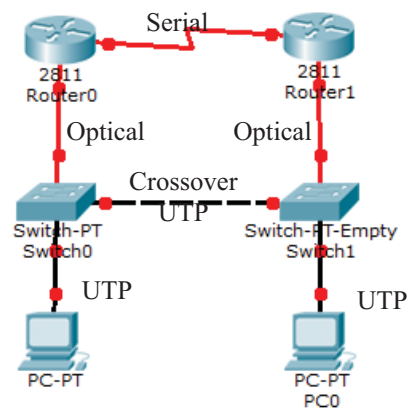

Figure 3. Network Connectivity and Configuraiton

After building the phyical network, students need to learn Cisco IOS commands for design and device configuration. The final step is to generate the traffic and test the design.

4.2 Network Design

The major advantages of the emulation tool are availability, reliability, and scalability:

1. *Availability* – the environment is local on the student computer, so it is 24×7 available. Because it is software, there is no issue with hardware power outage or wear out.

2. *Reliability*. In general, an emulator supported by a vendor is highly reliable, at least much more reliable than hardware boxes. There are limitations about certain expected functions not available, but we have not experienced any *real* software bug.

3. *Scalability*. Compared to the physical lab environment, network emulator is a lot more scalable as we can easily build a relatively large and complex network as illustrated in Figure 4.
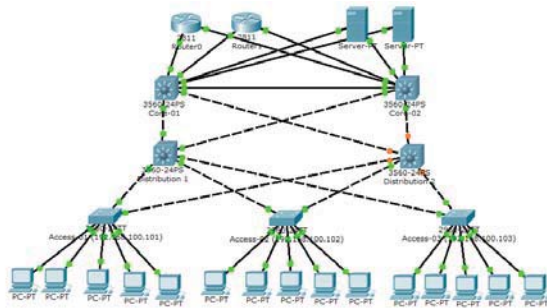

Figure 4. Building a Three-Tier Network in PacketTracer

4.3 Pros and Cons of Network Emulator

We already discussed the pros of network emulator, which are availability, reliability, and scalability. Of course, cost is also an advantage as it is free from the vendor(s). Technical support for network emulator is very minimal, and can be easily handled by the instructor and a lab tutor.

There are two major disadvantages of network emulator: protocol and performance analysis. In the emulation environment, we cannot capture the traffic and *open* the packets to study the protocol. For example, we designed a VoIP lab on PacketTracer, and students could learn how to configure individual devices. However, students cannot see any messages and study message flow for call establishment and termination.

Another major disadvantage is performance analysis. From our experiments, the round trip time (RTT) from PacketTracer is off by several factors and useless, and there are no measurement tools for throughput. In addition, the emulator fails to support protocols with <1 second fail-over time. For example, we measured the fail-over time for Rapid Spanning Tree Protocol (RSTP) for <100 ms on our physical lab, but it is several seconds on the emulation environment.

One minor issue is that many Cisco IOS commands are not supported on the PacketTracer, but we can usually overcome this issue by using the commands that are available on PacketTracer.

5. Network Simulation

Unlike emulation, network simulation is a *programming* environment to simulate the behavior of a network. Examples of network simulator are ns2 (www.isi.edu/nsname/ns), ns3 (www.naname.org), mininet (www.mininet.org), and Opnet (www.reiverbed.com). In a simulation environment, there are no specific concepts of network devices, such as switches, routers, or firewalls. A network is a collection of nodes and links: a node can be *programmed* as any network device and a link can be *programmed* for any protocol and any speed.

As a programming environment, network simulator is capable to simulate any protocol behavior as long as the protocol is *programmed* correctly. The strength of a simulation environment is traffic analysis, and it is easy to capture the traffic, study the protocol, and conduct performance analysis [8]. The performance measures, from our experience, are useful for comparison study, but could be significantly different from measures from the physical labs. It is also relatively easy to create various traffic scenarios via simulation. The major advantage of simulation is scalability. A physical lab is limited to no more than 10 network devices. An emulator could build a network with up to 50 devices, but unlikely to go beyond 100. A simulator has no limitation. For example, the following script easily creates a network of ring topology with 1,000 nodes.

```
set num_node 1000
#creating nodes:
for {set i 0} {$i < $num_node} {incr i} {
   set n($i) [$ns node]
}
#creating links to form a ring topology
for {set i 0} {$i < $num_node} {incr i} {
        $ns duplex-link $n($i) $n([expr ($i+1)%$num_node]) 10Mb 1ms DropTail
}
```

Figure 5. ns2 Script for 1,000-node Ring

Because network simulation is a programming environment, students who are not familiar with the corresponding programming language usually have a steep learning curve. For example, students need to learn Tcl to be proficient on ns2, and need to use C++ or Python to build a network on mininet. For some students, performing lab exercises on simulation does not feel like doing hands-on lab work, and it is more like a programming assignment. Our experience is that the network simulation environment is useful in advanced courses for large scale enterprise network design, and is most useful for network research.

6. Conclusions

The paper presents three environments to support OL-based networking education: physical labs, emulation, and simulation. We conclude that all three environments are required to support our network curriculum. In the introductory courses, we use the emulation environment and students can quickly learn to build, design, configure, and test a network. Students also learn to use wireshark where they can capture traffic on their local computers and study its data.

In the intermediate and advanced courses, we use the physical labs and students learn to design small-scale network experiments and configure network devices. We also emphasize the learning on protocol analysis where students need to create various scenarios to generate traffic of different protocols and capture the traffic. Performance analysis is also a learning goal where students need to predict the performance and verify their theoretical calculation from empirical data.

In our research, we use simulation extensively where we can modify a protocol and observe the behavior change from our modification. It also supports the scaling to a large network from which we can study the impact of the modification.

We recently did a preliminary study on the GENI network (geni.net) [9]. Our experience is that its performance (response time) is unpredictable, and it would not be easy to support a large number of students to conduct hands-on exercises on it. We acknowledge its potential to build a large-scale network with real networking devices, and we plan to conduct more experiments before considering it for our networking curriculum.

References

[1] G. Scheets and M. Weiser, "Implementing a Remote and Collaborative Hands-on Learning Environment," Chap. 10 of The Foundation of HRD in a Networked World, Springer, 2001.

[2] S. A. Mengel and C. D. Bowling, "Supporting Networking Courses with a Hands-on Laboratory," Frontiers in Education Conference, Atlanta, GA, November 1995.

[3] S. Yoo and S. Hovis "Remote Access Internetworking Laboratory," Proceedings of the Thirty-fourth SIGCSE Technical Symposium on Computer Science Education, Norfolk, VA, 2004

[4] M. A. Vivar and A. R. Magna, "Design, Implementation and Use of a Remote Network Lab as an Aid to Support Teaching Computer Network," 3rd International Conference on Digital Information Management, London, November 2008, pp. 905-909.

[5] E. Monsef, et. al. "Remotely Accessible Computer Network Laboratory with Hands-on Experience," IEEE International Conference on Electro/Information Technology, Milwaukee, WI, June 2014. pp. 367-372.

[6] N. I. Sarkar, "Teaching computer networking fundamentals using practical laboratory exercises," IEEE Transactions on Education, Volume 49, Issue 2, May 2006, pp. 285 – 291

[7] J. Yu, "A Policy-Based Scheduling Tool for Network Labs," 41th Midwest Instruction and Computing Symposium (MICS), La Cross, Wisconsin, April 2008, pp. 352-363.

[8] J. Dong and H. Guo, "Effective Collaborative Inquiry-based Learning in Undergraduate Networking Curriculum," ASEE Annual Conference, Atlanta, GA, June 2013.

[9] P. Calyam, S. Seeharam, R. B. Antequera. "GENI Laboratory Exercises Development for a Cloud Computing Course," 3rd GENI Research and Educational Experiment Workshop, Atlanta, GA, March 2014, pp. 19-24.

Towards a Research Road Map for Assessment of E-learning Systems:
A Systems Engineering Approach

Aula Al-Shagran[1], Abd-El-Kader Sahraoui[2]
[1]FCIT-Information System Department. King Abdul-Aziz University, Jeddah, KSA
[2]LAAS-CNRS, Université de Toulouse, CNRS, UT2J, Toulouse, France

Abstract-*This paper is on the issue of assessment of E-Learning systems. The originality of the work is to identify main drawbacks mentioned in the literature and propose a systems engineering framework approach.*
E-learning is more and more used and mainly in developing countries. A large number of E-learning systems have been developed in the institution around the world. These systems can be assessed using multiple dimensions and criteria. KSA started implementing the E-Learning since 2002. Although of this evolution up to our knowledge, limited research work have been carried out on assessing such system. In response to this limitation this paper is a preliminary research study that attempts to propose the requirements list needed to develop a reliable technique or methodology to evaluate an E- learning system. The contribution of this position paper proposition of a framework for future research as seeing ELearning as a system as any other system, and hence the assessment becomes a partial validation of the systems with respect to requirements. Requirements can be criteria of ABET accreditation.

Keywords: ELearning, systems engineering, modelling, Assessment, Evaluation Criteria

1   Introduction

Technology affects all the fields of our life. Learning is a critical field; so the impact of technology should improve the learning process [1]. All institution strive to achieve high education outcomes. In a suitable way for every course separately and within the whole program curriculum.

Electronic learning is simply to apply the use of electronic devices to improve and facilitate the learning process [2]. The development of electronic learning tools and web technology lead to start the distance learning which allow synchronous, asynchronous, and self-learning. For all of that many Learning Management Systems were developed and used in many institutions.

E-Learning must go through evaluation process to check its capability for achieving the outcomes expected from using it. Such outcomes can be requirements set by an accreditation body as ABET or specific to the education body.

"ABET, Inc.", formerly named Accreditation Board for Engineering and Technology, developed a system for accreditation of engineering programs that includes 8 criteria [3]. The criteria are: Students, Program Educational Objectives, Student Outcomes, Continuous Improvement, Curriculum, Faculty, Facilities and Institutional Support. "ABET accreditation provides assurance that a college or university program meets the quality standards of the profession for which that program prepares graduates" [4].

Till now there is no approved and accepted evaluation system of E-Learning [5]. To have a good E-Learning that fulfills the needs for high quality learning environment, E-Learning requirements should be defined first.

The expected outcome of this paper is a preliminary work on state of the art and propose a system engineering approach. By proposing a categorization of selected criteria for designing and assessing the E-Learning system. These criteria based on leaning quality standards and technology standards.

2   Background

Interest in E-Learning has increased after its evolution in higher education in KSA, the reason of that its ability to overcome the obstacles of delivering the education services to all population. Some of these obstacles are: First, KSA Islamic culture and isolation education campus for both male and female with limitation of the human resources and other facilities. Second, the large number of people who tried to apply for higher education. Third, personal reasons which prevent individuals from enrolling in the higher education. After this growth of applying E-Learning it's the time to

investigate if E-Learning is a good solution for overcoming these limitation of spreading the education. Actually a very little researches had been done in the field and further contribution is a need [6].

Ministry of Higher Education launched a National Center of E-Learning in 2008, to deliver the E-Learning in KSA universities [6]. On 10/8/2011 the Saudi Electronic University (SEU) was launched as a first government educational institution which for graduate and undergraduate degree programs. It aims to support the lifelong and self-learning [7].

3   Related work

The rapid development in technology and communication methodologies affects positively the improvement of the learning process [1]. Systems need to be checked to ensure that they meet the learning objectives. A relevant researches, performed around the world for this purpose. Interested way was established by number of researchers, their approaches were attempting to evaluate the E-Learning from different aspect by defining the main criteria for evaluation for every aspect.

3.1   Stakeholders

As in the literature, E-Learning system has number of stakeholders, understanding of various stakeholder's needs and expectation with having all information about the level of restriction will help in developing a good requirements list for E-Learning evaluation. Students and instructors are key entity in the learning process, their role will be E-learning instead of learning, as E-teaching for teachers, number of challenges arise from both side's students and teachers [1]. Students and faculty are one of the ABET accreditation criteria. Number of questions should be answered:

- Who are the leaner?

- Is this first E-Learning program to be conducted?

- Is there a need to change their performance?

- Do all learner have same chance of learning availability?

Student and program outcomes should be met by the E-Learning system by enforcing the procedures to ensure that.

In [1] authors see that the students are very critical factor for initiating ELearning, the learning success depend on the students acceptance and enjoyment of the learning process, a good researches have been done to check the students attitude regarding the EL education and its impact on them. Taking in consideration different factors affect their attitude such as gender, self-efficiency in using computer. This result will help the designer of E-Learning and LMCS to make their designs more effective [8].

Others who affected by E-Learning and who will affect the success of it, are not only these two item but also Employers, Educational Institutions, Content Providers, Technology Providers and Accreditation Bodies [9] [10].

All system stakeholders should be analyzed, to identify everything that may has influence on the learning process through the ELearning Systems. Even within each stakeholder you will have different characteristics that will influence the acceptance of E-Learning systems.

3.2   Design and usability

Design and usability of the E-Learning system have a good weight in the system quality evaluation [8]. Quality means meeting the user expectation. Different dimensions of quality should be defined and appropriate evaluation should be conducted to each dimension [11].

Software engineers always attempts to have a best implementation of the E-Learning systems before design them [12]. Institutions should has appropriate infra-structure, the courses should be redesigned to keep the learning process effective as possible, and Instructors and students must have the needed skills for using E-learning system. An evaluation technique was implemented on public universities in Kenya also concentrated on usability of Moodle E-Learning. The usability evaluation based on number of factors: learnability, user-friendliness, technological infrastructure, usability policy, culture and gender. The finding of that study was the learnability and friendliness highly affects the usability [13].

Different categories are integrated to evaluate the design and usability of the system: user experience, accessibility, hardware and software, layout, and other system details [14].

3.3   Effectiveness

Other researcher suggested a framework to evaluate the effectiveness of E-Learning process which focused on four dimensions: readiness, course delivery strategies, quality of E-Learning and effectiveness blended ELearning each of these four dimensions has components and number of items for every component [10] [15].

In [15] an investigation was conducted to find the factors that has impact on the E-Learning effectiveness. The finding of that investigation the ten different dimensions of the E-Learning effectiveness: technology, pedagogy, motivation, usability, content and material, support for learners, assessment, future- direction, collaborative and interactivity.

3.4   Multi criteria evaluation

There are number of learning system adopted at many universities WebCT, Blackboard, Moodle and other systems.

Some researchers consider number of factors affect E-Learning in addition to stakeholder as: material and capability of learner [2].

A survey was applied at SMCS (School of mathematics and computer science) for student who enrolled in ELearning system in programming, analysis and design, and object oriented programming courses. In years (2009-2011) for three different systems Edunet, Moodle, Canvas [12]. The survey used four different aspects: Learner interface, Teaching community, System Content, and Personalization. Each of these four aspect has different criteria used to check the quality.

It was implemented to evaluate the E-Learning course by applying 73 items according to number of characteristics. The study concentrated on the course design, they found that evaluating usability is part of quality which concentrates on the design of different part of the E-Learning system and the authors mentioned that a lot of usability problems still unsolved.

4   Drawbacks

Despite all these effort no approved international quality standards defined for E-Learning. The main limitations of the previous research is that they concentrate on the technical issues, and very few studies concentrate on the knowledge side. In addition to that not all evaluation characteristics have been analyzed which are: flexibility of the system, can be used to evaluate different types of courses, Simple, Reliable and Economical.

Any systems can be assessed only performance criteria set at the requirements levels. Such requirements are traced forward and backwards as to satisfy such criteria. We believe, in that context, that such requirements are not well set with respect to all stakeholders being high level stakeholders as managers, ABET authorities and low level stakeholders as students and teachers.

"TAFE means Technical and Further Education. TAFE in New South Wales comprises 10 institutes which cover different geographic areas of the state. Each Institute has more than one campus. TAFE NSW is Australia's largest training provider, with over 500,000 enrolments every year" [16] . Below are some criteria proposed by TAFE NSW.

- The ability to transfer skills to different training environments and learner groups

- Evidence of the preparation of a minimum of two delivery plans:

- One of these delivery plans must address a learning program that is linked to competency standards

- One delivery plan should address the whole or substantial part of a learning program and contain session plans for a series of training sessions

Assessment must also include evidence of both developing and contextualizing learning activities for the delivery plan and of developing new learning materials such as handouts, overheads etc and organizing the material and physical requirements for delivery.

5   Proposed methodology

To investigate the characteristics and requirement of a high quality E-Learning system with respect to all stakeholder point of view, a deep reading of relevant literature had been conducted. After investigating and searching good repositories as IEEE, IGI, Google Scholar, and Electronic world library using related key words. With the search result mind mapping process was conducted to classify the E-Learning evaluation criteria and hierarchal framework according to the importance of each category was developed. At this stage we are trying what suitable approach can be carried out and we believe that systems engineering approach can be beneficial as first step towards such methodology

5.1   Towards a Systems Engineering Framework for E-learning

In previous researches all agree on the need of evaluation approach for E-Learning system. The tools and techniques which were used in these researches were used several criteria and items [13]. Like any technology system E-Learning systems should fulfill the relevant overall learning and teaching requirements [17]. To have such integrated evaluation system, all different E-Learning aspect's criteria need to be checked and evaluated. These criteria should be defined.

5.2   Systems engineering:

System engineering is an art to develop a system that satisfies the needs, concerned of building effective and efficient system which satisfy the requirements of stakeholders. System engineering discipline consist of: product development, (V&V) methods to assess system quality, and cost. In system engineering the requirements collected for every part of the software then these requirements integrated to understand the whole system [18].

5.3   Towards a systems engineering approach

Many work have been developed by systems engineering community on assessment and validation of education systems. Up to our knowledge, this approach has never been extended and deployed for E-Learning systems. In that respect, we can see dual complementary approach. The first is to make assessment of an education system as ABET accreditation type for a specific course and then the

second is to build the associated E-Learning systems and make sure that objectives are met by using E-Learning systems. Hence such systems engineering approach will have in the next research goals to have a computer aided systems for E-Learning improvement; this is will be refined in the sequel.

5.4   Requirements and validation

As suggested earlier in the 5th part, we consider E-Learning systems and associated requirement and show that assessment is partial validation. Complete validation can of course be done only through formal validation and of course experimentally validation

5.4.1.   E-Learning requirements

We can set requirements for any systems to be developed. The question is to go back to the basic: what were the objective of E-Learning. Possible requirements:

- were the objectives same as learning objective of ABET
- Were they different and hence why E-Learning just as distance learning
- E-Learning can it be a lecturer support
- Can be mean to cover the need for lecturer
- Are they addressed to any level, any discipline, any context

So we need to overcome the requirement issue for any E-Learning systems before embarking into its evaluation.

5.4.2.   Assessment as a partial validation

We believe that Assessment can be considered as partial validation for any system design and implementation. In this respect we will be using standard EIA 632 where we have seven items of validation and verification; we mention briefly these validations
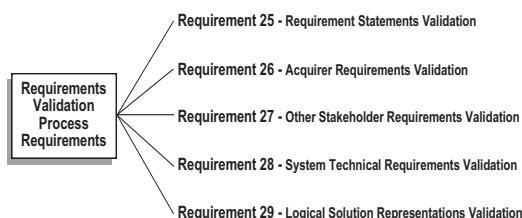

Figure 1. Validation Process Requirements

5.5   The proposed framework

The proposed framework of E-Learning evaluation criteria attempts to combine the effort of several researcher. And the criteria representation was merged with ABET criteria. The main aspects of the proposed framework criteria shown in Table 1.

5.6   Modelling dynamic lifecycle

The lifecycle of E-Learning systems can be modelled in the next research with Petri nets, colored version; and the tool being used on CPN developed at Aarhus University [19].

6   Conclusion and future work

It's very important to have an evaluation technique for E-Learning systems, to make sure that the learning process give a high quality learning outcome according to the market demand and comparing with the quality of the accredited curriculum.

Developing of professional technique require a detailed requirement list, to know which criteria should be checked to ensure the quality of the E-Learning systems. We proposed a list of criteria which need improvement and also for each criteria all items should be defined. And that will help to develop different models to evaluate every aspect of the E-Learning process. Considering the discipline of system engineering while developing any EL system or tools, with a very deep analysis of the EL environment will lead to a strong system. Then the system will be able to undergo the evaluation process.

We gave in this paper a possible direction of research on assessment of E-Learning systems. We will use V& V approach pruned in systems engineering and modelling the dynamics of such model with UML for information model and dynamic model with Petri nets.

Table 1. E-Learning Assessment Factors

Dimension	Factors	Items
Stakeholders	Instructors	Teaching Effectiveness
		interaction Level
		Satisfaction Level
		Teaching Effectiveness
		interaction Level
		Satisfaction Level
	Students	Student Characteristics Level of attainment Familiarity with technology interaction Level
	Contents Providers	Learning Resources Multimedia Comply with standards Appropriate Content
	Technology providers	Training Technical Support (Hardware & Software)
	Employees	
	Developer	Services design Website Utilization Communication tools Tools Website usability
	Accreditation Bodies	Guidelines for requirements

Dimension	Factors	Items
Organization	Department	Academic Affair Administrative Affair Assessment Virtual Class Learning Outcome
	Student Learning Management	Student tracking Time management Learning tracking Use of e-portfolios
	Technological infrastructure Policies on e-learning staff representatives E-learning special funds	
Technology	Infrastructure Readiness Support Cost	Hardware Software
Environment	geographic Location	
	Social Factors	Ethics Information Access Culture
	Learning Style	Asynchronous Synchronous Self-Learning
	Culture Awareness	Learning culture Change in study habits
Pedagogic and curricular	Match to the curriculum Effective learning	
Quality E-learning Systems	E-learning Management System Design	Adaptability of course module platform
		Ease of navigation
		Consistency of course module platform
		User-friendliness
		Multi-culturally appealing
		Accessibility of course module content
		Event management
		User management
		Security of user data
		Collaborative learning
		Interactive learning
Effective Blended E-Learning	Impact on E-learning Readiness, Quality of E-learning Systems and E-learning Course Module Delivery Strategies	Student retention
		Student access to learning
		Cost effectiveness
		Performance and quality of lecturers
		Academic achievement
		Improvement of research and education

7   References

[1]   M. Y. Ibrahim and C. Brack, "From e-Teaching to Online Learning:Evolution in Engineering Course Design," IEEE, 2010.

[2]   J. Q. G. W. a. X. W. Fei Li, "Traditional Classroom VS E-learning in Higher Education: Difference between Students' Behavioral Engagement," iJET, vol. 9, no. 2, 2014.

[3]   ABET, "http://www.abet.org/," ABET-Board of Directors, 2014. [Online]. Available: http://www.abet.org/wp-content/uploads/2015/05/E001-15-16-EAC-Criteria-03-10-15.pdf.

[4]   "http://www.abet.org/accreditation/," [Online].

[5]   U. Tudevdagva, . W. Hardt2, T. Evgen and M. Grif, "New Approach for E-Learning Evaluation," IEEE, no. 978-1-4673-1773-3/12/, 2013.

[6]   S. Alkhalaf and A. Nguyen , "Assessing eLearning Systems in the Kingdom of Saudi Arabia's Higher Education Sector: An exploratory analysis," in International Conference on Intelligent Network and Computing (ICINC 2010) , 2010 .

[7]   "https://www.seu.edu.sa/sites/ar/AboutSEU/," [Online].

[8]   I. Balaban, . G. Bubas and M. Pipan, "Key elements of an e-learning course evaluation survey: An empirical validation," IEEE, pp. 336-343, 2011.

[9]   K. H. a. M. H. Nicole Wagner, "Who is responsible for E-Learning Success in Higher Education? A Stakeholders'," Educational Technology & Society, pp. 26-36, 2008.

[10] B. Aguti, G. B. Wills and R. . J. Walters, "An Evaluation of the Factors that Impact on the," IEEE, 2014.

[11] T.-L. Militaru, G. Suciu and G. Todor, "The Evaluation of the e-Learning Applications'," in 54th International Symposium ELMAR-2012, Zadar, Croatia, 2012.

[12] N. Munkhtsetseg, D. Garmaa and S. Uyanga, "Multi-criteria comparative evaluation of the e-learning systems: a case study," in Ubi-Media Computing and Workshops, 2014.

[13] N. . K. Kiget, G. Wanyembi and A. I. Peters, "Evaluating Usability of E-Learning Systems in," IJACSA, Vols. 5, No, 8 2014.

[14] C. Press, "The Universal Access Handbook, C Stepanidis (ed), CRC Press, 2009," June 11, 2009.

[15] D. Gamage, S. Fernando and I. Perera, "Factors affecting to effective eLearning: Learnere Perspective," Scientific Research Journal(SCIRJ), vol. II, no. V, 2014.

[16] "http://www.studyintafe.edu.au/study/tafe," [Online].

[17] . L. Price and A. Kirkwood, "achieving Improved Quality and Validity:Reframing Research and Evaluation OF Learning Technologies," in EDEN, Oxford, United Kingdom, 2014.

[18] S. . M. White , "Integrating System and Software Engineering Processes Using the Views and Viewpoints of a New Discipline," IEEE, no. 978-1-4799-2086-0/, 2014.

[19] "http://cpntools.org/," [Online].

Effects of Crossover Activities by K-pop Stars on College Student Consumer Loyalty

Yeokwang Yoon[1], Inhee Cho[2], Chungon Kim[3], Hyeju Lee[4], SungHoon Park[5]
[1]Sportschosun Reporter
[2]Namseoul University Adjunct Professor
[3]Dankuk University Professor
[4]ChungAng University Professor
[5]ChungBuk National University Professor

Abstract - *The 'genre destruction' of K-pop stars is continuing to accelerate. Rather than captivating consumers around the world simply with singing and dancing, they are engaged in crossover activities expanding to the fields of acting and commercial films based on their music. They are de-idolizing by going beyond the boundaries of singing, acting as commercial models. These idols in various activities such music and acting or music and advertisements are called 'actor-dols' and 'CF-dols'. stud So how do fans evaluate these crossover activities of K-pop stars? Unfortunately, there are few preceding studies on the crossover activities of K-pop stars and there are insufficient studies on the effects of 'genre destroying' activities of idol singers on consumer loyalty. Therefore, this study identifies the impact of crossover activities by K-pop stars on fan loyalty among college students, who are the biggest consumer groups of K-pop to provide implications on Hallyu marketing, etc. The components of variables deduced from preceding studies are as follows. The crossover activities of K-pop stars were set in the three fields of acting, music and CF (commercial films, advertisements) and the fan loyalty of consumers were categorized as star loyalty and fan community loyalty. Furthermore, the hypothesis was set based on preceding studies, and in order to examine the influencing relationships, surveys were held for college ents in Seoul and surrounding areas. The empirical analysis results of this study are as follows. First, it was found that the crossover activities of K-pop stars affected the 'star loyalty' of college consumers. In other words, the loyalty of consumers for K-pop stars were found to be a compound outcome of not only music activities, but various celebrity activities (acting, CF, etc.). Second, it was found that loyalty in communities was only affected by music activities, while acting and CF activities did not have significant impact on community loyalty. Community activities are completed with the assertive participation and actions of fans. It can be said that it is the most assertive method of expressing loyalty. Therefore, while it is good for K-pop stars to engage in various celebrity activities through genre destruction, they are also expected to strengthen their identity as idols through music.*

Keywords: Hallyu, K-pop star, Crossover activity, Loyalty, Fandom

1 Introduction

1.1 Background and Purpose of Research

From Yoona of 'Girls' Generation; to Seolhyun of 'AOA'!

The fields of activities of K-pop stars who mainly focused on singing and dancing have been expanding boundlessly. De-idolizing that crosses over the boundaries of singers, actors and commercial models are in full gear. In the case of first-generation K-pop stars, once they reached a certain level of popularity, they began acting in the manner of a 'two-cropping system', but there are many cases today where they move strategically right after their debut. 'Kara', one of the top K-pop girl groups, officially announced that they disbanded on January 15, 2016. After enjoying huge popularity as second-generation idol groups together with 'Girls' Generation' and 'Wonder Girls', they gave up their lucrative Japanese market and began their career as actresses [1]. Then why do idol stars also act or decide to change their career paths altogether into actors? While there may be a number of reasons, the biggest would be financial profits. By becoming a popular actor, their income model can become diversified such as by appearing in advertisements. Suzy of the girl group 'Miss A' became an established actress and posted earnings of over 10 billion won and Hyeri also earned over six billion won in advertisements since appearing in the tvN drama 'Reply, 1988'. Thus, there are many cases in which all members of idol groups such as Secret, Girl's Day and CN Blue all double over as actors and actresses [2]. So how do domestic consumers evaluate the crossover activities of K-pop stars? Most studies on K-pop stars until now only described the Hallyu phenomenon or measured the musical reactions of Japanese and Chinese consumers through surveys. The studies were on K-pop stars only as singers. However, K-pop stars are expanding their domain of popularity through various genres in addition due to their 'day job' as 'actor-dol (acting idols)' and 'CF-dol (idols who are CF (commercial film; advertisement) idols)'. It is now difficult to pin-point K-pop stars and call them singers. This

is because the popularity of K-pop stars manifests through the combination of celebrity activities in diverse genres such as musical activities, acting, and CF. There are very few academic studies on the crossover activities of K-pop stars as well. There are very few preceding studies that evaluates the crossover activities of K-pop stars by consumers, as well as studies measuring the influence relationship of the activities by genre of K-pop stars on domestic consumer loyalty. Therefore, this study aims at examining the consumer preference and interaction according to the crossover activities of K-pop stars among college students who are the major consumer groups in Korea, and then to empirically identify their influencing relationship. The detailed goals of this study are as follows. First, it is to verify the most preferred Hallyu contents genre for college student consumers, and to check how they obtain information on Hallyu stars and contents through which media, and how the consume the Hallyu contents. Second, college student consumers will be examined on how they evaluate the crossover activities of K-pop stars. Third, the effects of crossover activities by Hallyu stars on college student loyalty will be verified. Fourth, the impact on crossover activities of Hallyu stars on the fan community activities of collegiate consumers will be examined.

1.2   Research Hypothesis

This study is on verifying the influencing relationship of the crossover activities of K-pop stars on college student consumer loyalty. The following hypotheses were set for this.
1) [Hypothesis 1] The crossover activities of K-pop stars will have a significant positive (+) impact on consumer loyalty.
1-1) The acting activities of K-pop stars will have a significant positive (+) impact on loyalty towards the stars.
1-2) The music activities of K-pop stars will have a significant positive (+) impact on loyalty towards the stars.
1-3) The CF activities of K-pop stars will have a significant positive (+) impact on loyalty towards the stars.
2) [Hypothesis 2] The crossover activities of K-pop stars will have a significant positive (+) impact on fan community loyalty.
2-1) The acting activities of K-pop stars will have a significant positive (+) impact on fan community loyalty.
2-2) The music activities of K-pop stars will have a significant positive (+) impact on fan community loyalty.
2-3) The CF activities of K-pop stars will have a significant positive (+) impact on fan community loyalty.

2   Research Method

2.1   Survey Target and Method

In order to identify the influencing relationship of crossover activities of K-pop stars on the loyalty of college student consumers, this study deduced a research hypothesis based on preceding studies. In order to verify this, the questionnaire was comprised focusing on measurement items for each variable, and surveys were held for college students currently enrolled in universities in Seoul and adjacent areas.

Surveys were conducted for a total of ten days from December 11 to December 21, 2015 for this study. A total of 228 people participated in this survey, and excluding nine questionnaires with insufficient responses, 219 questionnaires were used for analysis.

2.2   Questionnaire Composition

The questionnaire was comprised based on the theories and results of preceding studies. the questionnaire was drafted in four areas such as ①acquisition of information on Hallyu stars(contents) and Hallyu contents consumption media, ②crossover activities of K-pop stars, ③loyalty of consumers, and ④demographical features. For the internal consistency of items measured in the 'crossover activities of K-pop stars' comprised of five areas, the Cronbach's α coefficient was .805 for 'acting activities', .755 for 'music activities', and .824 for 'CF activities'. Cronbach's α coefficient for items measured in 'consumer loyalty' comprised of seven areas was found to be .879 for 'loyalty to star' and .964 for 'loyalty to community'.

2.3   Organizational Definition of Variables

1) Crossover activities of K-pop stars

Crossover activities of K-pop stars, which are independent variables, are defined as TV dramas, songs and CF(commercial films, advertisements) with the biggest influence and ripple effect among the various Hallyu contents including Korean dramas, songs, movies, musicals, CF, food and fashion, which are attracting popularity throughout the world. In order to accurately measure the crossover activities of Hallyu stars in this study, the components per contents genre of Hallyu stars based on preceding studies were set as ①acting activities of Hallyu stars, ②music activities of Hallyu stars, and ③CF activities of Hallyu stars, and was broken down into 15 areas of measurement in relation to consumer loyalty.

2) Consumer loyalty

In this study, consumer loyalty is defined as 'the emotional fellowship and actual behavior modes with Hallyu stars felt by consumers' based on preceding studies. The two following elements were extracted to find the loyalty scale of stars for consumers.

①Loyalty desire for stars: Level of emotional identification as a fan of a specific star and expression in behavior with a sense of intimacy.

②Loyalty desire for fan community: Level of sense of belonging as a member of a specific star's community and assertive participation with a sense of unity. In order to measure the two elements above, 14 items were made up.

[Table 1] Questionnaire Composition

Variables		Measurement Items	No. of Questions	Scale	Cronbach's α
Hallyu star information and Hallyu contents consumption media		-Preferred Hallyu contents genre -Path for acquiring information on Hallyu contents -Hallyu contents consumption media	3	Nominal scale	
Crossover celebrity activities of K-pop stars	Acting	Reliability / approachability / amicability / charm / support	5	Likert's 5 point scale	.805
	Music		5		.755
	CF		5		.824
Loyalty	Loyalty to star	Sustainability / interest level of others / identification / sense of unity / interaction / reliability / affection	7		.879
	Loyalty to community	Participation level / intimacy / interaction / reliability / sense of unity / change in attitude / affection	7		.964
Demographical features		Gender/major/year in school	3	Nominal scale	
Total number of questions			35		

3   Theoretical Background

3.1   Contents of Hallyu

Hallyu refers to not only Korea's popular culture, but items related to Korea made into products to fit the preference of people from other nations and receiving popularity. Hallyu is a term that was made in China and it is a phenomenon that started with Kroean dramas in which people admire and want to learn about Korea's popular culture such as movies, music, fashion and food, and the celebrities who are the target of such popular culture. In the fall of 1999, the Korean Ministry of Culture and Tourism distributed an album(Song from Korea) to promote Korea's popular culture overseas, and from this time on, the term 'Hallyu' was officially used in Korea [3].

Since then, Hallyu expanded from pop culture contents to preferences for products related to Korea and this was called Shin-Hallyu(New Korean Wave). Thus, Shin-Hallyu refers to the added-value industry that OSMU's(One Source Multi Use) the Hallyu contents to create actual achievements in related industries such as tourism, shopping and fashion [4]. When summing up the numerous definitions on Hallyu above, Hallyu occurred in a specific period and is on formats and contents standardized in a given country,

[Table 2] Definition of Hallyu

Researcher (Year)	Definition
Jung Sang-chul et al., (2002)[5]	Korean Culture Phenomenon Trends in Southeast Asia of the Chinese Cultural Belt
Shin Yoon-hwan (2002)[6]	Phenomenon of Korean Popular Culture Trending in East Asia
Korea Tourism Corp. (2003)[7]	Cultural Phenomenon of East Asian Adolescents Admiring and Wanting to Learn about Korean Popular Cultural Contents (music, drama, movies, etc.) and Korean Celebrities
Jang Soo-hyun (2004)[8]	Korean Pop Culture Boom that Began Asian Countries such as Mongolia, Vietnam, Japan and the Chinese Cultural Belt such as China, Taiwan and Hong Kong from the Late 1990s
Koh Jung-min et al., (2005)[9]	'Korea' Preference Phenomenon Overseas
Shin Yoon-hwan, Lee Han-woo (2006)[10]	Cultural Phenomenon to Admire and Learn about Korean Popular culture (music, drama, fashion, games, food, hair style, etc.) in China, Taiwan, Hong Kong and Vietnam
Cho In-hee, Yoon Yeo-gwang (2013)[11]	Global Interest Phenomenon on Korean Culture

*Recomposed by researcher based on preceding studies

place and period, and is an on-going cultural phenomenon that are not past-tense cultural contents, but continuously being generated and developed going beyond time and space.

3.2   Crossover Activities of K-pop Stars

1) K-pop Stars

Stars are cultural products with socio-economic value. Stars have social power and create massive values by mobilizing fans and being distributed as an economic product. Furthermore, stars create a processed image through multimedia such as drama, movies, music videos, music, CF, and broadcasts. The processed image of a star created by a producer becomes the unique character that symbolizes that star, and as that character forms more contact points with consumers, that star's influence and power rises. Therefore, stars are not simply producers of popular culture, but are one-person companies with various economic ripple effects, and are social symbols that encourage the commercial desires of fans and commands their absolute loyalty.

Among the various types of Korean music, K-pop can be defined as music by idol groups(girl and boy groups) gaining huge attention among youngsters around the world. In other words, this is a concept in which it is pop music in Korea, but it transforms into K-pop by being consumed overseas [12]. In addition, K-pop stars can be defined as singers(including idol groups) that perform such music.

2) Categories of Hallyu Star Activities

There are various fields in popular culture and popular culture contents that affect Hallyu such as drama, movies, music(albums or concerts), sports, food, fashion, cosmetics, and games. The Hallyu phenomenon spans across various cultural spectrums and they differ slightly depending on the country and society [13]. According to the Korea Creative Content Agency (2014), the contents industry can be described as industries related to production-distribution-consumption, and the scope is defined as 11 fields(publication, comics, music, concert, games, animation, advertisements, broadcasts, characters, knowledge information, contents solutions) according to the '2012 Standard Contents Industry Statistics Report' [14]. Therefore, this study focuses on the three crossover activities of K-pop stars as shown below.

First is the 'acting activity of Hallyu stars' represented by movies and broadcasts (dramas) that have the biggest influence among popular cultural contents. : Dramas were the first to start the Hallyu boom in the Asian market(China, Japan, Southeast Asia) and acquiring the absolute loyalty of overseas consumers. Actors in these Hallyu dramas became Hallyu stars and through these stars, they acquired an emotional intimacy with Korea. The emotional intimacy on Korea resulted in the cycling effect that led to likings for Korean culture and preference for Korean product. Second is the 'music activity' represented by music and concerts : K-pop has become established as a music genre to people around the world, and global K-pop fans are consuming Korean pop music in real-time anywhere and at any time through the internet and SNS(Social Network Service). In particular, the reason why Korean idol groups are receiving explosive reactions around the world is judged to be because of the high quality music, excellent vocal abilities, and extravagant performances [15].

Third is the 'CF activity' represented by advertisement activities : Chinese and Japanese consumers tend to feel higher intimacy and kinship with Korean stars who have similar appearances and share cultural and emotional values. Thus, companies use Hallyu stars with high popularity in overseas markets as models for their brands, and they are constructing and strengthening their brand image through the image of Hallyu stars.

3.3   Consumer Loyalty

The definition of consumer loyalty is as follows. Oliver(1999) defined loyalty as a psychological attachment to repurchase their preferred product or service despite outside influences or marketing that could bring about a change in behavior [16]. Johns and Taylor(2007) [17] said that loyalty is the intent to continuously use a previous supplier based on past experiences and expectations for the future [18]. The concept of loyalty first appeared in the 1940s and at the time, it was conceptualized in the singular dimension of repurchase behavior [19]. Day(1969) claimed that in addition to loyalty from a behavioral aspect, loyalty in an attitude aspect was also important [20]. Day(1969) stated that the reason for this was because that for the concept of loyalty from a behavior aspect, it is necessary to differentiate from true loyalty and false loyalty resulting from inevitability [21]. In other words, having 'true loyalty' is when the consumer voluntarily becomes enthusiastic for the character or image of a star, and it can be explained as continuously consuming relevant products derived from such. For the attitude aspect, Jones and Taylor(2007) [22] said that it includes ①level of differentiation from substitutes, ②relative attitude that shows the intensity of preference, ③recommendation intent to other consumers, and ④altruism to help the service provider or other consumers. Furthermore, loyalty from a cognitive aspect has recently been highlighted. Cognitive loyalty is based on a conscious evaluation for the benefits and compensation for consumers such the repurchase of a specific brand or continuous use [23]. Thus, when interpreting the concept of loyalty in the broad sense, it can be divided into the three aspects of behavioral, attitude and cognitive.

4   Research Results

4.1   Characteristics of Research Subjects

The demographical features of the 219 college students who are the subjects of this study are as shown in <Table 3>. There was a similar distribution in males(107: 48.9%) and females(112: 51.1%). By year in school, 80(36.5%) were freshmen, 61(27.9%) were sophomores, 46(21.0%) were juniors, and 32(14.6%) were seniors. By field of study, it was in the order of sociology and engineering at 52(23.7%) each, followed by humanities at 41(18.7%), economics and finances at 30(13.7%), theological at 25(11.4%), other majors at 10(4.6%), and arts at 9(4.1%).

[Table 3] Characteristics of Research Subjects

		N	(%)
Gender	Male	107	48.9
	Female	112	51.1
Grade	Freshmen	80	36.5
	Sophomore	61	27.9
	Junior	46	21.0
	Senior	32	14.6
Field of Study	Humanities	41	18.7
	Sociology	52	23.7
	Economics and Finance	30	13.7
	Engineering	52	23.7
	Arts	9	4.1
	Theology	25	11.4
	Others	10	4.6
Total		**219**	**100.0**

4.2　Hallyu Contents Preferred Genres

Hallyu contents that college students like the most are K-pop(41.1%), followed in the order of drama(27.9%), movies(21.5%), musicals(4.1%), and CF(4.1%). Males were in the order of K-pop(33.6%), drama(28.0%), and movies(26.2%), and for females, it was in the order of K-pop(48.2%), drama(27.7), and movies(17.0%). Females showed a relatively higher preference for K-pop compared to males <Table 4>.

[Table 4] Preferred Hallyu Contents Genre

N(%)

	Male		Female		Total	
	N	(%)	N	(%)	N	(%)
Drama	30	(28.0)	31	(27.7)	61	(27.9)
Movies	28	(26.2)	19	(17.0)	47	(21.5)
K-pop	36	(33.6)	54	(48.2)	90	(41.1)
Musical	5	(4.7)	4	(3.6)	9	(4.1)
CF	6	(5.6)	3	(2.7)	9	(4.1)
Others	2	(1.9)	1	(.9)	3	(1.4)
Total	**107**	**(100.0)**	**112**	**(100.0)**	**219**	**(100.0)**

4.3　Perception of Crossover Activities of K-pop Stars

Upon measuring the perception on the crossover activities of K-pop stars on a five point scale <Table 5>, positive reactions were highest for acting activities(3.56), followed by music activities(3.29), and CF activities(3.25). The perception on the acting activities of K-pop stars did not have significant difference between male(3.59) and female(3.53) students, and the perception for music activities also did not display significant difference for male(3.30) and female(3.29) students. The perception on CF activities was higher in females(3.36) than males(3.14), and the difference

was statistically significant($t(217)=-2.440$, $p<.05$). Thus, female students showed more positive reactions to the CF activities of K-pop stars compared to male students.

[Table 5] Difference of Perception on Activities per Genre of Hallyu Stars

		N	*M*	*SD*	*t*	*p*
Acting Activities	Male	107	3.59	.69	.712	.477
	Female	112	3.53	.56		
	Total	**219**	**3.56**	**.63**		
Music Activities	Male	107	3.30	.72	.109	.913
	Female	112	3.29	.58		
	Total	**219**	**3.29**	**.65**		
CF Activities	Male	107	3.14	.69	-2.440	.015
	Female	112	3.36	.64		
	Total	**219**	**3.25**	**.67**		

4.4　Loyalty to K-pop Stars

Upon measuring the loyalty for K-pop stars by gender on a five-point scale as shown in <Table 6>, loyalty to stars(2.80) was higher than loyalty to community(2.38), but loyalty for both stars and communities were relatively low. For loyalty to stars, compared to females(2.78), male students(2.82) were higher, while for loyalty to communities, females(2.44) were higher than males(2.32), but it was not statistically significant. Therefore, there was no difference in loyalty for K-pop stars and communities for male and female students.

[Table 6] Loyalty to Hallyu Stars

		N	*M*	*SD*	*t*	*p*
Loyalty to Stars	Male	107	2.82	.77	.313	.755
	Female	112	2.78	.83		
	Total	**219**	**2.80**	**.80**		
Loyalty to Fan Community	Male	107	2.32	1.06	-.850	.396
	Female	112	2.44	1.05		
	Total	**219**	**2.38**	**1.05**		

4.5　Verification of Research Hypothesis

Before examining the impact of the crossover activities(acting, music, CF) of K-pop stars on the loyalty(stars, fan communities) of college student consumers, correlation analysis was conducted to examine the relations between the crossover activities of K-pop stars and loyalty. The results are as shown in <Table 7>. First, between the crossover activities of K-pop stars and loyalty to stars, acting activities($r=.398$, $p<.001$), music activities($r=.567$, $p<.001$), and CF activities($r=.405$, $p<.001$) all showed significant positive correlation in 'loyalty to stars'. Between the 'genre destroying' celebrity activities of K-pop stars and loyalty to communities, significant positive correlation was displayed in acting activities($r=.164$, $p<.05$), music activities($r=.442$, $p<.001$), and CF activities($r=.270$, $p<.001$) as well for the 'loyalty to community' Therefore, it shows that there is a close

relationship between loyalty to stars and communities with the acting, music and CF activities of K-pop stars.

[Table 7] Correlation between Crossover Activities of Hallyu Stars and Loyalty

	Activities by Genre			Loyalty	
	Acting Activities	Music Activities	CF Activities	Stars	Fan Community
Acting Activity	1				
Music Activity	.466***	1			
CF Activity	.307***	.487***	1		
Star	.398***	.567***	.405***	1	
Community	.164*	.442***	.270***	.552***	1

*p<.05, ***p<.001

Next, in order to examine the effects of the crossover activities of K-pop stars on the loyalty of college student consumers, multiple regression analysis was conducted.

1) Effects of the crossover activities of K-pop stars on consumer loyalty The results of verifying [Hypothesis 1] that predicted that the 'genre destroying' celebrity activities of K-pop stars would have a significant positive(+) impact on the 'loyalty to stars' by college student consumers are as shown in <Table 8>.

[Table 8] Effects of Crossover Activities of Hallyu Stars on Star Loyalty

	Unstandardized Coefficients		Standardized Coefficients	t	p	VIF
	b	Std. Error	β			
(constant)	-.192	.296		-.648	.518	
Acting Activity	.199	.079	.156	2.519	**.012**	1.294
Music Activity	.513	.083	.419	6.216	**.000**	1.532
CF Activity	.182	.075	.153	2.445	**.015**	1.324

R^2=.362, adjusted R^2=.353, F(3. 215)=40.623, p=.000

First, the crossover activity variables(acting, music, CF) of K-pop stars explained the loyalty to stars at about 35.3%(adjusted R^2=.353), and the regression model was statistically significant(F(3. 215)=40.623, p<.001). Results of the regression analysis showed that for loyalty stars, acting activities(b=.199, t=2.519, p<.05), music activities(b=.513, t=6.216, p<.001), and CF activities(b=.182, t=2.445, p<.05) all had significant positive(+) effects, and that music activities(β=.419) had higher impact on loyalty to stars than acting activities(β=.156) and CF activities(β=.153). Therefore, [Research Hypotheses 1-1, 1-2, 1-3] were all adopted.
Through such results, it was found that the music, acting and CF activities of K-pop stars had positive impact on the loyalty to stars by college student consumers, and it was predicted that the music activities of Hallyu stars would have a bigger impact on loyalty to stars compared to acting or CF activities.

2) Effects of the crossover activities of K-pop stars on loyalty to fan communities The results of verifying [Research Hypothesis 2] that the crossover activities of K-pop stars would have a positive(+) impact on loyalty to communities by college student consumers is as shown in <Table 9>.

[Table 9] Effects of the crossover activities of K-pop stars on loyalty to fan communities

	Unstandardized Coefficients		Standardized Coefficients	t	p	VIF
	b	Std. Error	β			
(constant)	.050	.436		.114	.909	
Acting Activity	-.104	.116	-.062	-.889	.375	1.294
Music Activity	.698	.122	.433	5.745	**.000**	1.532
CF Activity	.122	.110	.078	1.114	.267	1.324

R^2=.203, adjusted R^2=.191, F(3. 215)=18.290, p=.000

First, the crossover activity variables(acting, music, CF) of K-pop stars explained loyalty to fan communities at approximately 19.1%(adjusted R^2=.191), and the regression model was statistically significant(F(2. 215)=18.290, p<.001). Results of the regression analysis showed that for loyalty to communities, only music activities(b=.698, t=5.745, p<.001) had a significant positive(+) impact, and that acting activities and CF activities did not have a significant impact for loyalty to communities. Thus, [Research Hypothesis 2-2] was adopted and [2-1] and [2-3] were dismissed. Through such results, the fan community loyalty for college student consumers was predicted that the music activities of K-pop stars would have especially more positive impact.

5 Research Results and Limitations of Research

This study examined the consumer preference and interactions according to the crossover activities of K-pop stars for college students, and then empirically identified their influencing relationship. Results of verifying the detailed relationship of the hypothesis set for this study and the variables are as follows. Verification results of [Hypothesis 1] It was analyzed that the crossover activities of K-pop stars had a significant positive(+) impact on 'loyalty to stars' for college student consumers. Regression analysis results showed that for loyalty to stars, acting activities(b=.199, t=2.519, p<.05), music activities(b=.513, t=6.216, p<.001), and CF activities(b=.182, t=2.445, p<.05) all had significant positive(+) impact, and that music activities(β=.419) had relatively bigger impact on loyalty to stars compared to acting activities(β=.156) and CF activities(β=.153). Therefore, [Hypotheses 1-1, 1-2, 1-3] were all adopted. Verification results of [Hypothesis 2] Results of the regression analysis showed that in loyalty to community, only music activities(b=.698, t=5.745, p<.001) had significant positive(+) impact, and that acting activities and CF activities did not have significant impact on loyalty to communities. Therefore,

[Research Hypothesis 2-2] was adopted and [2-1] and [2-3] were dismissed. It was thus displayed that while college student consumers were fine with the acting and CF activities of K-pop stars, they wanted them to continue their main job as musicians. However, because this study surveyed only students in colleges in Seoul and the surrounding area, it has limitations in terms of region and age. It is thus necessary to expand the number of persons surveyed by region and age and reflect the opinions of various groups in the research.

6   References

[1]   Seoul Shinmun, Reconstitution of article on Jan 25, 2016

[2]   Seoul Shinmun, Jan 25, 2016

[3]   Korea Creative Content Agency, www.kocca.or.kr

[4]   Korea Tourism Corporation, www.visitkorea.or.kr

[5]   Jung Sang-cheol, Ahn Sung-bae, Lim Ho-jung (2002). 『A Study on Support Plans for the Korean Popular Culture Industry to Enter Foreign Markets: Focusing on Continuation Plans of Hallyu』. Seoul: Korea Cultural Policy Institute

[6]   Shin Yoon-hwan (2002). 『Hallyu Phenomenon in East Asia: Comparative Analysis and Evaluation』. Sogang University Institute for East Asian Studies, Vol. 42 pp.5-35.

[7]   Korea Tourism Corporation www.visitkorea.or.kr

[8]   jang Soo-hyun (2004). 『Special: 2004 Domestic Academic Conference Presentation Paper: Theory of East Asian Community through Hallyu of China』. Chungnam National University Humanities Science Research Center Vol. 31-2 pp.215-226.

[9]   Koh Jung-min, Kang Shin-gyeom, Lee Ahn-jae (2005). 『Plans for the Continuation of Hallyu』. Samsung Economic Research Institute Issue Paper pp.1-88.

[10]   Shin Yoon-hwan, Lee Han-woo, Jeon Seong-hong, Lee Min-ja, Kim Sun-ho, Kim Sang, Kim Heung-gu, Shin Gyeong-mi (2006). 『East Asia Hallyu』. Permission: Jeon Ye-won.

[11]   Cho In-hee, Yoon Yeo-gwang (2013). 『A Study on the Ripple Effects of YouTube that Affected the Hallyu Culture: Focusing on the Singer PSY Syndrome』. Korea Entertainment Industry Association Thesis Collection Vol. 7-2 pp.9-18.

[12]   Choi Bong-hyeong, Park Ji-hye (2015). 『Policy Plans to Strengthen Competitiveness of K-pop』. Seoul: Korea Institute for Industrial Economics & Trade

[13]   Lee Hye-sun (2015). 『Impact of Hallyu Star Activities on Desire for Identification and Consumption Activities of Fandom』. Chung-Ang University Graduate School, Master's Degree Thesis

[14]   Korea Creative Content Agency(2014). 『2014 Q1 Contents Industry Trend Report』. Seoul: Korea Creative Content Agency

[15]   Korea Creative Content Agency(2011). 『2011 KOCCA Focus』. Seoul: Korea Creative Content Agency

[16]   Oliver, R. L.(1999). Whence consumer loyalty?. Journal of Marketing, 63(4), 33-44.

[17]   Johns, T., & Taylor, S. F.(2007). The conceptual domain of service loyalty: How many dimensions?. Journal of Service Marketing, 21(1), 36-51.

[18]   Hwang Young-chan (2013). 『Structural Relationship of SNS Sharing by Media Sports Consumers, Channel Immersion, Channel Conversion Intent, and Channel Loyalty』. Dankook University Graduate School PhD Thesis

[19]   Anderson, R. E., & Srinivasan, S. S.(2003). E-satisfaction and e-loyalty: A contingency framework, Psychology and Marketing, 20(2), 123-138

Rundle-Thiele, S.(2005). Exploring loyal qualities: Assessing survey-based loyalty measures. Journal of Service Marketing, 19(7), 492-500.

Oh Jung-ho (2010). 『Loyalty to Portal: Perceived Service Quality, Direct and Indirect Effects of Conversion Expenses, and Adjusting Effect of Pursuing Diversity』. Journal of Media Economics and Culture, 8(4), 7-55.

Hwang Young-chan (2013). 『Structural Relationship of SNS Sharing by Media Sports Consumers, Channel Immersion, Channel Conversion Intent, and Channel Loyalty』. Dankook University Graduate School PhD Thesis

[20]   Day, G. S.(1969). A two-dimensional concept of brand loyalty. Journal of Advertising Research, 9(3), 29-35.

[21]   Day, G. S.(1969). A two-dimensional concept of brand loyalty. Journal of Advertising Research, 9(3), 29-35.

[22]   Johns, T., & Taylor, S. F.(2007). The conceptual domain of service loyalty: How many dimensions? Journal of Service Marketing, 21(1), 36-51.

[23]   Hwang Young-chan (2013). 『Structural Relationship of SNS Sharing by Media Sports Consumers, Channel Immersion, Channel Conversion Intent, and Channel Loyalty』. Dankook University Graduate School PhD Thesis

Challenges of Supporting Specialized Diagramming in the e-Learning Environment

Janet L. Kourik[1], Jiangping Wang[1] and John Aleshunas[1]

[1]Department of Mathematics and Computer Science, Webster University, St. Louis, Missouri, U.S.

Short Research Paper

Abstract - *Many disciplines require learners to create diagrams that are standard to the practice. Diagramming, or drawing, has many benefits in learning and helps prepare students for diagramming in professional practice. Online e-learning, in which the student and teacher are not collocated, compounds the challenge of learning specialized diagramming. Recent developments in web-based diagramming tools are changing the landscape by reducing some barriers to diagramming in the e-learning environment. Cloud computing and Software-as-a-Service (SaaS) are the major enablers of web-based tools. This paper provides background on specialized diagramming in both learning and in professional practice, examines problems with traditional diagramming tools, explores the benefits of emerging web-based diagramming tools and argues the need for further research regarding specialized diagramming in the e-learning context.*

Keywords: Diagramming, web-based software, software-as-a-service (SaaS), e-learning

1   Introduction

Many science, technology, engineering, and mathematics (STEM) fields require specialized diagramming to analyze problems and learn to apply concepts. Examples of specialized diagrams include process flow, chemical structure, electronic circuit, and systems analysis diagrams. Students need both exposure to the diagrams and practice using the diagrams. In the face-to-face classroom setting it is easier to work problems on a whiteboard or review student work on paper. In the e-learning environment obtaining experience with diagramming and submitting practice for feedback becomes more challenging.

1.1   Diagramming

Ainsworth, Prain, and Tytler [1] write about the importance of drawing in order to learn science. Drawing can enhance engagement, deepen understanding, and support learning to reason. Drawing can show conceptual understanding, communicate complex ideas, and can be transformative in developing new inferences.

Both Lane [2] and Ainsworth, Prain, and Tytler [1] emphasize the importance of going beyond learning the rules for constructing diagrams to using diagrams to think about problems and solutions. In this way the emphasis is placed on the application of the diagramming technique to solve new problems. A diagramming tool that supports activities over artifact introduces the engagement that activity-based learning engenders [3]. Encouraging students to make multiple representations or models of problems and proposed solutions can enhance conceptual understanding [4].

Model-based reasoning involves analysis and problem solving. Developing models entails selection, organization, and integration of ideas. The process of building external models also leads to the development of internal models, an important educational goal [5].

Learners need experience using the diagrams and practice preparing professional quality versions of the diagrams. Benefits of experience include: practice applying diagramming techniques versus reading diagrams; experience using diagrams that are used in professional practice; and communicating more clearly with others than with rough sketches. Using a tool to generate diagrams that are professional in appearance can boost student confidence and contribute to a polished portfolio for future use.

1.2   Diagramming in professional practice

The old adage that a picture is worth a thousand words suggests the fundamental merit of using specialized diagrams. Diagrams can represent complex systems in ways that are difficult to do in written narrative [2]. Diagramming is a means of communication that conveys abstract representation of real work problems. They can transcend the confusion and ambiguity of written descriptions. Using diagrams is an important communication skill and also valuable in learning. Students may not be aware of the value of diagrams in communicating ideas and do not use diagrams as effectively in communication [6].

Many aspects of diagramming are fundamental to developing professional expertise [1]. Yet there is very little research on drawing in practice [7] and specifically in software development. However, Lane [2] presents four categories for diagrams used in both learning and professional practice: analogue, schematic, symbolic, and conceptual representations. Each category encompasses diagrams that represent real work problems.

A of survey found that 100% of the respondents found diagrams to be essential or helpful. Drilling down, 73% of respondents considered diagrams essential to any systems study with the remaining 27% reporting that diagrams are helpful [2]. It is noteworthy that the vast majority of respondents in this study (63%) were practitioners. Given the dominance of practitioners the study findings it can be inferred that diagramming is central the work process in practice. The rational about the benefit of using diagrams in system studies is shown in Table 1. Yet, in an investigation into the use of diagramming by distributed developers of the operating system Ubuntu, even professionals experience barriers to using diagrams in a distributed environment including lack of compatibility across tools [8].

Table 1. Reasons given for using diagrams in systems studies [2].

Reason	Percentage Reporting the Reason
Provides clarity of thought or understanding	31
Shows relationships, boundaries, and links	31
Showed whole situation	22
Helped communication	17
Quicker to produce and read	12
Sharing or exchanging knowledge and ideas	12
Helping with reflection and discussion	10
Making assumptions explicit	8
Sharing own thinking	4

2 Diagramming Software

A learning management system (LMS) is software that provides the mechanism for interaction in online and distance education. LMS are designed for general purpose use rather than for a specific discipline [3] and hence lack the flexibility to support specialized needs [4].

Some LMS can integrate other software systems into the LMS via software called plugins. The plugins related to computer science tend to have a narrow focus on one diagramming model such as Unified Modeling Language (UML) or dynamic visualizations rather than providing a broad range of drawing tools.

Learning management systems (LMS), frequently used to implement e-learning, may have a digital whiteboard feature or lack diagramming tools altogether [4]. In either case it is difficult to support modeling and diagramming needs in e-learning. The whiteboards in LMS require freehand drawing with a mouse, stylus, or finger making students self-conscious about drawing skills and making it difficult to generate professional diagrams.

Going outside the limits of a LMS using traditional software introduces a number of additional barriers to the adoption and application of specialized diagramming in e-learning.

Traditional specialized diagramming tools suffer from a variety of potential problems or barriers to adoption. Traditionally, specialized diagramming tools required the download and installation of software on the user's computer and presented users with several potential barriers to adoption. Some users may simply not be comfortable downloading and installing software. User computing platform, operating system or specifications may pose a barrier in that the user's platform (e.g. PC versus Apple) or operating system, such as Android, is not supported. Further the user's computer may have insufficient resources to easily run the diagramming software.

A single class of students may have many variations in their computing systems. Installation raises the challenge of properly configuring the software for the myriad of systems. This is a particularly challenging problem in e-learning. It can be very difficult for the instructor to provide sufficient configuration support particularly in a distance environment. Experience with configuration problems can delay their ability to carry out course assignments. The inability for a student to begin their assignments is debilitating for courses delivered in an accelerated format such as eight-weeks.

Traditional diagramming software is sometimes offered as freeware. More common is software that requires a purchase after a trial period. Sometimes the output from trial software is overlaid by a watermark bearing the vendor's logo. Prices for specialized diagramming may be prohibitive for students, ranging from educational discount rates (e.g. US$69) to hundreds of dollars US. In some cases the diagramming software serves a specific niche but not the range of diagrams needed for a given course.

2.1 Benefits of Web-based Diagramming Tools

Many of the problems may be solved by using web-based diagramming tools. Rather than installing software locally, the vendor hosts the software on their own servers. This is a fundamental paradigm shift brought about via cloud-based computing. In cloud-based computing the software is provided using the SaaS model. In SaaS the user uses the vendor-hosted software by means of the internet. The software offered on a pay-as-you-go basis. SaaS provides users with the ability to use software almost instantly on demand. Further the SaaS model allows users to increase or decrease their usage without investing in new hardware to support a period of peak demand. Another key to the success of SaaS is that software is often accessed via the ordinary, even ubiquitous, web browser.

Web-based tools do not require download or installation beyond the typical web browser. Nor is configuration a concern. Further, user familiarity with the browser helps to reduce the learning curve for a new diagramming tool. Not only are users familiar with the browser itself, the software is designed using established standards. The commonality in design eases the user experience with new diagramming tool.

In addition, web-based diagramming tools typically offer web-based tutorials to assist students in using the tool. Such web-based tutorials help instructors transition to the diagramming tool while devoting fewer resources to developing new user guides or tutorials.

A survey of web-based diagramming tools show support for a wide range of symbol sets as shown in Table 2.

Table 2. Symbol sets supported by a variety of web-based diagramming tools.

Business Process	Organization Charts
Cause – Effect	SIPOC
Data Flow	Software Design
Database	SWOT
Engineering	UML Diagrams
Flowcharts	User Interface
Industrial Process Control	Value Stream
Mindmap	Venn
Mockups	Wireframes

Software delivered as SaaS in the cloud computing paradigm can reduce initial startup costs and sometimes a version is offered at no charge as shown in Table 3. When a fee is required to use the software, that fee may be much smaller than the outright purchase of software, reducing the entry barrier as well as start-up costs and delays.

2.2 Drawbacks of Web-based Diagramming Tools

Web-based diagramming tools are not without potential drawbacks. Accounts may be required and some students may be reluctant to register with a vendor. Free versions of the tools may limit the number of diagrams or amount of storage that can be used. There may still be a learning curve for students although web-based tools usually have web-based tutorials in the form of short videos. Otherwise the instructor may need to develop training materials for a specific product.

With web-based software one is highly dependent on the vendor. The vendor may update the product version in the middle of a course, causing confusion for students and requiring the instructor to rapidly revise materials. With purchased software the installed version continues to operate until the user installs the update. The vendor determines how accounts are managed and when maintenance will take place.

When software is entirely hosted by the vendor users have little recourse if the vendor discontinues operation.

If SaaS adoption entails a fee there may be a lower start-up cost but, as Table 3 shows, recurring fees accumulate if access is needed for longer than a course.

Table 3. Examples of pricing for SaaS diagramming tools in USD.

Type of Service	Creately	Draw.IO	Gliffy	Lucid Chart	Office Online PowerPoint
Personal limited use	Free	Free	Free	Trial	Free
Single User-Month	--	Free	4.95	4.95	Free
Single User-Year	--	Free	47.88	39.96	Free
Single Pro -Month	5	--	9.95	9.95	--
Single Pro-Year	49	--	95.88	99.96	--
Team Pro-Month	25	--	--	25	--
Team Pro-Year	249	--	--	252	--
Education-Month	--	--	--	Free	Free
Education-Year	--	--	--	Free	Free

3 Case: Computer Science – Information Systems Analysis and Design

The information systems course sequence in a computing degree provides an example of types of diagramming needed in the computing curriculum at Webster University. In the computing curriculum the path started by COSC 2810 Systems Analysis and Design culminates in a pair of capstone courses: COSC4810 Information Systems I and COSC4820 Information Systems II. As a part of capstone courses students must demonstrate both breadth and depth of learning through an extended project. The project is covers several phases of the systems development lifecycle from feasibility through both logical and physical design. Often a prototype is developed based on the finalized design.

Students must demonstrate the application and mastery of many specialized diagrams in the process of completing the course project. The typical information systems project requires the following diagramming: Entity Relationship Diagram (ERD); System Use Case using Unified Modeling Language (UML); Dataflow Diagram (DFD); Gantt Chart; Flowchart detail where needed; Ishikawa Cause and Effect Diagram; Organization Chart; and Program Evaluation and Review Technique/Critical Path Method (PERT/CPM).

The variety diagrams needed for a single project illustrates the challenge students face in the course. The range of diagrams encompasses both STEM diagrams specific to information systems as well as business diagrams. Fewer diagramming tools provide support across disciplines, yet diagrams for a single project in information systems do cross disciplines. Using a diagramming tool helps students create

diagrams that are professional in appearance without having to worry about artistic drawing skill.

In the e-learning environment the challenge of installing and learning several kinds of diagramming tools would be too much for students particularly in the accelerated eight-week format. With the advent of web-based diagramming tools, the installation and configuration effort is removed from consideration. Further, web-based software tools are often accompanied by web-based tutorials to assist students and reduce the learning curve. An excerpt from a sample DFD is shown in Figure 1.

Figure 1. Excerpt from a Sample Data Flow Diagram (DFD) modeled in Creately.

During the conversion of a face-to-face course to online delivery, one instructor addressed the dilemma of diagramming tools by adopting Creately for several important diagramming techniques in the course – DFD, ERD, and UML.

The instructor created recorded tutorials addressing diagraming concepts as well as techniques using screen capture software. E-learning students were successfully able to complete the required diagrams for their course without having to install or configure software on their local machine. Furthermore, using Creately for specialized diagramming was so successful online that it was integrated into the face –to-face course as well, thereby standardizing the tools and the learning experience in the two environments.

4   Conclusion and Future Directions

Both practitioners and academics alike note the importance of diagramming to learning and practice. Drawing can help students develop skills in many areas from reasoning to problem-solving. Building on active learning, drawing can engage students while facilitating the development of internal conceptual models. Yet, relatively little research addresses the problem and potential of using specialized diagramming tools for learning in e-learning courses. The findings suggest that the specialized diagramming tools provide a fertile area for research.

Future directions may investigate the student adoption and use of diagramming along with its efficacy for learning. Comparative studies may explore the learning efficacy of hand-drawn versus software-prepared diagrams. The comparative user experience (UX) for traditional versus web-based specialized diagramming tools may be explored.

5   References

[1]   Ainsworth, S., Prain, V., Tytler, R.: Drawing to Learn in Science. Science, vol. 333, (26 August, 2011)

[2]   Lane, A.: A review of diagramming in systems practice and how technologies have supported the teaching and learning of diagramming for systems thinking in practice. Systems Practice and Action Research, vol. 26(4) pp.319-329, (2013)

[3]   Feldstein, M., Masson, P.: Unbolting the chairs, making learning management systems more flexible. E-Learn Magazine, ACM, (2006), http://elearnmag.acm.org

[4]   Rößling, G., Crescenzi, P., Ihantola, P., McNally, M., Radenski, A., Sánchez-Torrubia, M.: Adapting Moodle to better Support CS Education. In: ITiCSE-WGR'10, Bilkent, Ankara, Turkey, pp 15-27. (2010)

[5]   Quillin, K., Thomas, S.: Drawing-to-Learn: A Framework for Using Drawings to Promote Model-based Reasoning in Biology. CBE Life Sci.Education, vol. 14 issue 1 pp 1-16 (2015)

[6]   Manalo, E., Uesaka, Y., Perez-Kriz, S., Kato, M., Fukaya, T.: Science and engineering students' use of diagrams during note taking versus explanation. Educational Studies vol. 39 issue 1, pp. 118—123 (2013)

[7]   Socha, D., Tenenberg, J.: Sketching Software In the Wild. In: 35th Annual IEEE International Conference on Software Engineering (ICSE 2013), pp. 1237—1240. IEEE, San Francisco, CA, US (2013)

[8]   Yatani, K., Chung, E., Jensen, C., Truong, K. N.: Understanding How and Why Open Source Contributors use Diagrams in the Development of Ubuntu. In: 27th Computer Human Interaction (CHI2009), pp. 995—1004, ACM, Boston, MA, US (2009)

An online Capstone Experience course – Approved by Internal Quality Matters Reviewers

Suhair Amer
Department of Computer Science,
Southeast Missouri State University, One University plaza, Cape Girardeau, MO, USA 63701
samer@semo.edu

Abstract- *In this paper we discuss the steps followed to approve an online Capstone Experience course. In addition, we provide brief explanation of what have been done to satisfy each of the standards required by Quality Matters to approve the course through informal reviewers at our institution.*

Keywords: Quality matters, ethics in cyber world

1. Introduction

Quality Matters (QM) [QM] is a process that allows institutions and faculty within that institution to improve the quality of online, blended and even fact to face courses. It involves the use of a rubric that the instructor will use to evaluate his/her own course and make sure that almost all of it requirements exist in the course. Then the course is submitted for peer review to evaluate the quality of the design of the course. QM has been developed by the National Standards, Research Literature, Best Practices and Instructional Design Principles. It lists 40 standards, divided into eight areas that guides through the design of an online course. The main principle of QM is continuous improvement. That means that even if a course has been approved; within a couple of years the course should go through another review.

The instructor first makes sure that his/her course is aligned with the different required standards. The trained reviewers are responsible for providing specific feedback to the course instructor with suggestions for improving the course. The instructor then can improve the course so that it eventually meets QM standards. There are two types of reviews. Informal reviews are completed at an institution and are performed by trained reviewers from the institution. This type of review does not gain QM recognition. Official reviews gain QM recognition and have specific requirements for the team members. One member must be from outside the institution and another must be an expert in the subject matter. In both types, all reviewers must be certified by QM.

2. Process of approving the course

To introduce this process, at our university the information was explained during university wide talks to faculty. Handouts of information about Quality Matters along with the implementation plan were sent to faculty members and administrators. Faculty was informed about the deadlines related to approving different courses. Faculty were asked to attend a 5 week workshop, taught once a week, discussing different techniques to be used to build or improve an online course using the QM rubric. The workshops were taught by QM instructors. In the workshop, faculty saw other courses, reviewed their own courses against the rubric and went through commonly asked questions regarding the different standards. Upon completion, faculty received a certificate of completion. Faculty then worked on fixing their courses to meet Quality Matters rubric. Once finished, the faculty then submitted a copy of their course for review.

Although within two years almost all courses are to be approved, faculty has the choice to design their own courses. The Faculty can always ask questions and obtain clarification and support. A reviewer is assigned to the course when it is submitted. The reviewer will send, once finished with the review, the score and any comments and suggestions back to the faculty. If the course has met Quality Matters standards, no additional action is required from faculty and he/she can indicate that it has been approved to students. If it did not meet, the faculty is given the chance to make changes, reject some of the suggestions and explain why and then resubmit. This process is complete once the course meets the standards.

3. Describing the course

This course allows senior students to work on group-based solution of open-ended problems based on "real world" scenarios requiring interaction among students

with diverse training. The pre-requisite is: Completion of the University Studies Core Curriculum and senior standing in one of the disciplines specified for the particular section. Additional prerequisites may be required for particular sections.

Course objectives stat that the course is intended to provide students with an experience simulating that of professionals in their major disciplines, whether in industry, business, or academic research. Each section proposal will be evaluated both for its requirement of rigorous application of scientific or mathematical skills and knowledge as well as the extent to which the project is interdisciplinary. Individual sections will have purposes and objectives specific to the content areas addressed and the nature of the particular problem. Every section, however, will address the following common objectives:

A. "Oral communication:
   - Students will use effective oral communication skills to communicate with group members.
   - Students will make presentations appropriate to a general audience regarding their progress and proposed solutions to problems.
   - Students will orally present design alternatives or questions to a general audience and solicit necessary input.
B. Written communication:
   - Students will compose written progress reports that are suitable to a general audience.
   - Students will use written memos to record progress, solicit information, and suggest approaches within their groups.
C. Natural systems:
   - Students will apply background knowledge from their major disciplines to identify issues pertinent to the problem.
   - ·Students will apply content and methods from their major disciplines to propose possible solutions to the problem.
   - Students will apply content and methods from their major disciplines to develop a solution for the problem.
   - Students will devise experimental, modeling, application, or verification approaches and test the efficacy of proposed solutions.
D. Professional Ethics (Major related objective)
   - Identify, synthesize evidence from different sources and describe a conclusion to current professional ethical scenario. (Note: This may be different for each participant (group). Groups will gather evidence that can be used to support their claim or conclusion. These conclusions will be presented in the form PowerPoint Presentation.)"

4. Actions to satisfy standards

In this section we will discuss what have been done to satisfy each of the standards for an online version of the Capstone Experience Project/course using [Bruegge and Dutoit 2010] and [Lucidchart] as References. Our institution utilizes Moodle for the delivery of both online and face-to-face courses. We have used weekly format, where units and their corresponding activities are published and should be completed weekly. Moodle provides this information in blocks with a main block appearing at the top of the Moodle page. For each unit/week, we list the objectives of the unit/week. We list resources and what should be completed in that week. Activities may include an assignment, quiz, forum discussion, paper, report, or presentation. In the main block we list the syllabus, course objectives, faculty information, policies, etc.

4.1.Course Overview and Introduction General Standard

" The course overview and introduction set the tone for the course, let learners know what to expect, and provide guidance to ensure learners get off to a good start." [Rubric].

We used weekly format for this course through Moodle. We started the first block of the website having a lot of information. We took time to be very specific and provided a link for each category in the syllabus thinking that students will have fast access to the information. However, we realized while approving this course that reviewers differ and have different views of how a course should look like. The reviewer assigned to this course believed that the first block is a little bit long. They suggested to have a shorter first block in a shorter and cleaner style (not a list of webpages) and include a general course overview, present the schedule of activities, guide the learner to explore the course site, and indicate what to do first, in addition to listing detailed navigational instructions for the whole course. We also state the structure and purpose of the course.
The group will be scheduled a weekly recurring meeting with their adviser or client. As a group they need to set up their own meetings among themselves. At the beginning of the semester, a list of potential client projects will be available for students. The students are then asked to choose a project and start forming groups. This is done in a forum where a student is asked to start his/her own discussion thread and then other students may join.
Course schedule is available to students (activity, its description, grading rubric and due date) in advance.

A page entitled "Rules for Discussion/Email Communication" where the expectations for how learners are to communicate online and in the classroom is clearly stated.

A list of detailed pages for policies including policies established by the instructor or by the institution is listed. Late work policy should be explicitly listed and consistent throughout the document. In addition we list policies regarding the following: incomplete, withdrawal without penalty, confidentiality in the classroom, student grievances, electronic communication, etc.

At the beginning of the webpage, the instructor included a page entitled "Minimum Technology Requirements", where learners are provided with detailed, clearly worded information regarding the technologies students will need throughout the course. There is a page entitled "Prerequisite" at the beginning of the course webpage and this was also mentioned in the syllabus. The syllabus also includes "Minimum Technical Skills". For such a course, students have completed a majority of the computer or information systems courses that will enable them to be ready for working on projects for clients.

There is a page about the instructor such as phone number, email address, webpage, etc. Since this is an online course, the students don't see the instructor face-to-face class, so it would be helpful to build a better student-teacher relationship if they know each other better. The page may contain more information regarding the instructor such as hobbies, teaching philosophy etc., so that students can view the instructor as more approachable. In addition, in the first week the students are required to complete an introductions forum where they introduce themselves to the instructor and to the rest of the class.

4.2. Learning Objectives (Competencies) General Standard

"The learning objectives or competencies establish a foundation upon which the rest of the course is based. " [Rubric].

We dedicate a page describing and listing the objectives of the course. We also include activities that need to be completed with its assessment. A summary of the activity, assessment and to what objective it relates to is described in a table similar to table 1.

Table 1: relating objective with assessment and activity.

Activity	Total points	Total percentage	Related Objective(s)
Presentations			
Ethics	50	5%	A.1, A.2, A.3, D.1
Intro and General Analysis	50	5%	A.1, A.2, A.3, C.1
Detailed Design	50	5%	A.1, A.2, A.3, C.1, C.2, C.3
Implementation progress	50	5%	A.1, A.2, A.3, C.1, C.2, C.3, C.4
Final Internal	100	10%	A.1, A.2, A.3, C.1, C.2, C.3, C.4
Final External	200	20%	A.1, A.2, A.3, C.1, C.2, C.3, C.4
Reports			
Ethics	50	5%	B.1,B.2, D.1
Intro and General Analysis	50	5%	B.1, B.2, C.1
Detailed Design	50	5%	B.1, B.2, C.1, C.2, C.3
Implementation progress	50	5%	B.1, B.2, C.1, C.2, C.3, C.4
Final Internal Report	100	10%	B.1, B.2, C.1, C.2, C.3, C.4
Final External Report	200	20%	B.1, B.2, C.1, C.2, C.3, C.4
Total	**1000**	**100%**	

Students may be working on an activitiy for a couple of weeks. The unit/weekly objectives are stated and explained. The university studies objectives and competencies are aligned and the requirements for each section clearly stated. Because each project could be so different and there are general guidelines to be followed by the students, having general not specific guidelines or objectives satisfy the standard.

4.3. Assessment and Measurement General Standard

"Assessment is implemented in a manner that corresponds to the course learning objectives or competencies and not only allows the instructor a broad perspective on the learners' mastery of content but also allows learners to track their learning progress throughout the course." [Rubric].

In this course the students are required to develop a system for an adviser or client. To make sure that the students within a group will complete the project, the instructor put deadlines for several stages that lead to the final demo. For each stage the student should complete a report and a presentation. The stages include: analysis, design, and implementation. Course assessments are consistent with the course learning objectives. There is a section in the syllabus that is concerned with "Assessment, topics and Grading" with a table that fully explains how the course grades are calculated. The points, percentages, and weights for each component of the course grade are clearly stated. Late policy and how many points are deducted are stated. For each activity a rubric is provided. For example, table 2 explains the rubric used to evaluate a presentation.

Table 2: Rubric evaluating a presentation.

Criterion	Points
Presentation had a title slide (with project name, semester, group member names, etc.) and outline. The group members introduced themselves. Dress code: business formal.	8
Project description (summary) including client information.	8
Software Product Functionality(List functional and non-functional requirements and explain if the system does what it is supposed to do)	8
Use of Software Engineering Process(Follow the phases of a methodology)	8
DEMO - Software Product Functionality (Clarity; Organization, Navigation)(Group will run the system and try several scenarios. May use a video of how some parts of the system runs.)	100
Quality of Documentation (Requirements Spec,	30
Design and User Notes) (Have your complete document ready in a binder and indicate that the Document is available for review after presentation). In the final external presentation the Faculty and Advisory members will be meeting briefly with students after the presentations.	
Presentation had a "conclusion / future work" and "any questions?" slides and students answered questions in a professional way.	8
Overall quality of the product	30
Total	200

This is a capstone experience course and hence the main activities required are those that would advance and make sure that objectives are satisfied. The students are required to form groups, contact clients and work on their projects and submit a working project towards the end of the semester. A drop box titled "drafts" is provided for the students for every activity so that the student may submit a draft for the instructor to check and provide feedback before final submission.
After each presentation and report the student should expect feedback and the grade within a week.

4.4. Instructional Materials General Standard

"The focus of this Standard is on supporting the course objectives and competencies, rather than on qualitative judgments about the instructional materials." [Rubric].

This is a 4XX level course and there is no assigned text book for the course but a list of references. Each group's client will provide the resources necessary and the students should find/locate all material as needed. Projects differs from one project to another. Clients usually provide resources to the student (including equipment if required). In addition, since not all students may know the programming language and applications to be used for the project, we expect that the student will dedicate time to learn them.

4.5. Course Activities and Learner Interaction General Standard

"Course components that promote active learning contribute to the learning process and to learner persistence." [Rubric].

There are several objectives for this course that are mainly concerned with developing a system for a client. This will include completing several stages such as analysis, design, implementation and testing. The student

is required to complete a presentation and report regarding these phases. In addition, the students are required to work in a group and demonstrate how well they are completing their parts of the project and how well they are interacting with each other. They are required to use means of communication that will promote the advancement of the project.
We provide for the students a forum where as a group they may interact with each other. However, the student may use any type of communication tool. Students may use cell phone messaging, email, and tools such as [Com1][Com2][Com3].

A page is dedicated for "Policies regarding Feedback". The student/group should expect feedback within a week after the due date of the activity. For presentations, the group is also evaluated by their peers who will fill an evaluation form by the end of each presentation. The score and feedback/comments are compiled and published.

When developing this online version of the capstone experience course, we made sure that the student will perform the same activities that would be performed in a face to face version of this course. However, we kept in mind that they will be completed differently. For example, students are required to present their work as a group. One of the pre-requisites of this course is an oral communication university study course which teaches students how to make online presentations. In addition we provide supporting resources to how to develop a presentation [Present1][Present2][Present3], how to add voice[Voice], how to add a video [Video1][Video2][Video3] of them presenting, and how to add notes[Notes].
In their report, we required that they provide evidence of using a communication tool to communicate with each other and with client.

4.6. Course Technology General Standard

"The technologies enabling the various course components facilitate rather than impede the learning process." [Rubric].

It was unclear when submitting this course to evaluation how to satisfy this standard. Students are expected in this course to have enough knowledge about using different tools without us specifying every single one for them. A disagreement between the instructor and the reviewer on how to satisfy this object happened. As an instructor and with senior students, we expect students to know many tools and that even if they don't know it to go ahead and learn it. From the point view of the reviewer, a list of tools to be used is either listed or not. A statement indicating to students that they should devote time to

learn the tools that they need was not sufficient for the reviewer. In addition, it is hard for an instructor to list all possible tools out there since each project is unique and different. Anyway, the instructor decided that mainly, if the students agreed to work on a project, they need to learn all the techniques and tools to complete it. The instructor provided links to some tools.
For example, students can use [https://www.lucidchart.com/] to prepare design related graphs. Student can use the following tools to support communication as they see fit [https://realtimeboard.com/][·http://edtechreview.in/news/825-20-options-for-real-time-collaboration-tools][http://www.educatorstechnology.com/2012/08/the-top-27-free-tools-to-collaborate.html]. They can use other tools; however, they need to inform the instructor about them. In this course we are depending heavily on functionalities provided by Moodle and students submit their work via assignment drop boxes or complete forums so they are readily obtainable. Students are aware of any privacy policies of any tool used.

4.7. Learner Support General Standard

"It is important to ensure online learners know they have access to and are encouraged to use the services that support learners at the institution. In the Learner Support Standard, four different kinds of support services are addressed: technical support, accessibility support, academic services support, and student services support." [Rubric].

A link to the contact information of technical support is provided. We have a link to the institution's accessibility policy, a statement that informs the learner how to obtain an institution's disability support services; for example, a telephone number or link for the disability services office. There are links to the academic support services, and computer lab hours. All links are checked every semester to make sure that they are still working.

4.8. Accessibility and Usability General Standard

"The course design reflects a commitment to accessibility, so that all learners can access all course content and activities, and to usability, so that all learners can easily navigate and interact with course components." [Rubric].

Each of the pages used or referenced was clearly named and easy to navigate. After reviewer recommendation, we made requirements every week more concise so that the student will not be overwhelmed.

Most of the material is text-based, and the letters are clear and not a lot of multimedia material was used.

5. Conclusion

In this paper we discussed the process followed to approve an online Capstone Experience course. Brief explanation of what have been done to satisfy each of the standards required by Quality Matters to approve the course through informal reviewers at the institution has been provided. It took a period of time to have the course qualified for submission, and the reviewer also took time to review the course and provide feedback. The instructor had to make additional changes depending on reviewer comments and resubmit. In general, this approval process did improve the quality of the course and increased the satisfaction of both the instructor and the students. All courses are not the same. Although the instructor had other courses previously approved, this course took more effort and was harder to fix. This is because as a reviewer, there was no flexibility with standards. Either the website had the items required or did not. Since many of the standards were assumed such as knowing how to use tools, the instructor could not list all possible tools out there. After many tries the instructor provided some solutions but also kept it possible for students to choose other means and to report it. Finally, the course was approved and met Quality Matters and is currently offered at the university.

6. References

[QM] https://www.qualitymatters.org/
[Rubric]
    http://www.elo.iastate.edu/files/2014/03/Quality_Mat
    ters_Rubric.pdf
[Blooms]
    https://oit.semo.edu/oit/InstructionalDesign/BloomsT
    axonomy.aspx
[Bruegge and Dutoit 2010] Berd Bruegge and Allen H.
    Dutoit . Object-Oriented Software Engineering. 3rd
    edition. Pearson / Prentice Hall (2010).
[Lucidchart] https://www.lucidchart.com/.
[Com1] https://realtimeboard.com/
[Com2]   http://edtechreview.in/news/825-20-options-for-
    real-time-collaboration-tools
[Com3]http://www.educatorstechnology.com/2012/08/the
    -top-27-free-tools-to-collaborate.html
[Present1] https://support.office.com/en-sg/article/Create-
    and-store-a-PowerPoint-Online-presentation-
    ba9f56eb-3862-4027-9b91-1ce2a14b9323
[Present2]http://www.wikihow.com/Create-a-PowerPoint-
    Presentation

[Present3]https://support.office.com/en-us/article/Basic-
    tasks-for-creating-a-PowerPoint-2013-presentation-
    efbbc1cd-c5f1-4264-b48e-
    c8a7b0334e36?CorrelationId=c196a973-4242-42a6-
    96c6-c378bd857370&ui=en-US&rs=en-US&ad=US
[Video1]http://teacherlink.ed.usu.edu/tlresources/training
    2/PowerPoint/Adding_a_Video_to_a_Powerpoint_Pr
    esentation.pdf
[Video2]http://think.stedwards.edu/computerhelp/adding-
    video-powerpoint-presentation
[Video3]https://support.office.com/en-us/article/Add-and-
    play-a-movie-in-a-presentation-f3fcbd3e-5f86-4320-
    8aea-31bff480ed02?CorrelationId=7fd80ac8-3474-
    4b94-a6c4-e814dd87c2f9&ui=en-US&rs=en-
    US&ad=US
[Voice]https://support.office.com/en-au/article/Add-
    narration-to-a-presentation-0b9502c6-5f6c-40ae-
    b1e7-e47d8741161c
[Notes]https://support.office.com/en-us/article/Basic-
    tasks-for-creating-a-PowerPoint-2013-presentation-
    efbbc1cd-c5f1-4264-b48e-c8a7b0334e36

SESSION

E-BUSINESS, E-COMMERCE, ENTERPRISE INFORMATION SYSTEMS, AND RELATED MANAGEMENT ISSUES

Chair(s)

TBA

Using BPMN-based Business Processes in Requirements Engineering: the Case Study of Sustainable Design

F. Santana[1*], D. Nagata[2], M. Cursino[2], C. Barberato[3] and S. Leal[2]
[1]Faculty of ESTeM, University of Canberra, ACT, Australia
[2]CMCC, Federal University of ABC, São Paulo, Brazil
[3]CECS, Australian National University, ACT, Australia
[*]Corresponding Author: Fabiana.Santana@canberra.edu.au

Abstract - *Global economic challenges force companies to constantly seek alternatives to become more efficient in order to grow, or even survive. Process improvement has the potential to transform a company and lead to innovation while information technology is an enabler of business change. Both must evolve together to maximize the outcomes. This paper introduces the case study of a business process to support the sustainable design (SD) of products and services. The purpose is to illustrate how processes can be used to support eliciting and managing system requirements for highly complex domains, where both processes and requirements are difficult to define. The process was designed in Business Process Model and Notation (BPMN). The case study shows how information is gained during process mapping and how this information can be used in requirements engineering. Relevant SD knowledge and best practices are presented, making this process also very helpful for SD beginners.*

Keywords: Requirements engineering; Business process management (BPM); Business process model and notation (BPMN); Sustainable design.

1 Introduction

Business processes can be applied for mapping detailed information about a domain. They document and formalize best practices and the experts' knowledge about a subject, being a reliable guide to identify gaps and failures, extra work and improvements needed in informal/semi-formal processes present in most companies [7].

Business Process Management (BPM) comprises the activities of representing, analyzing and improving business processes in order to improve quality and efficiency, supporting innovation [5,7].

Business Process Model and Notation™ (BPMN™, in the following referred simply as BPMN) is a standard notation developed by OMG™ [9] for BPM, based on flowcharts. It was designed to be easily understandable by the main stakeholders of a process, such as business analysts, technical developers responsible for implementing the technology, and business people [5,9].

Requirements engineering (RE) is concerned with eliciting and managing requirements for the life cycle of software systems products. Business processes can be used to elicit and understand software system requirements due to the knowledge they summarize [7]. Keeping software systems aligned with business process is fundamental for companies to remain competitive nowadays. Therefore, business process are important assets to RE and must be perceived as such.

Business processes may also be helpful in other steps of systems development life cycle (SDLC). For example, they represent an important source of information for building software solutions based on services. Notorious examples are SaaS (Software as a Service)-based solutions and SOA (Service-Oriented Architectures) applications, where processes are very helpful to understand and identify service requirements, understand interoperability challenges and guide system integration [6,7].

A software package to design business processes in BPMN is usually known as Business Process Management System (BPMS). Different BPMSs incorporate different functionalities, such as performance evaluation, process analysis and execution. In this paper, the BPMS Bizagi Process Modeler™ [http://www.bizagi.com/] was chosen because it is compliant with the BPMN standard and it is a free, easy BPMS solution for modeling purposes. [6,7,9]

This paper presents a case study to illustrate how BPMN-based processes can be used to support requirements elicitation in highly complex domains, where both processes and requirements are difficult to understand and define.

The case study is focused on RE applied to the development of a software system to support sustainable design of products and services. It shows how information is gained during the design of a process and how this information simplifies RE. Results show how BPM can become a fundamental activity for RE and why it should be incorporated to SDLC, at least for complex systems.

The case study introduces relevant SD knowledge, techniques, challenges, pitfalls and best practices, which also makes the resulting process very helpful as a guide for SD beginners.

2   Sustainable design

Eco-efficiency studies the development of products and services to raise quality of life of populations worldwide while trying to reduce environmental impacts of the productive process and maintain competitive prices for products and services [1]. Clean production focuses on the continuous application of environmental strategies to raise eco-efficiency [http://www.uneptie.org/pc/cp/home.htm]. Product-Service System (PSS) is a system created to evaluate if either a product or a service should be chosen to address current needs, providing sustainability for both consumption and production [4]. Sustainable design (SD) is the activity of designing products and services to satisfy customer needs while reducing environmental impacts, providing eco-efficiency and clean production in a PSS scenario [3,4,8].

Life Cycle Assessment (LCA) is an ISO/IEC standard applied to evaluate environmental impacts associated with the production of goods [2]. LCA is essentially a quantitative method to measure emissions in each stage of the productive process, from raw material acquisition until the final destination of each product after usage. Considering only the relevant activities, LCA can be adapted to evaluate the corresponding impacts associated with the provision of services.

SD is a very complex activity [4]. It must consider social and economic impacts of introducing new or replacing products or services. Legal and human aspects that can interfere in the productive process or product/service adoption have to be taken into account. Evaluating potential consumption increases is also mandatory in SD, as well as evaluating rebound-effects (increase of environmental impacts in unexpected areas, such as people printing emails and several copies of the same documents in the early days of email adoption), as tthey may worsen the overall environmental impacts, even when a so-called "green" product is conceived [3,8].

In [8], a reference process for SD was proposed. The process is presented in Figure 1. In this process, six main steps for SD were identified: 1) functionality conception; 2)

Steps	PSS Aspects	LCA Aspects	Social Aspects	Economic Aspects	Other Aspects
1. Functionality conception	• Define the functionality (market demand) to be attended and the steps to achieve it • Identify options for PSS and evaluate environmental impacts of both products and services, to choose the best alternative • Carefullly study the consumer before replacing a product by a service	• Verify safe and health in product regular usage • Evaluate the complete life-cycle, inputs/outputs and environmental impacts of a PSS	• Evaluate quality of physical and social life • Verify the social impacts to replace a product for a service and vice-versa • Evaluate dynamic (time) approach	• Verify if the PSS is cost effective • Verify the cost of the PSS when compared to a competing versions of a product or a service able to attend the same requirements • Consider the environmental external costs (e.g. end of life recovery, reuse, treatment, disposal) • Apply this reasoning for all phasis of the product design process • Evaluate distributed economic model, with local resource supply (creative communities /cooperative networks)	• Verify legal aspects to the product introduction • Innovation of the life cycle basis • Platforms to implement PSS
2. Raw material aquisition	• Minimize the volume of materials used • Substitution of none/less hazardous raw materials • Analize the extraction and processing • Minimize energy, water , emissions, wastes and eliminate toxic components • Evaluate/reduce transport impact • Eliminate or reduce non-renewables usage	• Verify and reduce impacts in environmental management • Quantification of greenhouse gas emission • Evaluate environmental burden of the activity • Quantitative results	• Verify where and how do the raw materials are extracted/processed • Verify the ownership rights • Verify if the trading arrangements are equitable		• Stakeholder reconfiguration • Identification of new research areas and professional competence • Compliance with legal and technical specifications • Evaluate quality aspects • Obtain data to evaluate environmental burden
3. Manufacturing	• Optimise production technology • Minimize energy, water , emissions to air, wastes, and effluents • Eliminate /minimize toxic components and non-biodegradable substances • Maximize ecology efficiency	• Perform periodic greenhouse analysis • Evaluate environmental burden of the activity • Priorize quantitative results	• Analyze employee conditions of work (at company or subcontracted companies) and impacts on local community • Analyse local investments and adverse impacts for local and global community • Evaluate local initiatives		
4. Trade and delivery	• Evaluate/reduce transport impact for both products and services • Evaluate volume and nature of transport, and the type of fuel usage • Eliminate/reduce emissions to air / waste				• Stakeholder reconfiguration • Get data to evaluate environmental burden
5. Use / Maintenance	• Minimize energy, water , emissions to air, wastes (product and packing), and effluents • Eliminate non-biodegradable substances • Maximize durability	• Reason for PSS choice • Perform periodic greenhouse analysis • Evaluate environmental burden of the regular use	• Analyze adverse health/safety impacts for the local and the global community		• Evaluate rebound effects • Prevent colateral effects to PSS introduction
6. Re-use / recycling / energy recovery / disposal	• Apply strategias to extend the product life cycle • Design for repair and modular design • Simplify recovery of components for reuse and for recycling or waste treatment/disposal	• Perform periodic greenhouse analysis • Evaluate environmental burden of the activity	• Adverse adeverse health/safety impacts for the local and the global community		• Get data to evaluate environmental burden

Figure 1 – A reference process to design information systems for sustainable design based on LCA, PSS, social and economic aspects proposed in Santana et al. (2010) [8].

raw material acquisition; 3) manufacturing; 4) trade and delivery; 5) use/maintenance; and 6) reuse/recycling/energy recovery/disposal. PSS, LCA, social, economic, legal and other relevant aspects were identified. The main concerns and issues related to SD were also extensively discussed, leading to a complete understanding of SD while identifying major challenges and best practices for this activity.

However, the reference process presented in [8] was not in an ideal format to support RE nor it deeply studied the complexities inherent to each step. Deepening the reference process while designing the corresponding detailed process in BPMN provides the resources for a complete and realistic evaluation of the environmental impacts caused by introducing a new product or service, adequately guiding the construction of software systems to support SD. Functional requirements and quality attributes can be easily identified during the process mapping phase and from the BPMN-based business process for SD.

3   The BPMN-based business process for SD

The BMPN-based business process for SD starts with raw material acquisition and ends with residues disposal. With the exception of prototype development, the process must be executed before any product is manufactured or any service is implemented to ensure the proper application of SD principles.

The BPMN-based process can be applied to products or services under PSS. However, if a service is chosen, the required products to have it provided must be considered for SD, as well as additional requirements that may arise. For example, if having clean clothes is the SD need, a washing machine could be the product to be compared with laundry services but evaluating the latter should include transportation and labor. An overall evaluation should consider having a reduced number of washing machines worldwide vs. service-associated costs.

The main process for SD is presented in Figure 2. In BPMN, rectangles represent activities while diamonds are gateways to control the process flow. Rectangles with a plus ("+") symbol are macro-processes and thus must be detailed. Circles represent beginning and end of the process.

Raw material acquisition if followed by the "Resource Type" macro-process. In "Resource Type", the raw material "greenness" is evaluated to encourage the adoption of renewable or recyclable resources. "Resource Type" is presented in Figure 3.

Next step is to analyze pollutants emission caused by the product/service to be designed. This is described in the macro-process "Pollutants Emission" presented in Figure 4. Pollutants are classified as low, medium or high. Chemistry analysis and environmental laws will define specific values for low, medium and high. Classification depends mainly on products/services being designed, industry sector (e.g., plastics and chemical) and raw material usage (type and quantity). Unless minimum quantities of pollutants are being generated, optimization/redesign is required. Environmental contamination risks must be carefully evaluated. As every product or service always will generate at least a minimum amount of pollutants, the option "null" is disregarded in the "Resource Type" macro-process.

Transportation, the following step of the process, is one of the most important aspects to be evaluated when assessing products/services under SD. Transportation can, by itself, compromise completely a product/service "greenness", being local development always recommended but hardly adopted. Having manufactured products being developed locally is unlikely in the current global market. However, there are means of transportation that may reduce significantly environmental impacts. Therefore, global investments in efficient transportation networks are mandatory. Meanwhile, the adoption of products that can be transported via the available efficient networks must be prioritized.

The production process is evaluated in the next step of the BPMN-based business process for SD. The macro-process
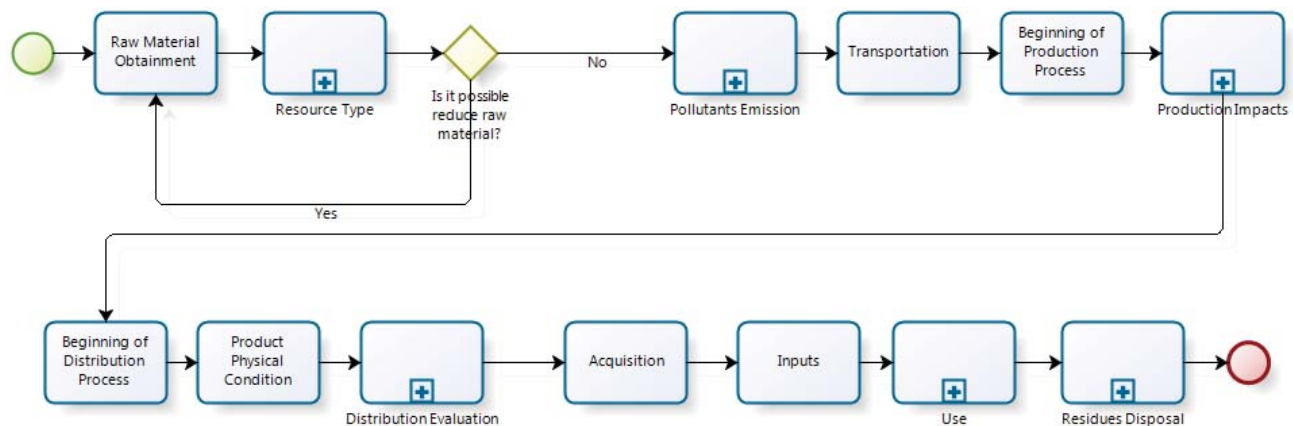

Figure 2 – The macro-process for SD.

"Production Impacts" is presented in Figure 5. This process evaluates the whole impact of manufacturing, considering energy expenditure, equipment wear and pollutants' emission by the manufacturer. Specific issues must be considered for each one of them, such as plant modernization and residues treatment.

Quality control and calculating waste are also important to ensure SD principles are being properly addressed in the "Production Impacts" macro-process. For example, environmental impacts caused by production rejects that cannot be recycled must be properly assessed, as well as associated costs for recycling whenever applicable.

Figure 6 presents the macro-process "Distribution Evaluation," which is the next step of the main process for SD. In this step, priority must be given to the analyses of possible distribution processes and scenarios. Transportation networks and risks attributed to transportation must be considered. This step is followed by product acquisition and inputs, where the assessment must be made from the manufacturer point of view. Environmental impacts caused by resellers should also be assessed when the producer has any control over the process.

Next step in the main process for SD is "Use", detailed in Figure 7. In this step, the designer must consider all

Figure 3 – The "Resource Type" macro-process.

Figure 4 – The "Pollutants Emission" macro-process.

Figure 5 – The macro-process "Production Impacts"

different uses/destinations that can be given by users to products/services, including incorrect use. Producer/provider's responsibilities are usually restricted to the specifications provided in the manual/contract that accompanies each product/service, but environmental impacts must still be assessed under SD rules to predict and minimize undesirable results (e.g., rebound-effect).

Last step of the BPMN-based business process for SD is "Residues Disposal", presented in Figure 8. In this macro-process, different forms of product discard must be considered, such as recycling, reuse and additional treatments to reduce environmental impacts.

Finally, the PSS system is presented in the Figure 9. It compares SD for products and services from the supply chain management point of view. Simplified LCA is performed in

the beginning to help the designer to start, but afterwards a complete assessment is provided and it includes all relevant steps of the main process, such as production, distribution, use and residues disposal.

4   Discussion

Defining the BPMN-based business process for SD was essential to understand this complex activity and define the problem domain, representing a valuable contribution for RE.

The process covered all technical aspects related to PSS and satisfaction of consumer's needs. The main functional requirements for designing a software system to support SD may be easily gathered by using a systematic approach to analyze the process step-by-step.

Figure 6 – The macro-process "Distribution Evaluation"

Figure 7 – The macro-process "Use".

Figure 8 – The macro-process "Residues Disposal"
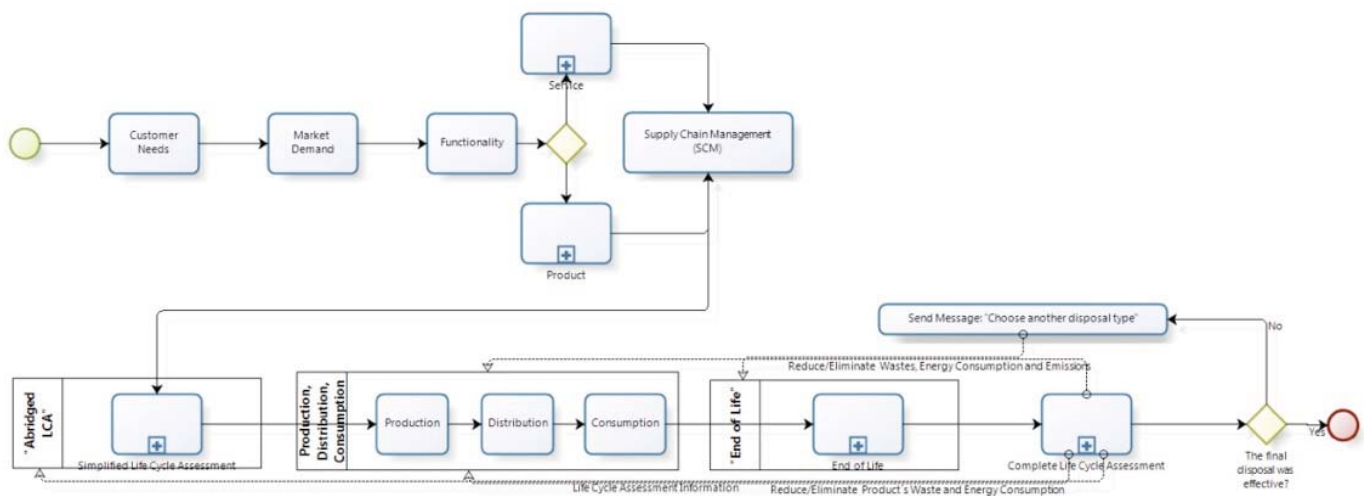

Figure 9 – Product Service System

Non-functional requirements may also be inferred, such as integrability and interoperability, as external information will be necessary for SD (e.g., information provided by transportation companies).

For example, the "Transportation" step showed that calculating distance between suppliers, manufacturers and distributors is an important requirement for SD. The same for incorporating recommendations and rules on pollutants' emissions according to classifications provided by industry or application field, identified in the "Pollutants Emission" macro-process (e.g., energy consumption is important for fridges manufacturers while other factors have more relevance for furniture and plastic manufacturers, such as quantity and type of raw material used).

Requirements on product disposal also could be identified, being treatment one of most important of them. For example, disposal issues caused by coffee machines designed to work with capsules has led some companies to create special disposal programs for collecting and recycling the capsules themselves. Had the SD process being followed since the beginning, those recycling programs could have been proactive instead of reactive.

Requirements must be well defined and quantifiable whenever possible, so words like "minimize" and "reduce" as presented in the process must, during the requirements elicitation phase, be replaced by numeric criteria or at least by intervals of confidence. Otherwise, applying LCA to measure and classify environmental impacts according to well-accepted international standards will not be possible.

The process presented in the case study is also a very reliable, detailed source of knowledge on SD. Thus, it can be used for training purposes, helping the designer to understand the inherent complexity of this activity, as well as the main challenges, pitfalls and best practices required to design clean products/services.

Finally, the business process presented in this work can be used as a reference guide to SD, independent of the development of a corresponding software system. As this process introduces a global analysis of environmental impacts instead of localized actions, unexpected synergies may occur, resulting in more appropriated, real "green" products that can also bring consumer satisfaction, profitability, competitiveness and environmental benefits.

5   Conclusions

This paper presented a BPMN-based business process to illustrate how they could support RE in highly complex domains, where gathering requirements was inherently difficult. Results showed that BPM was fundamental for mastering the complexity and defining the problem domain.

The case study was focused on RE applied to the development of a software system to support SD. The purpose was to show how information could be gained during the design of a process to simplify RE. As relevant SD knowledge and best practices were presented, this process can also be used for training purposes, being very helpful to introduce SD beginners to this complex activity.

6   Acknowledgements

7   References

[1] Stark, J. (2015). *Product lifecycle management* (pp. 1-29). Springer International Publishing.

[2] *ISO/IEC 14040: LCA – Principles and Frameworks. ISO/IEC 14044: LCA – Requirements and Guidelines.* (2006)

[3] Beuren, F.H., Ferreira, M.G.G., & Miguel, P.A.C. (2013). Product-service systems: a literature review on integrated products and services. *Journal of Cleaner Production*, 47, 222-231.

[4] Vezzoli, C., Ceschin, F., Diehl, J. C., & Kohtala, C. (2015). New design challenges to widely implement 'Sustainable Product–Service Systems'. Journal of Cleaner Production, 97, 1-12.

[5] Shapiro, R., White, S. A., Bock, C., Palmer, N., Muehlen Mz, B. M., & Gagné, D. (2012). BPMN 2.0 handbook second edition. Future Strategies, Lighthouse Point.

[6] Georgakopoulos, D., & Papazoglou, M. P. (2008). Service-oriented computing. The MIT Press.

[7] Santana et al. (2014) "A reference process for automating bee species identification based on wing images and digital image processing." Ecological Informatics 24 (2014) 248–260. http://dx.doi.org/10.1016/j.ecoinf.2013.12.001

[8] Santana, F. S.; Barberato, C.; Saraiva, A. M. (2010) "A reference process to design information systems for sustainable design based on LCA, PSS, social and economic aspects." In: What Kind of Information Society? Governance, Virtuality, Surveillance, Sustainability, Resilience. 1ª. ed. Boston: Springer, 2010, v. 328, p. 269-280.

[9] Object Management Group (OMG™) Business Process Model and Notation™ (BPMN™) v2.0 Standard. Available at http://www.omg.org/spec/BPMN/2.0/. Last accessed on May 2016.

Process-oriented IT-Management as management approach to face digitization

Isabell Schrader
Department of Business Studies
schrader.isabell@gmail.com

Olaf Droegehorn
Department of Automation & Computer Science
odroegehorn@hs-harz.de

University of Applied Sciences Harz
Friedrichstrasse 57-59
38855 Wernigerode, Germany

Abstract – *The increasing digitization in nearly all relevant market sectors speeds up the daily business and the whole economy. As companies strive to react faster to changing market conditions and increasing user expectations the need to adapt also their internal structures becomes more urgent every day. A major contribution to these structural updates can be done by IT-departments, as they are mainly responsible for providing necessary IT-solutions and – functions for the business units. Although these chances have clearly been identified the cooperation between IT- and business units is still difficult and underperforming. Capgemini, based on an international study, and project managers agree that the cooperation between business- and IT units needs to be redefined. A promising approach for this redefinition is typically described with the term Business-IT-Alignment, which basically means that the management of IT activities is aligned with the main business processes of the company, leading to a process-oriented IT-Management (po-ITM). In this paper the current state of IT-Management practices are reviewed and several approaches to implement po-ITM are discussed. Based on a business case several implementation scenarios are evaluated and a decision-making-baseline for executives is derived in order to ease the transition towards po-ITM and therefore to a more reactive and successful business strategy.*

Keywords: Organizational and management issues, IT-Management, Business-Process-Orientation, Business-IT-Alignment, Digitization

1   Introduction

Digitization, being one catalyzer for E-Commerce, is reaching nearly all market sectors, even those ones that have been analog and paper based in the past years. Due to this change the role of IT-departments in companies is getting more crucial as the production of goods and services, the valuable business objects, is nowadays heavily depending on IT-services and -functions. With the increasing speed of digitized businesses the need for more efficiency along the value chain rises up, because the production of goods and services can now be optimized in many more ways than ever before, hence the competition on the market is getting more challenging.

Therefore managers typically strive to increase efficiency and to reduce costs within an organization.

Due to the increasing digitization of processes modern companies are furthermore challenged by requirements arising from IT-aspects, for instance increased speed for the provisioning of IT services, more technical innovations, more data security, improved information analysis and better information usage.

Digitization conquered the agenda of top-managers for a couple of years already and is still an ongoing challenge.

Although suitable IT-Management frameworks and models to support IT-driven business processes exist, practical implementations of these process models are lacking behind mainly due to inefficient communication interfaces between units or a wrong or even a missing Business-IT-Alignment.

Within the process of digitization many structural reorganization decisions need to be made within an organization. The following observations are the typical starting point for the reorganization towards digitization:

- IT units are mainly focused on the provision of specific IT-functions and -services and work therefore primarily oriented towards those functions (function-oriented)

- Business-IT-Alignment, and therefore the understanding that also IT-services should be part of an overall process-oriented management, is not present

To stay competitive and to improve as well as increase business performance with ongoing digitization a process-oriented holistic management approach, and therefore also process-oriented IT-Management (po-ITM) is needed.

Within this paper several different scenarios for implementing po-ITM are discussed and evaluated based on a outcome of a research paper. Under the assumption that po-ITM improves business performance, scenarios are analyzed using a business case to figure out benefits and costs of various implementation strategies. Based on the findings a decision-making-baseline for executives is formulated in order to enable a qualified decision if and how po-ITM should be implemented within a selected company.

2   Motivation – Challanges for innovative IT-Management

Whereas it has been sufficient in the past years to manage IT-service- and application development and additionally the organisation of IT-operations to fullfill upcoming new IT-service needs the continuously increasing demands on security, stability and efficiency of IT services require different management and control structures throughout the whole IT service-lifecycle [2].

Kelleher quoted Britain's Winston Churchill: "Never have so few, been asked to do so much, for so many, with so little." In this context Kelleher summarizes the six most significant trends and challenges within the IT-Management of companies, which are: frequently new devices, bring your own device (BYOD), shrinking budgets, reduced headcount, advanced persistent threat and cloud services [13]. Consequently innovative companies are forced to enhance their IT-Management processes and tools [3].

Although suggestions about what kind of skills and abilities are urgently needed to enhance IT-Management processes and instruments as well as hints on how IT- and business units could and should work more closely together are under research, there is no fundamental answer to these questions so far and therefore no universal solution at the horizon.

According to the IT-Trend study at least a single, maybe several, IT units are essentially needed in modern, e-business related companies in order to produce business objects as well as value added services and therefore to produce revenue and to further enhance business opportunities [1]. If at least a single/central IT unit is no longer indispensable for the production of revenue, a differentiated Business-IT-Alignment is recommended in order to optimize the ressources used by the IT-unit and to actively integrate the IT-personell in the creation process of business objects for mutual understanding.

Studies, such as the "IT Compass 2014" [7] and "IT Trends 2015" [1], showed that functional cross cooperation, especially between business and IT units, are desirable, but it fails in most cases due to the understanding or communication between these parties. With the help of po-ITM this communication gap can be overcome and business relevant processes can be improved or increased.

3   IT-Management : Function- vs. Process-Orientation

IT-Management is the combination of the management of technical as well as disciplinary responsibilities that includes planning, preparing, directing, monitoring and evaluating all activities in the field of IT [4].

IT-Management addresses the monitoring and stearing of IT units [1], which means pursuing business objectives and supporting an organization by the use of information technology [1]. IT-Management in its institutional meaning includes also executives positions in the IT sector [4]. If IT-Management is viewed from a functional perspective, it can be divided into strategic, tactical and operational tasks [5].

The IT is guided by the IT-Management so that both the needs of the customers, the service recipients as well as the overall organization are taken into account. Hence IT-Management can be divided into areas of responsibilites that are illustrated in figure 1.
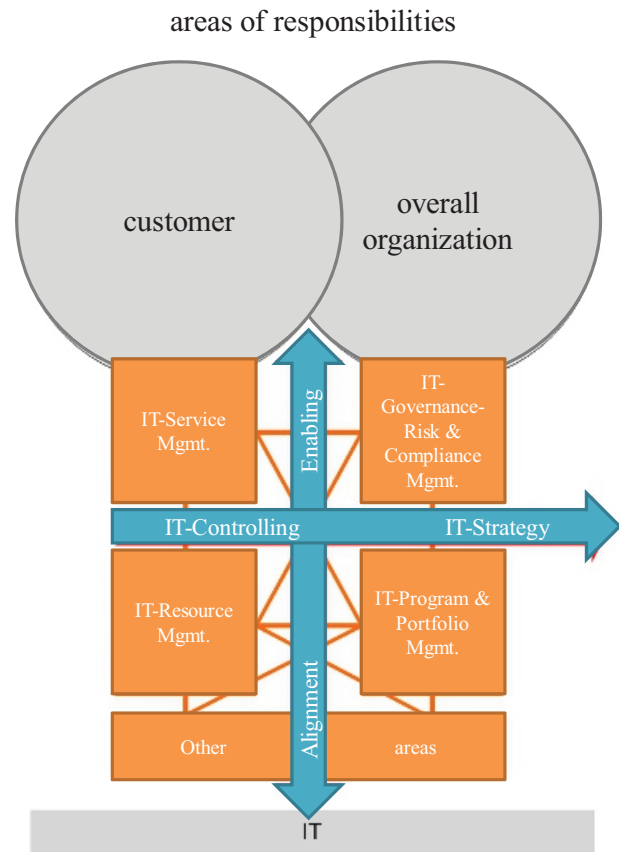

Figure 1: areas of responsibilites of IT-Management [11]

Process orientation means, thinking in value chains and process coherences. With a process-oriented organization the optimal interaction of all functions [in the sense of a process] within an organization (regardless of the organizational structure) shall be ensured in order to pursue a common business objective [5]. The main characteristics of a process-oriented organization are [6]:

- Orientation on the target object and thus focus on quality and efficiency of task completion
- Cross / integrative value chains with low organizational and media breaks
- flat hierarchies with short information paths
- seize only necessary activities (reduction of tasks)
- Contemplation of employees in terms of a decisive quality criterion (employee orientation)

In contrary the traditional organization is based on functions and hierarchies. Here every operational function pursues their own objectives and may be in conflict with the objectives of other functions [5] or the whole business. If a company works predominantly function oriented it is characterized by [12]:

- a hierarchy principle
- heavy regulation due to legal or other provisions
- specialization in service provision
- separation of technical and resource responsibility
- organizational structure aspects as a framework for processes

Usually IT departments work under the assumptions to provide dedicated functions, which means they are structured by specific tasks, needed for the related functions. Hence the IT department provides specialized technical services that are needed in various functions (e.g. procurement, logistics, production, marketing, research and development, administration, etc.). According to the German Federal Ministry of the Interior, a large part of process tasks (e.g. Service Support Management and Service Delivery Management) within IT operations and IT units are edited but "not organized as a process" [2] instead they operate based on their functions.

Althoug an overall process orientation is truely needed, the IT departments, and especially IT experts, should continue to work oriented on their major functions, because within the profound service/product production process (and its provison) indepth knowledge is required by individual employees, to ensure the process execution.

Nevertheless the responsibility of IT-Management is to align this knowledge with the overall business processes of the company, which means process-oriented alignment of the dedicated IT-functions.

As a matter of fact it is beneficial if the IT department, and the related personell, understands the processes of the business units, because only then solutions can be derived that might be useful across disciplines and several units. As a result the overall processes for the production of business objects and the service provisioning of a company can be supported more effectively and efficiently.

Achieving service targets in IT units (such as the best possible support for business service provisioning or how to troubleshoot a server failure in the shortest possible time) is a management responsibility. If po-ITM is implemented, all functions of an IT organization can be commonly aligned to business processes. Therefore the scope, quality and efficiency of service creation can be measured and controlled [2].

But why is a process-oriented IT-Management in most companies not implemented or only partially established in the corporate culture? One possible answer to this question is the fact that IT- and business areas cooperate in an inadequate way. The trend study "IT Compass 2014" [7] showed that the IT- and business units see the need, in times of digitization, to find a way to collaborate [7]. However this knowledge alone is not enough, the study gives no hints about how the two units could cooperate closer with each other in order to achieve the overall goal.

IT units are, according to the respondents of the study, a core component of corporate strategy [7]. If IT units are such a significant part of the corporate strategy po-ITM should therefore be introduced in those companies.

4   Approach to implement process-oriented IT-Management

To include the IT-unit into a corporate strategy a change from function to process-oriented IT-Management is necessary. In addition a company requires special knowledge and skills in the areas of organizational development and change management in order to raise awareness in an appropriate way and to incorporate all participants and stakeholders. Furthermore it requires well trained teams, that move along the value chain, so that a company can quickly adapt according to e.g. changing customer requirements. According to the German Federal Ministry of the Interior the following steps are necessary to perform a change from function to process orientation [6]:

- Identification and description of the necessary products / services and processes
- Decentralization of decisions and responsibilities (also decentralized resource responsibility)
- Adoption and consistent application of appropriate managerial control instruments
- continuous focus on customer benefit and thus checking / adjusting the type and quality of products and services
- Conversion of highly specialized, function-oriented divisions to work more integrated (optimal processes determine the structure of an organization, not vice versa)
- increased use of modern IT (e.g. document management systems (DMS), workflow management systems) to further increase transparency and efficiency and to overcome the concentration of expert knowledge to individuals [6]

The challenge is to introduce po-ITM in a company with well established structures and hierarchies. The human factor needs, however, still be taken into consideration which should result in an adequat "living of processes" [9]. According to Ebel change management is fundamental, because without the necessary awareness, each target concept and every vision is doomed to failure.

Therefore according to Ebel leadership qualities are essential [9]. At this point it should be decided whether the respective company uses external IT consultants for such a project to support or whether the necessary competence is available within the company itself. This decision can be qualified by the help of a business case.

Prerequisite knowledge and skills are helpful when implementing the intended target situation:

- Expertise / knowledge of po-ITM
- Structuring of projects
- Analytic skills
- Motivation of the company, why po-ITM needs to be introduced
- Knowledge of the business processes of the company to which po-ITM needs to be aligned
- Knowledge of methods and frameworks for IT processes
- Communication skills in accordance with IT and business units to communicate

In conclusion this means that certain skills, such as interdisciplinary communication skills, are essential for process orientation. This includes a comprehensive process knowledge that includes "both the business processes of the company as well as internal processes [or Features] of the IT organization" [8].

To conduct successfully training courses, workshops and change management a common language is the basis for a joint coordination between IT and business units (Business-IT-Alignment). According to Tiemeyer [8] an efficient and target-oriented management of employees and the ability to work within a team, a person who is able to integrate himself in all levels of the company, and constructively supports or enables sustainable solutions, is necessary for a successful IT-Management [8]. Finally the role of a CIO is a crucial role in the introduction of po-ITM. Expectations towards IT units are high. Corresponding to the study [7] business units expect the following range from IT departments:

- Supporting departments with business processes optimization
- Provision of IT solutions for corporate management
- faster response to new requirements of the business
- Empowering mobile working
- Implementation of compliance requirements
- Support for introducing new products / services
- Networking with business partners
- Support for the reduction in corporate costs
- Marketing and sales support

To meet the requirements, companies can not deny IT functions and their correspondence to po-ITM. However, processes can be designed for more flexibility and more effectiveness if both sides [business and IT] work well

together and according to the IDC analysis this helps in the process of digitization [7].

More and more companies are reacting to the increasing importance of IT to the business by allocating the role of the CIO in addition to the classic IT manager [8]. The following figure 2 summarizes the transformation of IT management and therefore the transformation of responsibilities of a CIO.

Typical orientation „old" classic IT-Management	IT-orientation „new" IT-Management as CIO
• Thinking and acting of IT Manager is predominantly cost-oriented • Technical orientation when finding decision as well as implementations • Customer orientation (customer are integrated as close as possible) • Employee orientation (alignment individual employee leadership) • Internal orientation (cooperation with business units) • IT Manager thinks in results (performance/value), Management is in the center of focus)	• performance-oriented • Business and company oriented • IT in cooperation with business (Business-IT-Alignment; person of contact for executives); this is done systematically with a clear concept • Not only concentrated on the leadership of single employees, but instead managing of teams (team-building, lead teams to success etc.) • External orientation (strategical, partner-orientation via business-relationship management)

Figure 2 : IT-Manager / CIO – change of the job profile [8]

In the new job description of a CIO it becomes clear by what po-ITM can be characterized: performance orientation, business and commercial orientation, cooperation between IT- and business units and the management of teams.

A business case may support a qualified decision on the introduction of po-ITM. First the own company's situation must be analyzed in order to identify a target situation and several different alternatives for going forward. These are then examined in terms of their strengths and weaknesses and the advantages and disadvantages, like a SWOT analysis, in order to identify the qualitative benefits (see figure 3). Subsequently it should be identified (preferably with the IT and business units together) how the benefits can be presented in monetary terms. Possible scenarios for implementing po-ITM, being comparable, are:

- Realization by external consultants
- In-house implementation by employees
- In-house implementation with in-house consulting
- A combination of external consultants and in-house consulting
- default alternative

alternative action	advantages / strengths	disadvantages / weaknesses
Realization by external consultants	Neutrality by performance-related compensation; available more quickly, because consultants work exclusively on the project; Efficiency as consultants are familiar with methods and techniques; Credibility towards management; Mediation if different stakeholders diverge	No transfer of knowledge; Dependence on consultants; Stanadardized project schedule by consultants, which may make it difficulte for everyone involved to understand and comprehend
Realization by external consultants	Quality if specialist consultants are selected; Innovation, because new knowledge comes into the company	
In-house implementa tion by employees	Entrepreneurship is promoted; Quality; Strengthening collaboration and cooperation; Understanding the project	Limited availability of employees due to daily business, inefficiency by lack of knowledge of methods, lack of credibility
In-house implementa tion by employees	Benchmarking option with other companies	Missing Input or missing perspective from outside → blindness
In-house implementation with in-house consulting	Benefit from expert knowledge of internal consultants, knowledge transfer remains in the company	Limited availability of employees due to daily business, inefficiency by lack of knowledge of methods, lack of credibility
In-house implementation with in-house consulting	Entrepreneurship is promoted, less cost, quality; Strengthening collaboration and cooperation; Understanding the project	Missing Input or missing perspective from outside → blindness
A combination of external consultants and in-house consulting	Benefit from expert knowledge of consultants, knowledge transfer, quality by knowledge combination	Divergent perspectives between external and internal consultants
A combination of external consultants and in-house consulting	Efficiency as consultants are familiar with methods and techniques; Credibility towards management	Limited availability of employees due to daily business
A combination of external consultants and in-house consulting	Quality if specialist consultants are selected; Innovation, because new knowledge comes into the company	
A combination of external consultants and in-house consulting	Entrepreneurship is promoted, less cost, quality; Strengthening collaboration and cooperation; Understanding the project	
default alternative	clear rules for employee responsibilities	Lack of communication and collaboration can lead to employee dissatisfaction; inflexible to new requirements (for example new products, cross-units tasks)
default alternative		Competitiveness decreases; Customer dissatisfaction increases; low innovation potential

Figure 3 : Generic comparison of alternativ actions in order to implement po-ITM

For alternative actions external and internal costs are gathered. Whereby a comparison of different offers by external consultants is necessary to examine external costs, so that the management can evaluate the extent to which the "concept" of po-ITM is understood. At the end it is essential that all the

company's employees are involved, because everyone is involved in the company's products and services provisioning and needs to receive the possibility to get a basic understanding of po-ITM. Figure 4 shows a summary of the generic implementation approach of po-ITM and a time-based estimation.
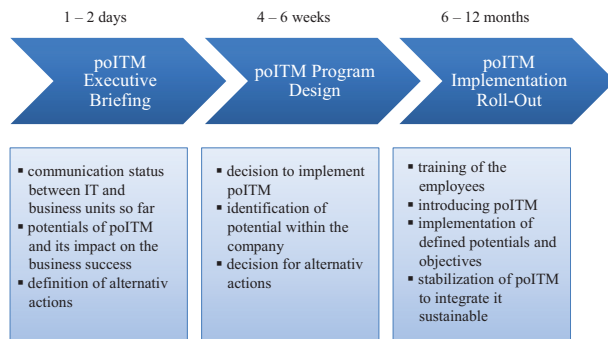

Figure 4: Generic implemenation approach for po-ITM

5 Conclusion & Outlook

Whithin this paper several possibilites, scenarios and the necessity for introducing po-ITM have been discussed and outlined. Under the assumption that po-ITM improves the production of business services, different alternative actions for implementing po-ITM were analyzed regarding their benefits and costs.

A business case may be used as a tool for decision making, whether and how po-ITM should be implemented. Different possibilities are existing to approach a colloboration between business- and IT units by using po-ITM and thus improve the company performance and thereby remain competitive.

Process-oriented IT management improves collaboration between IT- and business untis, whereby the company's performance runs more efficiently and effectively. In order to ensure the quality of processes for the provision of services an appropriate quality management needs to follow. To continusly support po-ITM after implementation, Six Sigma could be a possible method for quality assurance and management. As described in the studies above, business and IT units will work together much more closely across units in the future. Process-oriented IT management can be a supportive concept to do this collaboration.

A survey of companies can be used simultaneously to find out whether companies exist that already apply the principle of po-ITM and to find out why companies have not yet set up their structures in this regard. Furthermore other alternative actions could be considered within a business case that may arise for instance, if a company operates on a global scale. But even then the business expectations are high, although they are scattered through different markets and continents. As a consequence particular those large companies are facing the daily challenge of communication and collaboration across

timezones. It is precisely this collaboration which is crucial in the development and takeup of "digitization".

6 References

[1] Heimann T., Emenako D., Studie IT-Trends 2015: Digitalisierung gibt Zusammenarbeit zwischen Business und IT eine neue Qualität. Available: http://www.de.capgemini.com/sites/default/files/resource/pdf/it-trends-studie-2015.pdf (2015, Feb. 01).

[2] Bundesministerium des Innern/Bundesverwaltungsamt, ITIL und Standards für IT-Prozesse: Prozess-Standards für die Entwicklung der IT-Service-Organisation gemäß ITIL Best Practices. Available: http://www.cio.bund.de/SharedDocs/Publikationen/DE/Architekturen-und-Standards/studie_itil_und_standards_fuer_itprozesse_download.pdf?__blob=publicationFile (2016, March 09).

[3] Olufs D., Strategisches IT Management. Available: https://www.sysedv.tu-berlin.de/fileadmin/fg161/hp/lehre/StratITM/02-Strategisches_IT_Management_part_1.pdf (2016, March 09).

[4] Beißel S., IT-Management für Bachelor. Stuttgart: UTB, 2014., ISBN: 9783825241827

[5] Lehner F., Scholz M., Wildner S., Wirtschaftsinformatik: Eine Einführung, 2nd ed. München: Carl Hanser Verlag, 2008., ISBN: 9783446415720

[6] Bundesministerium des Innern/Bundesverwaltungsamt, Handbuch für Organisationsuntersuchungen und Personalbedarfsermittlung. Available: http://www.orghandbuch.de/OHB/DE/Organisationshandbuch/1_Einfuehrung/11_Organisation/112_FunktionVsProzess/funktionvsprozess-node.html (2015, Feb. 06).

[7] Quack K., "IT und Fachbereiche nähern sich an: Die Trendstudie "IT-Kompass 2014" zeigt vor allem eines: Die Notwendigkeiten der Digitalisierung führen IT und FAchbereiche enger zusammen," Computerwoche, 12 Mar, pp. 28–33, 2014, http://www.computerwoche.de/a/it-und-fachbereiche-naehern-sich-an,2555787.

[8] Tiemeyer E., Herausforderungen und neue Management-Aufgaben für IT-Verantwortliche – nachhaltige Kompetenzentwicklung ist unverzichtbar. Available: http://update.hanser-fachbuch.de/2013/07/herausforderungen-und-neue-management-aufgaben-fur-it-verantwortliche-nachhaltige-kompetenzentwicklung-ist-unverzichtbar/ (2015, Jun. 24).

[9] Ebel N., ITIL V3 Basis-Zertifizierung: Grundlagenwissen und Zertifizierungsvorbereitung für die

ITIL-Foundation-Prüfung. München [u.a.]: Addison Wesley, 2009., ISBN: 9783827325990

[10] Hochstein A., Six Sigma zahlt sich auch in der IT aus. Available: http://www.computerwoche.de/a/six-sigma-zahlt-sich-auch-in-der-it-aus,596016 (2016, March 09).

[11] Resch O., IT-Management. Available: http://www.enzyklopaedie-der-wirtschaftsinformatik.de/wi-enzyklopaedie/lexikon/daten-wissen/Informationsmanagement/Informationsmanagement--Aufgaben-des/it-management/index.html/?searchterm=Business-IT-Alignment (2015, Feb. 17).

[12] Bundesverwaltungsamt, Organisationshandbuch: Funktionsorientierung vs. Prozess-orientierung. Available: http://www.orghandbuch.de/OHB/DE/Organisationshandbuch/1_Einfuehrung/11_Organisation/112_FunktionVsProzess/funktionvsprozess-node.html (2015, Feb. 16).

[13] Kelleher D., The six most significant trends in IT management. Available: http://www.gfi.com/blog/the-six-most-significant-trends-in-it-management/ (2016, March 09.)

Business process change: A guide for implementers

Vahid Javidroozi, Hanifa Shah, Ardavan Amini, Gerald Feldman

Computing, Engineering, the Built Environment (CEBE) Faculty, Birmingham City University (BCU),
Birmingham, West Midlands, UK

Abstract – *Systems integration has become a need for enterprises, in order to deal with competitive business environment. Business Process Change (BPC) is known as the most imperative challenge for systems integration. Currently, a number of BPC methodologies have been developed by researchers and experts, but none of them comprises "identification of BPC type" as a significant stage for BPC. This research attempts to integrate this stage with others and activities of BPC and develop a BPC steps model, in order to specify them in various changing levels.*

Keywords: Business process change, Process change stages, Enterprise systems, Systems integration, BPC guide, BPC model

1   Introduction

Today's business environment is extremely changeable, unpredictable, and competitive. In this business environment, access to real-time data is necessary, in order to make on time decisions. Since 1940s systems integration has become the most important and useful change within the organization to provide cheaper, quicker, and high quality services [1]. Systems integration is a common term in enterprises, and it has been a crucial goal for them to improve their performance by sharing data, accessing real-time information, making decisions on-time, and perform their business processes efficiently and effectively.

As explained by [2], in a successful systems integration, it is critical to change its key drivers, which are process, people, technology, and flow of information amongst them. They have also introduced Business Processes as the main area of activities for systems integration.

In general, business processes are some systematic rules for addressing business issues [3]. Business processes are specific ways to perform business operations according to the organizational rules and policies [4]. Business processes connect input to output of an organization. People, management, roles, tasks, information flow, and technology add value to the inputs and generate some outputs such as products and services to the customers. In other words, all of these pieces try to create business processes to carry out the organizational operations [5]. In this research, business process is also defined as all enterprise's inter-related activities enabled by technology and performed by people, in order to fulfil business operations through enterprise's departments. Thus, Business Process Change (BPC) would be the most imperative and challenging task for enterprises to improve their business processes to highest level of performance. In other words, BPC is an enhancement

procedure, which can develop the business processes revolutionary (such as BPR) or evolutionary (such as TQM).

The role of BPC in other contexts, such as smart city development, which necessitate systems integration, is also significant [6]. Therefore, discussions about the guidelines, approaches, and stages of BPC are always popular for systems integration researchers and BPC implementers. In addition, identification of BPC type has not been emphasized as a step in previous BPC guidelines.

The aim of this research is to provide a comprehensive step-by-step guide for BPC implementers, by considering all aspects of BPC, including different approaches and levels. The objectives are also as follows:

- Explore the literature regarding BPC stages, types, and levels

- Summarizing and making relationships among various sets of BPC steps

- Developing a BPC steps model

The next section of this research reviews the literature regarding BPC stages. They are compared, conceptualized, and summarized in this section. Section 3 continues the critical analysis and provides an innovative set of BPC steps for systems integration. Then, each step will be discussed in detail. Finally, a BPC steps model is developed.

2   Existing BPC methodologies

Many researchers have suggested some stages for business process redesign, improvement, transformation, innovation, Business Process Reengineering (BPR), BPC, etc. for example, Davenport [7] identified five steps framework for business process innovation as follows:

1) Identifying process for innovation

2) Identifying change levers

3) Developing process visions

4) Understanding existing processes

5) Designing and prototyping the new process

Then, they extend them to 10 steps, according to activities of each step.

Another five-step has been suggested by Harmon [8] for business process redesign, which are planning, analyzing existing processes, design new processes, resource development for new processes, and management for

transition to new processes. Moreover, reference [9] defined six steps for business process change especially by BPR technique. Those six steps are envision, initiation, Diagnosis, redesigning, reconstruction, and evaluation (S-A methodology). This methodology has been cited, argued, and critically analyzed by many researchers such as [10]–[13]. Some of them have followed S-A methodology in their research, some have added other aspects, and some have suggested different methodologies. For example, in addition to S-A methodology, Al-mashari and Zairi [12] has analyzed and compared eight more major sets of steps for BPR. Then, they identified 10 principles that should exist in BPR steps. Those principles are set strategies and goals, feasibility analysis, top management support, understanding customers' needs and performance measurement, integration with TQM, IT capabilities, communication between team members, process mapping and prototyping, changing management for whole organization. Furthermore, reference [10] argued that S-A methodology does not specifically identify BPR steps from organizational view. Thus, they provided another set of steps for BPR as follows:

1) Setup the vision, objectives, scope, and mode of BPR

2) Modeling

3) Analysis

4) Redesign

5) Continuous improvement

As characterized by previous researchers, despite the differences in terminology, all methodologies emphasize similar aspects and follow the same rules. For instance, analyzing and understanding existing business processes is one of the imperative steps that is described by all methodologies. In addition, according to complexity theory, Rhydderch [14] pointed out that "efforts to change practice should be preceded by efforts to understand it". Summarizing all explained methodologies introduces following steps for the purpose of this research (Table 1). The first two steps answer to this question: "Why change is required?

Table 1: A summary of popular BPC methodologies

Steps	Activities	study
1. Understanding project objectives (e.g. systems integration in this research)	- Identifying project vision and objectives in business - Identifying processes that support the project objectives as well as their performance target - Formulate process performance objectives	[7], [10], [15]
2. Understanding existing business processes	- Understanding and documenting current process flow and directions - Measure and assess the processes against new process objectives and attributes - Identify issues in current processess	[7]–[10], [12], [15]
3. Identifying processes for change	- Evaluating the role, culture, and politics of each process - Identifying process bundries	[7], [9], [10]
4. Preparation for the change	- Identifying change enablers such as technological and human resources - Defining scope - Setting the strategies and goals - Planning and scheduling - Establishing management commitment - Inform stakeholders - Organising change team	[7]–[9], [12]
5. Designing & Prototyping	- Defining and analysing new process concepts - Evaluating different design options in terms of feasibility, benefit, cost, risk and select one - Defining requirements for implementation phase - Prototype the new design - Utilising process mapping techniques	[7]–[10], [12], [15]
6. Implementing the change	- Address migration challenges according to the type of change and develop a migration approach and strategy - Developing new organisation structure - Training of employees	[7]–[9], [15]
7. Continious evaluation & improvement	- Evaluating process performance - Maintaining and modifying redesigned processes - Link to continuous improvement programs - Controling and improving the previous steps	[9], [10], [16]

3 Innovative BPC steps

The BPC methodologies described in section 2, are mostly BPR-oriented steps, not BPC steps. Most of the previous researchers, who have defined BPC methodologies, consider BPC as BPR. For example, despite the title of the research by [9], "Business process change: A study of methodologies, techniques, and tools", they have limited their research to BPR technique, which is a revolutionary approach [17], and they have identified six steps for BPR (S-A methodology). Nevertheless, they have discussed about radicalness level of the change as a customizer for BPR steps.

Therefore, as most of the BPC steps have been defined as equal as the stages for BPR, which is a revolutionary approach, there is no specific step to identify the type/approach of the change, while this is required for BPC, because before preparation of the enterprise for change, understanding the approach, type, and scope of the change is necessary. Thus, this research adds one more step, which is "identifying the BPC type", to the above steps in order to define a BPC steps model for systems integration. In addition, two sub-steps of first stage should be expanded to three individual steps, because they are also required for "identifying the change approach". As a result, the BPC steps would be as follows:

1) Understanding objectives of the main project (systems integration project for this research)

2) Understanding existing business processes

3) Identifying processes for change

4) Identifying the change approach

5) Preparation for the change

6) Designing & Prototyping

7) Implementing the change

8) Continuous evaluation & improvement

To summarize these steps, first and second stages as well as third and fourth ones can also be merged according to their tasks. As a result, BPC steps and activities will be defined as follows.

3.1 Comprehension

All understanding, analysis, and evaluation activities will be carried out during this step. The goal of the main project should be identified first. This will determine the purpose of BPC. This step firstly, answers to the following questions [15]:

- What are the scope, objectives of the main project?

- What is the role of BPC for the main project?

- Where does BPC seat in the main project's plan?

- Why business processes should be changed?

Then, all business processes will be analyzed against the main project's objectives. Main project in this research is systems integration. Therefore, we need to understand what the objectives of systems integration project are. As discussed in section 1, one of the main objectives of systems integration is integration of all departments, systems, and applications of an enterprise in order to access real time information. Thus, all business processes should be aligned with this purpose. Therefore, analysis and in depth understanding of all business processes are necessary. This will also develop objectives of new business processes.

Assessing existing business processes (As-Is), directions, and performance is necessary to understand existing business processes. Understanding customers' perspectives of current business processes is also an important input during this step [7]. Key activities in understanding existing business processes are listed as follows:

- Analyzing and documenting the current process flow (process diagram)

- Assessing and Measuring existing processes against new process objectives including fulfilling customers' needs

- Assessing cost of each business processes according to the cost of their activities

- Identifying any shortcoming in As-Is processes in order to fulfil the main project goals

- Assessing current relationships between processes

- Summarizing all findings

In summary, the purpose and scope of systems integration as well as status and capabilities of business processes are comprehended within this step, and these are carried out repeatedly, because in analyzing existing business processes we need to review the objectives of the main project several times.

3.2 Identification

A couple of fundamental identifications will be carried out during this stage. Firstly, a summary of all findings from previous step regarding

analysis of existing business processes are evaluated. If any of the business processes could not meet integration requirements appropriately, effectively, and efficiently, that would be candidate for change. In addition, the business processes, which are fully aligned with the objectives of main project will be recognized and documented. After that, the approach and type of BPC should be identified. As discussed before, a specific stage is required to understand the approach/type of the change in BPC. A few researchers have talked about the level of radicalness, change strategy, and mode of change. Valiris and Glykas [10] also argued about this matter as a limitation of BPR methodology. They have considered "identification of BPR mode (incremental or radical)" as an imperative task in first step of BPR. Furthermore, reference [9] have talked about the level of radicalness for BPR. They have developed a so-called "project radicalness planning worksheet" to identify the level of radicalness. According to this technique, the radicalness of BPR is scored by a number from 1 to 5, which is assigned to 11 factors/identifiers of level of radicalness (A modified version of this worksheet is represented by Table 2).

Then, the average score of the radicalness will be calculated. Subsequently, the score will be affected by risk propensity of the decision makers. Risk propensity (which is rated from 1 (risk averse) to 5 (risk taking)), can pull down or push up the radicalness score. Reference [12] have also discussed about this method, which is useful to determine the radicalness of change. However, BPR is a BPC type, and it is defined as a radical/revolutionary change for business processes [6]. Thus, it cannot have different levels of radicalness, such as no radicalness, because "radical change" is the most important characteristic of BPR [18]. In other words, if BPR has no radicalness, it would not be called BPR. Hence, this method is suitable for determination of radicalness level in BPC. In other words, as illustrated by Table 2, this method will be adapted, in order to be utilized for identification of BPC type/mode. Then, the average score will be applied, in order to identify the BPC approach by formula as follows:

$$RS = \frac{(Avg.\,score\,of\,contingency\,factors + RP)}{2}$$
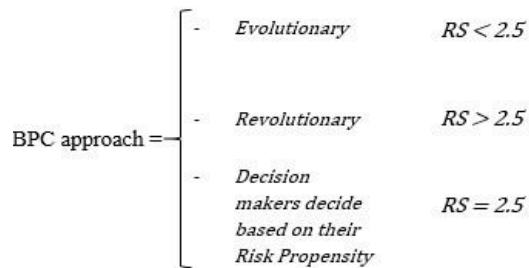
RS = Radicalness Score
RP = Risk Propensity

$$BPC\ approach = \begin{cases} - & Evolutionary & RS < 2.5 \\ - & Revolutionary & RS > 2.5 \\ - & \begin{array}{l} Decision \\ makers\ decide \\ based\ on\ their \\ Risk\ Propensity \end{array} & RS = 2.5 \end{cases}$$

Table 2: BPC type identifier (Adopted from [8])

Factors	Questions	BPC approach Evolutionary ⟷ Revolutionary				
		1	2	3	4	5
Strategic centrality	Is the targeted process merely tangential (1) or integral (5) to the firm's strategic goals and objectives?					
Feasibility of IT to change process	Does IT enable only incidental change (1) or fundamental process change (5)?					
Process breadth	Is the scope of the process intra-functional (1) or interorganizalional (5)?					
Senior management commitment	Is the senior management visibly removed (1) or actively involved (5) in the BPR efforts?					
Performance management criteria	Are the preferred performance measurement criteria effiency based (1) or effectiveness Effectiveness based (5)?					
Process functionality	Is the process functioning marginally (1) or is the process not functioning well at all (5)?					
Process resource availability	Are only minimal resources (1) available to support the process change or are resources abundant (5)?					
Structural feasibility	Is the organizational structure rigid (1) or is it flexibly conducive (5) to change and learning?					
Cultural capacity for change	Does the culture support the status quo (1) or actively seek participtory change (5)?					
Management willingness to impact people	Are only modest impacts on people tolerable (1) or is management willing to deal with the conse-quences of disruptive impacts (5)?					
Value chain target	Is the BPR effort targeted at an internal support process (1) or a core process (5)?					

3.3   Preparation

After identification of the candidate business processes for change and the BPC type, the scope and strategy of the change should be specified [6], [7]. Thus, all scheduling and planning activities will be carried out during this step [7], [8], [11]. In addition, all other business key drivers including the organization, human resources, and possible technological resources need to be identified and prepared for the change. Therefore, a full top management support is necessary [8], [11]. Then, a change team including business process experts, who are fully informed about the candidate processes will be assigned. Moreover, all stakeholders and other employees will be informed about the change.

3.4   Design

The actual changing and redesigning activities including brainstorming, defining and analyzing new process concept, prototyping, designing, and documenting new processes according to identified change approach are carried out in this step by a team, responsible for the change [7], [9], [15]. Appropriate techniques for process mapping and prototyping should be applied in this step [12]. Thus, different design options in terms of benefit for the business, cost, and feasibility must be evaluated and the best option must be selected. In addition, new redesigned processes should be fully understood, tested, and approved by designing team [7], [15]. Finally, a requirement analysis will be performed for the next step [7], [8].

3.5   Implementation

Having the prototype tested and approved, creating a pilot with the purpose of success can also be useful instead of a fully cutover. This is prefered for most of the BPCs, especialy for which are highly visible internaly and externaly, and/or involve with revenues, customers, or valuable employees. Phased approach is also an economic method of implementation, which generates some financial benefit from BPC in earlier time. This approach can also be utilised after a pilot implementation [7]. Any change on organisation structure, roles, and IT will be carried out during this phase. The implementation and migration team will be assigned and the capabilities of human resources will also be improved by training

programmes under full support of top management. BPC techniques such as TQM and Six Sigma will also be applied for fullfiling this step [8], [9], [15].

3.6   Sustainment

The last step of changing business processes is to continuously evaluate and improve the new processes's performance and if they have addressed the requirements [9], [16]. This will allow the organisation to continuously monitor and control the business processes after the change. This will also establish more comunication and coordination within the enterprise [9].

4   BPC steps model

Based on the explanations and objectives of systems integration and BPC, its steps and activities in this research, a model for BPC steps is illustrated by Figure 1.

As represented by this model, BPC is carried out as part of systems integration project. However, the stages are carried out in various levels, including systems integration, business process, and execution level. In other words, the activities of business process level are not separated from systems integration level, because changing business processes is designed within systems integration. Hence, the activities of every BPC step are performed in these three levels. For instance, the comprehension step starts at systems integration level, in order to understand the scope and purpose of the main project (systems integration). It endures with understanding of the role of BPC in the main project at both systems integration and process levels. As the next activity of this step, understaing of existing and objectives of proposed business processes is carried out in process level. Finally, a summary of the findings is prepared at execution level. In addition, the implementation stage is carried out only at execution level, because all the requirements for actual implementation have already been prepared in systems integration and business process levels and they are ready to be executed. In contrast, all three levels are involved in sustainment stage, as the improvement and evaluation should be continuosely performed in all aspects of BPC. Consequently, any modification and improvement initiates a return to the first step of BPC cycle.
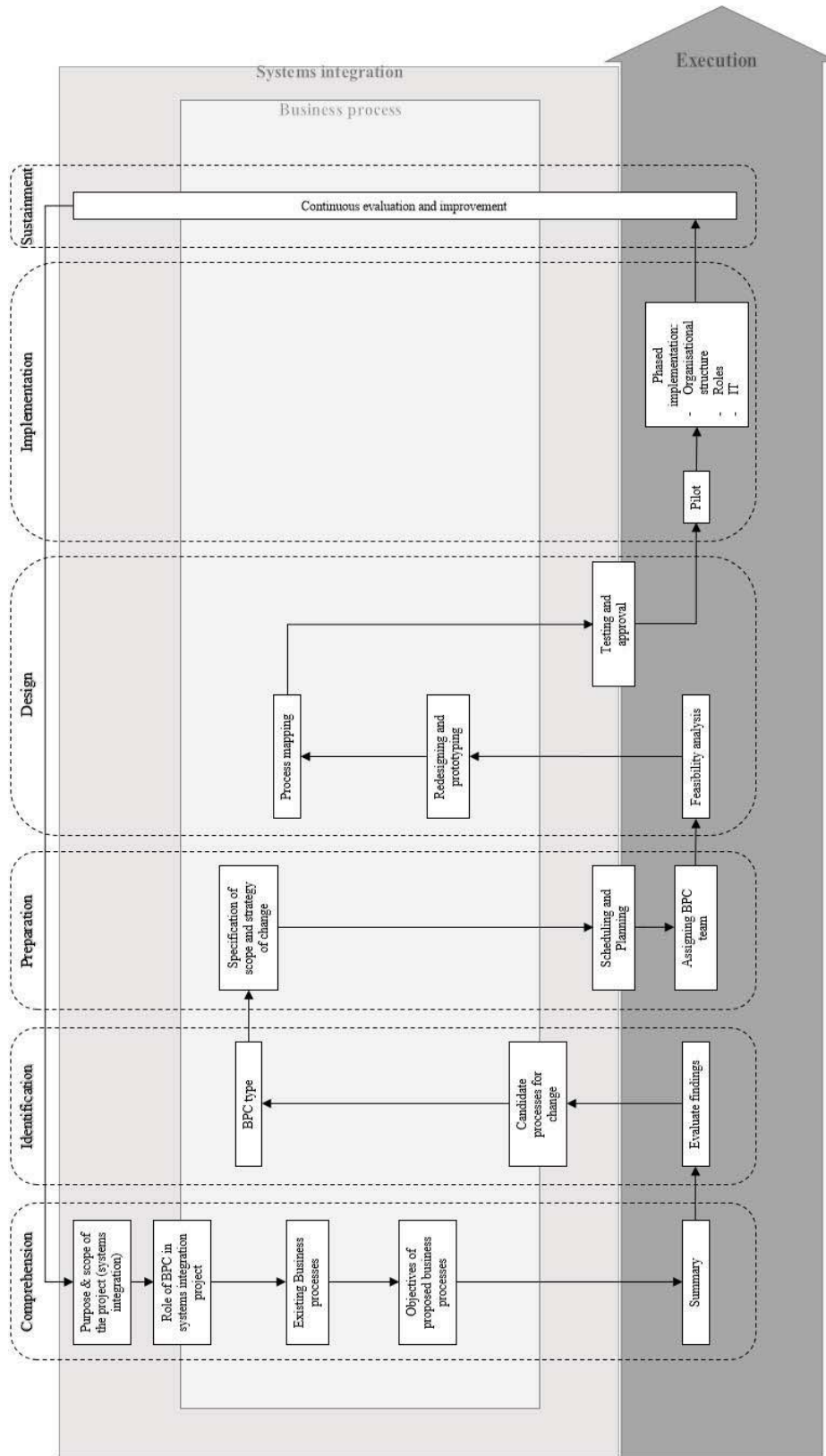
Figure 1: BPC steps model

5 Conclusion

BPC has been identified as a significant challenge of systems integration for enterprises in both private and public sectors. This study critically reviewed BPC methodologies provided by earlier researchers, conceptualized BPC stages for systems integration, and attempted to create an innovative model to the BPC. The model is a cyclic approach to the BPC stages, which includes identification of BPC type as an important activity within the early steps. This action clarifies the main approach for changing business processes, so that regulates the activities and provides boundries for the next steps of BPC. Moreover, based on this BPC model, any improvement in business processes should be carried out by conducting all steps of BPC again.

6 References

[1]   M. Hobday, "Systems integration: a core capability of the modern corporation," *Ind. Corp. Chang.*, vol. 14, no. 6, pp. 1109–1143, Aug. 2005.

[2]   V. Javidroozi, H. Shah, A. Amini, and A. Cole, "Smart city as an integrated enterprise: a business process centric framework addressing challenges in systems integration," in *3rd International Conference on Smart Systems, Devices and Technologies*, 2014, pp. 55–59.

[3]   M. Havey, *Essential Business Process Modeling*. O'Reilly Media, 2005.

[4]   A. Lodhi, V. Köppen, and G. Saake, "Business Process Improvement Framework and Representational Support," in *Proceedings of the Third International Conference on Intelligent Human Computer Interaction*, 2013, vol. 179, pp. 155–167.

[5]   N. Berente, B. Vandenbosch, and B. Aubert, "Information flows and business process integration," *Bus. Process Manag. J.*, vol. 15, no. 1, pp. 119–141, Jun. 2009.

[6]   V. Javidroozi, H. Shah, A. Cole, and A. Amini, "Towards a City's Systems Integration Model for Smart City Development: A Conceptualization," in *2015 International Conference on Computational Science and Computational Intelligence (CSCI)*, 2015, pp. 312–317.

[7]   T. H. Davenport, *Process Innovation: Reengineering Work Through Information Technology*. Massachusetts: Harvard Business Press, 1993.

[8]   P. Harmon, *Business Process Change: A Manager's Guide to Improving, Redesigning and Automating Processes*. San Francisco: Morgan Kaufmann Publishers, 2003.

[9]   W. J. Kettinger, J. T. C. Teng, and S. Guha, "Business process change: A study of methodologies, techniques, and tools - ProQuest," *MIS Q.*, vol. 21, no. 1, pp. 55–80, 1997.

[10]   G. Valiris and M. Glykas, "Critical review of existing BPR methodologies: The need for a holistic approach," *Bus. Process Manag. J.*, vol. 5, no. 1, pp. 65–86, Jan. 1999.

[11]   P. O'Neill and A. S. Sohal, "Business Process Reengineering A review of recent literature," *Technovation*, vol. 19, no. 9, pp. 571–581, Sep. 1999.

[12]   M. Al-Mashari and M. Zairi, "Revisiting BPR: a holistic review of practice and development," *Bus. Process Manag. J.*, vol. 6, no. 1, pp. 10–42, Jan. 2000.

[13]   A. Pateli and S. Philippidou, "Applying Business Process Change (BPC) to Implement Multi-agency Collaboration: The Case of the Greek Public Administration," *J. Theor. Appl. Electron. Commer. Res.*, vol. 6, no. 1, pp. 127–142, Apr. 2011.

[14]   M. Rhydderch, "Organisational change theory and the use of indicators in general practice," *Qual. Saf. Heal. Care*, vol. 13, no. 3, pp. 213–217, Jun. 2004.

[15]   P. Harmon and B. P. Trends, *Business Process Change: A Guide for Business Managers and BPM and Six Sigma Professionals*. Morgan Kaufmann, 2010.

[16]   D. B. Harrison and M. D. Pratt, "A Methodology for reengineering businesses," *Strateg. Leadersh.*, vol. 21, no. 2, pp. 6–11, Dec. 1993.

[17]   M. C. Jurisch, W. Palka, P. Wolf, and H. Krcmar, "Which capabilities matter for successful business process change?," *Bus. Process Manag. J.*, vol. 20, no. 1, pp. 47–67, Jan. 2014.

[18]   J. Kallio, T. Saarinen, S. Salo, M. Tinnilä, and A. P. . Vepsäläinen, "Drivers and tracers of business process changes," *J. Strateg. Inf. Syst.*, vol. 8, no. 2, pp. 125–142, Jun. 1999.

IMPORTANCE OF SELF-REGULATION IN ELECTRONIC TRANSACTIONS: SAFEGUARDING CUSTOMER INFORMATION AND PRIVACY

I. Alharbi[1], and B. alyoubi[2]

[1]Department of Management Information Systems, College of Business, University of Jeddah, Jeddah, Saudi Arabia
[2]Department of Management Information Systems, College of Business, University of Jeddah, Jeddah, Saudi Arabia

Abstract - *The emergence of electronic transactions has played an incredible role in increasing convenience and ease, in terms of performing purchasing/selling activities from remote location).The research is aimed at assessing the importance of self-regulation in electronic transaction, particular in terms of securing the information and privacy of the customers. However, electronic transactions have also brought several complexities and threats, in terms of protecting customer's information. In this situation, the integration of self-regulations in electronic transactions can be considered as an effective approach for protecting customer's confidential information from unintended threats and risk. This research paper encapsulates brief yet profound information about the relevance of using self-regulatory regimes in electronic transactions. In addition to this, it also includes the illustration of the fundamental elements that are crucial for the development of meaningful self-regulation for the electronic transactions, so as to ascertain the privacy of the customers. The study found that, businesses have started to put especial emphasis on the establishment of self-regulatory regimes, in order to ascertain the integrity of their client's data. Analysis shows that self-regulation is more effective and flexible, as compared to traditional governmental regulations.*

Keywords: Self-regulation, electronic transactions, privacy, information, regime, e-commerce

1   Introduction

The purpose of this research study is to examine and discuss the importance of self-regulation in electronic transactions. More specifically, the research work is intended to recognize the importance of self-regulations in terms of protecting the privacy and information of the customers in e-commerce environment. It has been established from the analysis of the study that was conducted by [5] that advanced information technologies have enabled the businesses to enable their customers to perform their transactions in a more efficient manner. In accordance of the study of [14], online shopping is one of the most desirable options of the customers, as it allows them to purchase their desired products or services, regardless of their geographical location. It is observed that the ease of selling and purchasing goods over the internet has played an inevitable and indispensable role in the development of the electronic payment and electronic commerce services. [24] has stated that customers find electronic transactions as the most efficient and convenient method, instead of visiting the specific location to perform financial transactions. Despite of extensive benefits of electronic transactions, like ease and convenience, a number of challenges are also associated with this technology. One of the most prominent issues that are related to the electronic transactions includes the security of the information and privacy of customer's information [23]. In this regard self-regulation has found to be one of the greatest approaches that may help the businesses in safeguarding the privacy and confidential information of the customers, while performing electronic transactions. In order to present more cohesive illustration of self-regulation and its importance in electronic transactions, the proceeding paper encapsulates its different beneficial aspects that foster customer privacy.

1.1   Research Aim & Objectives

The aim of this research study is to evaluate the importance of self-regulation in electronic transactions. In this regard, the researcher is intended to accumulate pertinent information about self-regulation, in terms of protecting customer privacy and information. Following mentioned objectives are going to be accomplished in the paper, in order to acquire the research aim.

The research will be covering many aspects of the self-regulation in the electronic transactions. The primary purpose of the research will be to understand the privacy of the customers' information in electronic transaction, examining the approaches and concepts of self-regulations. Moreover, the study will also be analyzing the fundamentals of effective self-regulation to safeguard the information and privacy of the customers. In the end the study will also be evaluating and discussing the significance of self-regulation in electronic transactions to protect customer information and privacy.

2   Methods and Materials

The present study has used secondary qualitative research approach. The researcher has adopted this method of research to accumulate pertinent and relevant information about the topic, in a more efficient, cost effective, and well-timed manner. It is significant to bring into the notice that different authentic databases have been accessed by the researcher to gather credible information. Some of the prominent resources that have been accessed include JSTOR, EBSCOHOST, and sage. These resources have commendably contributed in the successful accomplishment of the research objective.

3   Literature Review

3.1   Privacy of Customer`s Information

Type Technological developments have played an inevitable and indispensable role in transforming the entire paradigm of commerce and selling and purchasing of the products and services. In particular, it can be stated that the innovative and advanced technological tools have fostered the notion of electronic transactions or simply electronic commerce (e-commerce). Electronic commerce is nothing more the approach that encompasses the activities of performing business activities, electronically. It has been documented in the studies of [12] that electronic commerce is primarily based on the electronic processing and data transmission, which may include video, sound, and text. In order to support this idea, [25] has stated that electronic commerce or electronic transactions include several different activities. These activities may include after-sales service, direct consumer marketing, public procurement, online sourcing, collaborative engineering and design, commercial auctions, electronic bills of lading, electronic share trading, electronic fund transfers, digital content's online delivery, and electronic trading of services and goods [18]. It is important to note that electronic transactions may encompass both services (for instance, legal, financial, and information services) and products (for instance, specialized equipment, consumer goods), as well as the traditional activities.

It has been established that electronic transactions mainly include commercial transactions that are usually supported by the closed and open networked communication and information systems. These communication and information systems are connected with efficient software and computers that are usually used to foster the transmission of data. Although, these platforms play an appreciable role in smooth and hassle free transactions, but these platforms also increases the risk of security attacks [27]. Since, these platforms offers direct interface amid the internet and users, it eventually increases certain threats to the privacy of customer's confidential information. The analysis of the study of [16] has presented an idea that when a customer performs

transaction on any website or online platform, the backlog of the entire activity is automatically generated in the system. This backlog incorporates all information about the confidential and private information of the customers, like name, browsing history, address, credit card information. It has been analyzed that this information is utilized by the businesses to understand the demands of the customers to improve their products and services [10]. However, if the information systems or IT network infrastructure of an organization is targeted by the hackers, it may also cause severe damages to the integrity of customer's information. In typical electronic transaction environment, the payee, payer, as well as the financial institution, as shown in figure 1. Under this hierarchy, the customers have to exchange or share their information with the company, so as to complete the transaction. It is observed that this structure usually increases the threat of security breaches and other malicious activities. In this regard, [12] has stated that such situations usually result in identity theft, credit card frauds, fake financial transactions that ultimately results in irreversible harm to the customers as well as to the company, in terms of loss of repute. Therefore, it can be affirmed that electronic transactions is one of the greatest threats for the information and privacy of the customers [20].

Figure 1: Characteristic Scenario in Electronic Transactions

3.2   Self –Regulation Approach

Self-regulation can be understood as the regulatory process in which an industry level company enforces and sets standards and rules, related to the organizational conduct within the industry [13]. One of the notable aspects of self-regulation is that it is entirely different from the government level regulations. It has been recognized that businesses usually makes use of this approach in order to minimize certain potential risks and vulnerabilities that may affect the repute of the organization. In accordance with the study of [24] businesses have started to develop and implement self-regulation to avoid the threat of excessive regulations of the government. In some areas of the businesses, there is not any proper government regulation that could ensure the integrity of the business. In such circumstances, businesses usually prefer to develop their own regulations [22], so as to ascertain risk free operations. It has been examined from the analysis of different researches that enforcing and monitoring regulations are one of the most imperative aspects of the regulatory process [21]. However, self-regulation utilizes the approach of self-policing as the prime mechanism, in order to assure compliance while providing remediation.

3.3 Self-Regulation in Electronic Transactions

It has been observed in the study of [18] that initially the e-commerce sector adopted pure enforcement and pure market models to safeguard the confidentiality and privacy of customer's information. Unfortunately, both of these models got fail, as they did not reach and fulfill the desired requirements of privacy protection. On the other hand, the approach of self-regulation is found to provide higher levels of privacy and security to the confidential information of the customers, without affecting the budgetary conditions. When self-regulation is used to safeguard the information and privacy of the customers, in electronic environment, it can be occurred in three traditional components. These conventional components of power include adjudication, enforcement, as well as legislation [13]. In this regard, the study of [20] has presented an idea about legislation, which shows that this component mainly relates to the question that who should demonstrate adequate rules for privacy protection. On the other hand, enforcement is found to be related to the question that defines that who is responsible for initiating the actions of enforcing privacy legislations. Besides that, adjudication defines who should decide and evaluate the potential violation of the security rules [25].

All of these components of the self-regulation approach enable the companies and industries, specifically electronic commerce sector, to develop appropriate rules and legislations in order to secure the information of their client from malicious activities. It is significant to bring into the notice that self-regulation appreciably supports the electronic commerce industry, as compared to the conventional governmental standards and regulations. It is due to the fact that it enables the industry to develop their laws and regulations, according to the need of privacy, instead of following the general governmental regulations [17]. Within the electronic commerce industry, a number of self-regulations are being developed and used, in terms of development of organization based IT policies, deployment of certain standards, integration of verification methods, and data security standards. All of these initiatives solely intend to protect the integrity and confidentiality of the information and privacy of the customers, while enabling them to perform electronic transactions.

3.4 Fundamentals of Effective Self-Regulation to Safeguard the Information and Privacy of the Customers

The study of [8] shows that e-commerce sector is continually striving to develop consumer-friendly, meaningful, and fruitful self-regulatory regimes in order to protect their privacy of their business processes and customer's information. However, it is important to note that to be fruitful, self-regulation should do more than the articulate guidelines or policies. It is integral to note that effective and efficient self-regulation includes substantive means and rules to assure that customers also understand the rules that are developed by the company [7]. This approach plays an incredible role in improving and enhancing the overall security and privacy of customer's data [26]. It is because; this feature also enables the users to properly complying with the self-regulatory regimes that are developed by the industry. The proceeding research encapsulates the analysis brief analysis of the fundamentals of effective self-regulation that are crucial for the appropriate and foolproof protection of customer's privacy. One of the most fundamental elements of effective self-regulation for the protection of privacy includes fair information practices [23]. Fair information practices encompass various features including access of consumers to their identifiable data, appropriate security levels, choice, and awareness of customers about the regime [1].

In the context of awareness, it is observed that customers usually do not know about the identity of a person that collects their personal information. It is a fact that electronic transactions are fully automated in nature, but to some extent the consumers have to manually share their personal information with the e-commerce company [9]. It has been established that such situations increases privacy related risks. In terms of choice, companies must ensure to provide an open choice to their customers about the utilization of their personal information. In other words, e-commerce companies should provide an opportunity to their client to exercise choice, in terms of how and whether their personal information is utilized, either by business or by third party vendors [18]. Moreover, it is also essential for the development of the effective self-regulatory regimes that customers are provided with the facility to access their desired information, so that they can amend and correct their information. Data security also holds undeniable significance in the development of effective self-regulatory rules. It also includes the assurance of the protection level at the extended levels [5]. Privacy policies hold integral position in the self-regulatory rules, as it covers all aspects of the internal and external operations of the organization. The privacy policies play a commendable role in protecting the confidentiality and integrity of data, without intruding electronic transaction activities.

3.5 Importance of Self-Regulation in Electronic Transactions to Protect Customer Information and Privacy

Self-regulation can be considered as one of the most appropriate approaches that ensures the reliability of electronic transactions. It has been stated by [24] that self-regulation is more pertinent and credible than government regulations. It is due to the fact that government regulations are usually developed in the generalized manner, while considering the highlighted issues of the particular industry. On the other hand, self-regulatory rules are developed for

particular industry, while profoundly assessing its issues and potential risks [3] In terms of securing the private data of the customers, during electronic transactions, self-regulatory regimes enable the customers to properly understand that how they are supposed to exchange their data with the company. This feature ultimately helps the companies in reducing the risk of potential vulnerabilities, like security breaches, data theft, identity theft of the client, fraudulent transactions [26].

On contrary to the government regulations, self-regulations foster more effective and faster remediation, enforcement, monitoring, and rulemaking processes that ultimately results in the fruitful outcomes [6]. In addition to this, it has also been established that self-regulation also plays an incredible role in increasing the flexibility for the consumers and businesses, as it clearly elaborates all essential guidelines, crucial for the data protection. This feature also allows the industry to minimize their compliance expenditures, while increasing overall efficacy. It has been suggested in the research work of [5] that because of having uncountable benefits, industry self-regulation of the security and privacy of consumer data has been considered as the most flexible alternative to the conventional government regulations, specifically in the perspective of electronic transactions.

4   Discussion and Analysis

The emergence of electronic commerce or remote purchasing trends has played a major role in bringing ease and convenience for the consumers as well as for the business. However, electronic transactions have also increased the liability to the businesses towards the protection of their customer's data and ensuring their privacy. It has been established from the study of [15] that during incidents of security breaches and data theft are continually increasing, specifically in the area of electronic transactions. In this regard, recent statistical data is also presented in below mentioned figure 2.

Figure 2: Graphical Representation of the Security Issues related to Electronic Transactions

Above mentioned graph clearly depicts the idea that the information of the customers, performing electronic transactions, is at high risk of exposure or misuse. Figure 3 shows that remote purchase or fake transactions are the most prevalent threat in e-commerce industry [11]. During the year 2004, the total percentage for fraudulent transactions was approximately 30 percent. However, in the year 2014, it was eventually increased up to 69 percent, which shows that the situation has become graver; thereby, needs to have more cohesive strategies or approaches to combat this issue and safeguard the information of the customers as well as their privacy [6].
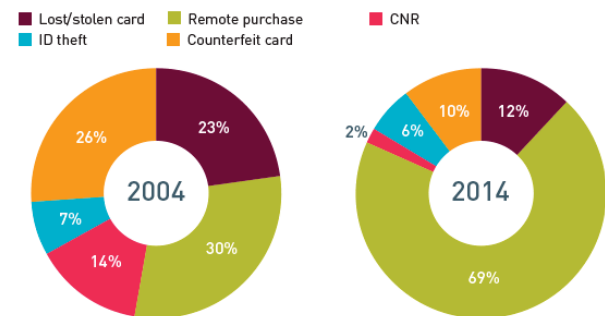

Figure 3: Diagram showing Statistics of Fraudulent Transactions due to the Weak Security of Customer's Information

In such circumstances, self-regulation can be considered as the most optimal solution to the problem. In electronic transactions, self-regulatory regimes or rules help in safeguarding the confidentiality and privacy of the customers. A self-regulatory security regime incorporates such mechanisms and features that ensure the strict compliance with the rules [16]. In addition to this, the approach also presents an opportunity to the affected party to immediately cope with the issue, even when the predefined rules are not appropriately followed. In accordance with the study of [16], self-regulation presents wide range of benefits to the e-commerce sector, particularly in the context of secured and highly protected electronic transactions. This approach allows the concerned authorities to develop such security rules and policies that ultimately secure the private information of the consumers, while providing hassle free access to the authorized personnel [4]. One of the most commendable aspects of self-regulation, in safe electronic transactions is that the approach mainly works on the ethical values and norms. In other words, it can be stated that the self-regulatory rules mainly focuses on the role of the profession or industry in enforcing and creating norms of behavior [2]. It depicts such idea that makes individual feel ethical constraints against exploiting the integrity of the personal information of the customers; hence, protecting the privacy of the customers, also from internal threats.

5   Conclusion

The preceding research has incorporated the profound assessment of the importance of self-regulation in electronic transactions, particularly to safeguard customer information and privacy. After the accomplishment of this research, it has been established that the protection of customer's information has become the greatest concern for the businesses, due to the transference of information through electronic transactions. Currently, businesses have started to put especial emphasis on the establishment of self-regulatory regimes, in order to ascertain the integrity of their client's data. Analysis shows that self-regulation is more effective and flexible, as compared to traditional governmental regulations. It is because; self-regulatory rules are especially designed after assessing the needs of the specific industry or users. This research work has presented the in-depth analysis of the importance of self-regulation in electronic transaction to protect customer's information. Moreover, customers will be now putting up extra trust on their vendors regarding the online transactions. Fact of the matter is that, with growing technologies and their implementation, there are various pros and cons that come into existence. Information travelling and e-transactions have highly facilitated users, though data security and privacy has been a point of concern. New issues arise and are subjected to be addressed by new solutions. Incorporation of technologies for ensuring data privacy and security, considering its significance has been drastically taken a good face, due to the fact of electronic transactions being a growing medium.

6   References

[1]. Adelola, T., Dawson, R. and Batmaz, F., 2014, December. Privacy and data protection in E-commerce: The effectiveness of a government regulation approach in developing nations, using Nigeria as a case. In Internet Technology and Secured Transactions (ICITST), 2014 9th International Conference for (pp. 234-239). IEEE.

[2]. Almunawar, M.N. Securing Electronic Transactions to Support E-Commerce. arXiv preprint arXiv: 1207.4292 (2012)

[3]. Brennan, M., 2013. Managing Risk and Ensuring Quality: Nova Scotia's Framework for Regulatory Excellence. Journal of Nursing Regulation, 4(2), pp.39-42.

[4]. Chhagan, M., Kauchali, S. and Van den Broeck, J., 2013. The Data Management Plan. In Epidemiology: Principles and Practical Guidelines (pp. 261-279). Springer Netherlands.

[5]. Ciocchetti, C. A. E-Commerce and Information Privacy: Privacy Policies as Personal Information Protectors. American Business Law Journal, 44(1), 55-126. (2007)

[6]. Dilling, O., 2012. From compliance to rulemaking: how global corporate norms emerge from interplay with states and stakeholders. German LJ, 13, p.III.

[7]. Djelassi, S. and Decoopman, I., 2013. Customers' participation in product development through crowdsourcing: Issues and implications. Industrial Marketing Management, 42(5), pp.683-692.

[8]. Ezzi, S.W., 2014. A theoretical Model for Internet banking: beyond perceived usefulness and ease of use. Archives of Business Research, 2(2), pp.31-46.

[9]. Fang, Y., Qureshi, I., Sun, H., McCole, P., Ramsey, E. and Lim, K.H., 2014. Trust, Satisfaction, and Online Repurchase Intention: The Moderating Role of Perceived Effectiveness of E-Commerce Institutional Mechanisms. Mis Quarterly, 38(2), pp.407-427.

[10].Gebauer, H., Paiola, M. and Saccani, N., 2013. Characterizing service networks for moving from products to solutions. Industrial Marketing Management, 42(1), pp.31-46.

[11].Gu, J. and Huang, S., 2014. Countermeasures of Coping With Lacking of Credibility in E-commerce Under the Background of the International Crisis. Contemporary Logistics, (16), p.49.

[12].Hu, Y. J., & Tang, Z. Protecting Online Privacy: Self-Regulation, Mandatory Standards, or Caveat Emptor Zhulei Tang. In in Proceedings of the Fourth Annual Workshop on Economics and Information Security. (2005)

[13].Jarupunphol, P., & Buathong, W. Secure Electronic Transactions (SET): A Case of Secure System Project Failures. Transactions, 16, 22 (2013)

[14].Jayabalan, S., Commerce and Consumer Protection: The Importance of Legislative Measures (2012)

[15].King, N.J. and Raja, V.T., 2012. Protecting the privacy and security of sensitive customer data in the cloud. Computer Law & Security Review, 28(3), pp.308-319.

[16].Listokin, S.B, 2015. Industry Self-Regulation of Data Privacy and Security.SSRN (2015)

[17].Morris, B.W., Kleist, V.F., Dull, R.B. and Tanner, C.D., 2014. Secure information market: A model to support information sharing, data fusion, privacy, and decisions. Journal of Information Systems, 28(1), pp.269-285.

[18].Murphy, M.M. Privacy Protection for Customer Financial Information, Congressional Research Service. (2014)

[19].Niranjanamurthy, M. and Chahar, D.D., 2013. The study of e-commerce security issues and solutions. International Journal of Advanced Research in Computer and Communication Engineering, 2(7), pp.2885-2895.

[20].Niranjanamurthy, M., and Dr Dharmendra C. The study of e-commerce security issues and solutions.

International Journal of Advanced Research in Computer and Communication Engineering 2, no. 7. (2013)

[21].Pearson, S., Tountopoulos, V., Catteddu, D., Sudholt, M., Molva, R., Reich, C., Fischer-Hubner, S., Millard, C., Lotz, V., Jaatun, M.G. and Leenes, R., 2012, December. Accountability for cloud and other future internet services. In Cloud Computing Technology and Science (CloudCom), 2012 IEEE 4th International Conference on (pp. 629-632). IEEE.

[22].Peltier, T.R., 2013. Information security fundamentals. CRC Press.

[23].Schwaig, K.S., Segars, A.H., Grover, V. and Fiedler, K.D., 2013. A model of consumers' perceptions of the invasion of information privacy. Information & Management, 50(1), pp.1-12.

[24].Singh, A., and Karan S. A review: secure payment system for electronic transaction. International Journal of Advanced Research in Computer Science and Software Engineering (JARCSSE) 2. (2012)

[25].Smith, H. J., Dinev, T., & Xu, H. Information privacy research: an interdisciplinary review. MIS quarterly, 35(4), 989-1016. (2011)

[26].Tang, Z., Hu, Y., & Smith, M. D. Gaining trust through online privacy protection: Self-regulation, mandatory standards, or caveat emptor. Journal of Management Information Systems, 24(4), 153-173. (2008)

[27].Turban, E., King, D., Lee, J.K., Liang, T.P. and Turban, D.C., 2015. E-Commerce Security and Fraud Issues and Protections. In Electronic Commerce (pp. 457-518). Springer International Publishing.

[28].Zimmermann, S. and Rentrop, C., 2014. On the Emergence of Shadow IT-A Transaction Cost-Based Approach.

DR. IBRAHEEM MUBARAK ALHARBI is Assistant Professor, Head of Management Information Systems Department in College of Business at University of Jeddah, Saudi Arabia. He received a PhD from School of Business at La Trobe University. He is membership of ACS since 2008, publishes widely including journal articles, and he regularly presents his research at international academic conferences. His academic information systems research interests include business and online transactions, security and information privacy, electronic commerce, and knowledge Management Systems. imalharbi@uj.edu.sa

DR. BADER ABDULRAHMAN ALYOUBI is Assistant Professor, Department of Management Information Systems in the College of Business at the University of Jeddah, Saudi Arabia. He received his PhD from the Department of Information Science at King Abdulaziz University in Jeddah, in the Specialization (knowledge management), including published widely journal articles, he regularly presents his research in international academic conferences. His research interests include academic information systems, knowledge management systems and commercial transactions on the Internet, and information security and privacy, e-commerce, and decision support systems knowledge perspective. balyoubi@uj.edu.sa

Toward Business Process Representation

Sabah Al-Fedaghi
Computer Engineering Department
Kuwait University
Kuwait
sabah.alfedaghi@ku.edu.kw

Abstract— **Selecting an appropriate representation of a process is an important task in the field of business process management. Complex processes are often very difficult to describe; hence, diagrams are used to represent them. Diagrammatic descriptions can be expressive and easily understandable by end users. Business Process Modeling Notation (BPMN) allows diagramming of information flow, decision points, and business processes. It is described as the de-facto standard for representing in a very expressive, graphical way the processes occurring in virtually every kind of organization one can conceive. Nevertheless, this should not discourage further research in developing and exploring new models for process representation. This paper proposes yet another approach to diagrammatically schematizing business processes based on the notion of flow and oscillates among several descriptive levels (e.g., requirements, design, and user interface). The method is characterized by coherence as the schema is built on five basic phases that form the blocks of flow systems. The proposed method is contrasted with BPMN by modeling the same study cases using the two methodologies and then comparing the results side by side. The results suggest the viability of the proposed scheme to enhance diagrammatic representations of business processes.**

Keywords-Business process management, conceptual modeling, process model language, BPMN

INTRODUCTION

Physical security is a critical part in any organization. "A Trends in globalization have pressured organizations to change their business processes to achieve more effective and efficient management of assets in order to handle "the rise in frequency of goods ordered; the need for fast information transfer; quick decision making; the need to adapt to change in demand; more international competitors; and demands for shorter cycle times" [1]. Information technology (IT) is destined to be the main vehicle for realizing the necessary changes in *business processes management*.

Hill et al. [3] claim that many business process management terminologies are often not well understood [3], notations often contain duplicating features [4], and they are loosely based on theoretical formalisms such as Pi-calculus and Petri nets [5]. According to Chinosi and Trombetta [6], *use case* descriptions of complex procedures are often "very difficult to understand." Users enrich descriptions with diagrams, and examining graphical representations of processes allows users to easily discover inconsistencies, non-terminating conditions, and so forth [6]. Therefore, "a clear

need" has increased for a modeling language that can be "expressive, formal enough, easily understandable by experts and end users**"** [6].

In this context, Business Process Modeling Notation (BPMN) was developed by the Object Management Group (OMG) [7] as a standard graphical modeling language. It is described as "reasonably intuitive notation" [8] and "allows users to express the information flow, decision points and the roles of business processes in a diagrammatic way" [2].

> The Business Process Model and Notation (BPMN) is the de-facto standard for representing in a very expressive graphical way the processes occurring in virtually every kind of organization one can think of, from cuisine recipes to the Nobel Prize assignment process, incident management, e-mail voting systems, travel booking procedures, to name a few. [6]

Chinosi and Trombetta [6] identify three different application domains for modeling languages, including *pure description*. "For descriptive purposes only, BPMN itself is probably the best choice, at the present time" [6].

This paper proposes an alternative base, called the Flowthing Model (FM), for describing (*representing*) business processes based on the notion of flow. The model oscillates among several descriptive levels (e.g., requirements, design, user interface). The underlying thesis of this presentation is that a key obstacle in BPMN is the lack of *an underlying model for creating a coherent description of processes*, analogous to techniques in engineering schemata (e.g., electrical) in which a few generic processes (e.g., AND, OR, XOR, etc.) are utilized in the specification of a system. The paper shows that utilizing only five generic, mutually exclusive *states* (creation, release, transfer, receiving, and processing) are necessary to describe Chinosi and Trombetta's [6] processes that occur "in virtually every kind of organization one can think of."

To substantiate such claims it is necessary to demonstrate the advantages gained by adopting FM representation of processes. One way of achieving this is through comparing it with BPMN—but how to compare two conceptual representations? Milton and Kazmierczak [9] utilized ontologies to answer such a question as, how well does a model represent reality? An analysis of methods is essentially accomplished by conducting evaluations "against selected reference ontology." The results indicate the degree to which

the reference ontology is reflected and utilizes this ontology as a benchmark against which the assessment is performed [9]. Items used in this comparison are Individual, Relation, Attribute, and classification. The results indicate a similarity among the selected modeling languages.

Alternatively, and since FM is not yet a well-known modeling approach, we select a more restrained approach of contrasting FM and BPMN by modeling the same study case with the two approaches to facilitate a side-by-side comparison of the two representations of the same problem.

As background for our conceptual representation and for the purpose of a self-contained paper, the next section reviews the general features of the proposed model. The model has been used in many applications [10–13], and this paper now uses it to model business processes.

FLOWTHING MODEL

The Flowthing Model (FM) is also based on the notion of *flow*. FM is used to develop a map of conceptual movement (analogous to the movement of blood through the heart and blood vessels) and states of *things* that are called *flowthings*. Goods, people, ideas, data, information, and money moving among *spheres* (e.g., places, organizations, machines, …) are flowthings.

Flowthings flow in a non-black box system called a *flowsystem*. The flowsystem is a "river bed," and the flowthing is the "water" that flows through it. It is a generalization of the input-process-output (IPO) model. The basic IPO conception is captured by a process acting on an input and producing an output. It views a system as a *black box* process with an interface, and the environment denotes everything outside that system. The interface can be invoked either by the system (output) or by the environment (input). The IPO notion of "process" hides structural (i.e., generic) divisions.

The FM *flowsystem* opens the black box by decomposing it into several specific (atomic/mutually exclusive) compartments and specifying flows within a system or a subsystem. *Flow* refers to the exclusive transformation of a flowthing passing among six states (also called stages) in a flowsystem: transfer (input/output), process, creation, release, arrival, and acceptance, as shown in Fig. 1. We use *receive* as a combined stage of *arrive* and *accept* whenever arriving flowthings are always accepted.

Fig. 1. Flowsystem

Each *stage* has its own vocabulary:

- **Create**: generate, appear (in the scene), produce, make, … In contrast to previous approaches, in FM *creation* is considered a type of flow, i.e., from the sphere of nonexistence to the current sphere.

- **Transfer**: transport, communicate, send, transmit, … in which the flowthing is transported somewhere within or outside the flowsystem (e.g., packets reaching ports in a router, but still not in the arrival buffer).
- **Process**: a stage in which the form but not the identity of a flowthing is transformed, indicated by a seemingly endless choice of English verbs (e.g., compressed, colored, edited, marked, evaluated, ordered, …)
- **Released**: a flowthing is marked as ready to be transferred (e.g., airline passengers cleared by security and waiting to board)
- **Arrive**: a flowthing reaches a new flowsystem
- **Accepted**: a flowthing is permitted to enter the system

These stages are mutually exclusive; i.e., a flowthing in the *Process* stage cannot be in the *Created* stage or the *Released* stage at the same time. An additional stage of Storage can also be added to any FM model to represent the storage of flowthings; however, storage is a not an exclusive or specific stage, because there can be *stored* processed flowthings, *stored* created flowthings, and so on.

The flowthings flow in specific "flow channels," changing in form and interacting with outside *spheres* (flowsystems in other systems), with **solid arrows** representing flows and **dashed arrows** representing triggering, e.g., receiving an action. Triggering may signify several semantics, including representing a flow. For example, in a case where a flowsystem triggers another flowsystem, it can indicate a signal flow, i.e., create a signal and send it to a destination flowsystem. When a *sphere* includes a single *flowsystem*, then only one box is drawn to represent both the sphere and its flowsystem.

The flow stream in FM is analogous to the assembly lines commonly used in mass production systems. An assembly line typically consists of a number of workstations (flowsystems) linked by flows. Flowthings are transported (flow) along the conveyors (flow lines) from one flowsystem to another. The flowthings can be handled (buffered, checked, examined, changed in form, moved to the next stage…) within each stage.

CASE STUDIES

This section applies FM to describe two published case studies: Traveler and travel agent collaboration and Hotel stay services.

A. Traveler and travel agent collaboration

W3C [14] introduced a case study with a scenario in which a traveler business process interacts with a travel agent business process. The following is a summary of the description of the scenario given by W3C [14]:

A Traveler decides where to go and when to return. She then submits her choices to a Travel Agent. The Travel Agent evaluates itineraries and finds the best plan. For each leg of travel, the Agent asks the Airline Reservation System to verify the availability of seats. For each leg, the Airline

Reservation System provides information about the availability of seats. The Travel Agent builds a proposed itinerary for the Traveler to verify. The Traveler has the following choices:

- *Rejection: she can submit the modifications and wait for a new proposal.*
- *Cancellation: she can inform the Agent of her decision and the process ends.*
- *Acceptance: she will provide the Travel Agent with her credit card information. The Traveler will also provide her contact information so the Airline Reservation System can send an e-Ticket directly from the Airline.*

Next, the Agent connects with the Airline to finalize the seat reservation. The validity period for such reservation is one day, meaning that if a final confirmation is not received within 24 hours, tickets will be unreserved and the Travel Agent will be notified. Next, the Travel Agent informs the Traveler about the reservation of her seats. The Traveler can now either finalize the reservation or cancel it. If she confirms the reservation, the Travel Agent asks the Airline Reservation System to book the seats. The Airline Reservation System books the seats for the chosen itinerary, then issues an e-Ticket to the Traveler. Finally, the Travel Agent charges the Traveler's credit card for the relevant amount and sends notification of the charge together with a detailed description of the itinerary to the Traveler.

Wong and Gibbons [15] constructed a BPMN diagram for this scenario describing the collaboration between the Traveler and the Travel Agent (adding some details) as shown in Fig. 2 (partial). Processes are represented by a type of (apparent) input→name (of process)→output where input can be data or control flow. The "surface view" includes many heterogeneous elements, including decisions (gateways) and black-boxed processes. In contrast, in FM, the black boxes are the *stages* of the flowsystem that hide the details of the process. For example, decisions (e.g., if …) can be "buried" within the *Process* stage; accordingly, flows and triggering originate from within flowsystems and thus do not disturb the "surface view" that includes essential flowsystems and flows.

The corresponding FM representation is shown in Fig. 3. There are minor discrepancies and omissions for various reasons in the original verbal descriptions (e.g., in Wong and Gibbons' [15] BPMN diagram, "The travel agent in return offers her an itinerary (not shown)") and in the FM representation, but these do not affect the issue under consideration.

In general, FM schemata handle flowthings (e.g., orders) regardless of the format, just as on an assembly line where "workpieces," at this level, are identical (e.g., either orders, itineraries, or tickets), but not fully described in the format. Flowthings can be, in principle, in different formats. For example, the orders in the study case can be emails, website entry, Fax, or even, in certain segments of the flow, physical paper forms. Accordingly, at the beginning, the "format" (e.g., UML class description) of the order is not a central concern.

In Fig. 3, the traveler creates (circle 1) an order that flows to the travel agent (2) where it is processed (3). This processing triggers (4) the agent to create (5) a travel plan.
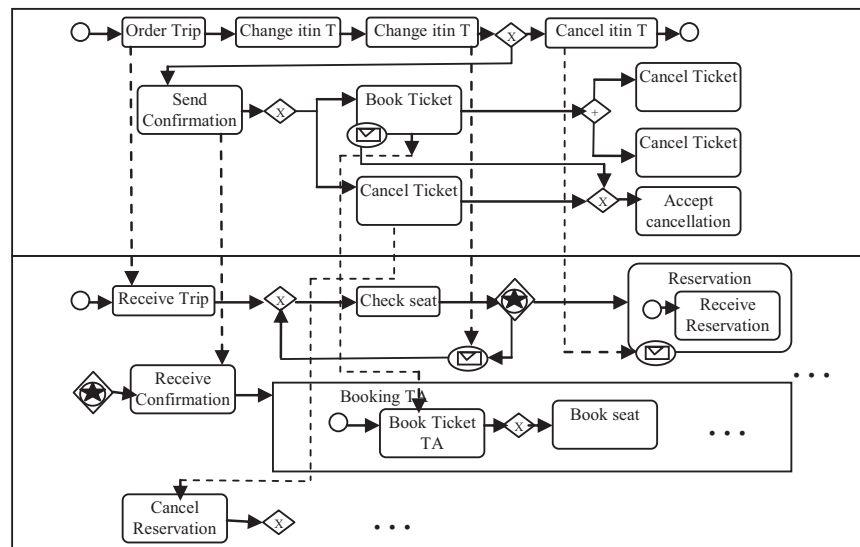

Fig. 2 Collaboration between the traveler and the travel agent (redrawn partially from [15])
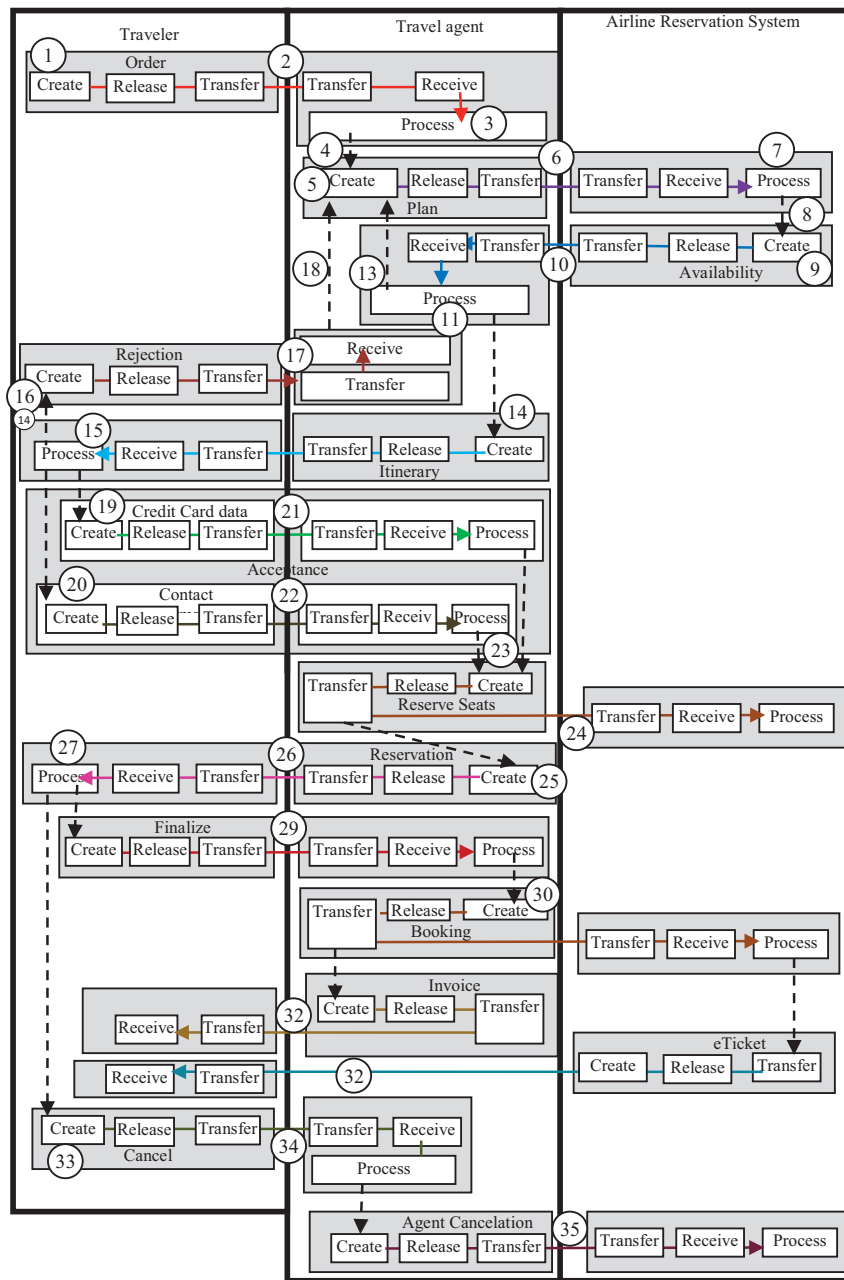
Fig. 3 FM description of the scenario where a traveler business process interacts with a
travel agent business process

The plan flows to the Airline Reservation System (6), where it is processed (7) to trigger (8) an availability response (9). The availability response flows to the agent (10) who processes it (11), triggering:

- Creating another travel plan to be sent to the airline (12), or
- Sending the itinerary to the traveler (14)

When the traveler receives the itinerary and processes it (15), one of the following responses is triggered:

- The itinerary is rejected (16), and this is communicated to the agent (17). The rejection triggers (18) the agent to create another travel plan.
- The itinerary is accepted, triggering the creation of credit card information (19) and contact information (20) that flow (21 and 22, respectively) to the agent. Upon

processing this information, the agent triggers (23) the creation of a request for seat reservation that flows to the airline (24). The agent also creates an acknowledgment of this reservation (25) that flows to the traveler (26), who processes it (27) and creates a finalization note (28). The finalization note flows to the agent (29) to trigger the creation of booking (30) that flows to the airline to trigger sending an e-ticket to the traveler (31). This triggers sending a complete invoice to the traveler (32).

- The itinerary is canceled, triggering the creation of a cancellation note (33) that flows to the agent (34), who notifies the airline (35).

Examining the two conceptual representations, BPMN and FM, we observe the following. BPMN has far richer notations: "thirty-eight language constructs plus attributes, grouped into four basic categories of elements, viz., Flow Objects, Connecting Objects, Swimlanes and Artefacts. Flow Objects, such as events, activities and gateways, are the most basic elements used to create Business Process Diagrams" [8]. However, these constructs form a multifarious "surface view" with heterogeneous shapes and sizes that create an image of unity without a "mortar" that makes it an integrated system. Consider "processes" mentioned in Wong and Gibbons' [15] model of the collaboration between the traveler and the travel agent (Fig. 2). It includes the commands Order, Change, Cancel, Send, Book, Receive, Accept, Check, Reserve, "Error," and Request. Potentially any English verb could be a BPMN in this list. Examining some of these processes more closely in terms of FM flows reveals the following.

A. Order (a trip) in Wong and Gibbons' [15] (Fig. 2)
Assuming the flowthing is an order, this "process" can be represented in FM as,

Create (bytraveler) → Release (by traveler) → transfer (traveler/agent) → receive (by agent) → process (by agent)

Note that the arrow in Wong and Gibbons' [15] Fig. 2 represents control flow. Thus, "Order trip" in that figure embeds a great deal of detail that is uncovered by the FM representation. It is not a mere "order a trip" but instead, "generate a request for a trip, send it to the agent, who when he or she receives it processes it to decide on further action." Such a description is not verbose; the structure of stages and the flows express the actions that follow each other. Alternatively, "order a trip" could mean "trigger the secretary to contact the travel department to prepare the company's private jet."

B. Change (itinerary)
The BPMN representation seems to mean that the agent "changes" the itinerary by contacting the airline's website. Representing this in FM requires two flowthings: *request* (to change) and *availability*,
Request:
Create(agent)→release(agent)→Transfer(agent/airline)→Receive(airline)→Process(airline)

Availability:
Create(airline)→release(airline)→Transfer(airline/agent)→Receive(agent)→Process(agent)

The point here is that the source of the richness in BPMN is a failure to categorize "processes" into generic types. The scenario's processes are essentially a series of process names: order→check→cancel, … Of course, these processes are detailed at a lower level of description, while FM captures the essence of the processes through flowsystems with their five stages and flows.

Accordingly, BPMN representation seems to be a "sketch" of *names of processes*. The connections (lines) seem to be hollow links because the interiors of the processes are not there to specify the origins of the connections. The interiors of the processes cannot be included because this would mess up the whole diagram and an overall "forest view" would disappear. All BPMN processes can be expanded into FM description, but the two previous examples are sufficient to contrast the diagramming methodologies.

Wong and Gibbons [15] also have reservations about the capability of BPMN to model *negative requirements*:

> Some behavioral properties, against which developers might be interested to verify their business processes, might not be easy or even possible at all to capture in BPMN. Consider Requirement [*The travel agent must not allow any kind of cancellation after the traveler has booked her ticket, if an invoice is to be sent to the traveler*] of the ticket reservation example (Fig. 2). It could be difficult to specify these behaviors in the same BPMN diagram. Since BPMN is a modelling notation for describing the performance of behavior, in general it is difficult to use it to specify liveness properties about the refusal of some behavior within a context while asserting the availability of it outside the context. [15]

Using FM, we have no difficulty in expressing the requirement: *The travel agent must not allow any kind of cancellation after the traveler has booked her ticket, if an invoice is to be sent to the traveler*, as illustrated in Fig. 4 (a portion of Fig. 3). When the agent sends the booking request to the airline, he/she blocks, e.g., a cancellation icon on the web page and receiving of any cancellation (circle 36). Upon sending the invoice to the traveler, he/she unblocks this receiving of cancellation (37).

B.   Hotel stay services
According to Bitner et al. [16],

> One of the most distinctive characteristics of services is their *process* nature. Unlike physical goods, services are dynamic, unfolding over a period of time through a sequence or constellation of events and steps. The service process can be viewed as a chain or constellation of activities that allow the service to function effectively.

Bitner et al. [16] used *service blueprinting*, which shares similarities with BPMN as a visual notation for business processes and is used to represent high-level overviews of conceptual processes. Fig. 5 is an example of a blueprint for a hotel stay service.
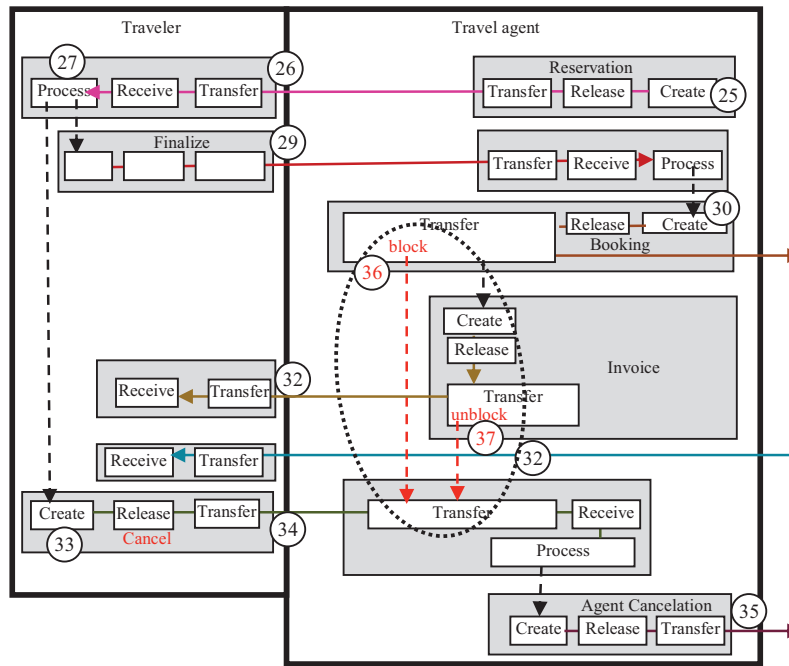
Fig. 4 Partial view of Fig. 3, with a requirement added to the description
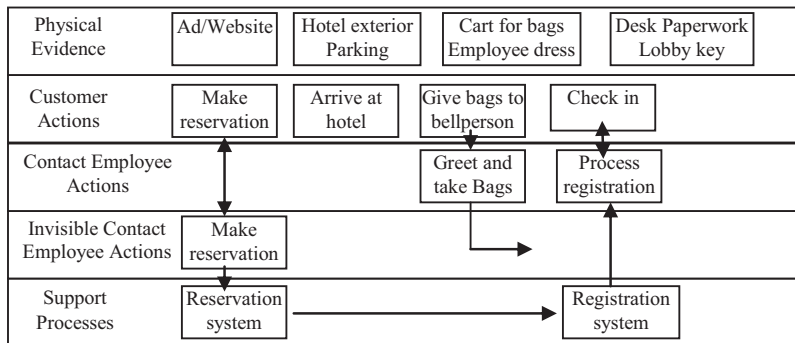

Fig. 5 Blueprint for a hotel stay (partial; redrawn from [16])

Simon et al. [17] introduce a BPMN representation of this service blueprint (Fig. 6). It should be noted that the purpose of displaying these blueprinting and BPMN diagrams is not to give a fair, in-depth discussion of the diagrams, but rather to illustrate the types of diagramming used in modeling the problem. One motivation for such a demonstration is the hope that the reader might recognize the merits of FM by comparing these representations side by side.

Fig. 7 shows the corresponding FM representation. In Fig. 7, the traveler creates a reservation request (circle 1) that flows to the reservation employee at the hotel (2) who generates a reservation in the system. Upon the arrival of the customer as a (physical) guest (4), along with his/her bags (5) at the hotel, he/she is greeted (7) by the bellperson, who takes his/her bags (8).

The guest proceeds to the lobby desk (9) where he/she is processed (10) to create a registration by the reception desk (11). This triggers (12) the system to create a registration (13) using information in the database relevant to the reservation (14). The bold vertical bar indicates a join operation in which the registration is created from information input by the reception clerk and also from the reservation database. FM can be supplemented with such notation of logical, synchronization, and timing notions that can be overlaid on the basic FM diagram.

Note the types of flowthings present in Fig. 7. There are information/data flowthings (e.g., reservations), physical flowthings (e.g., guests and bags), and actions such as greetings.

Contrasting Physical and FM Maps

In contrast the typical physical maps used in security with FM maps, the physical security map takes space as a starting position: space exists by itself furnished with things (e.g., a collection of sensors that provides data). is purely static relational scheme used at emergency to construct the totality of the situation where other details are added. By contrast, in FM, an *empty* space embodies synchronic order of states (stages): creation, release, transfer, receives and process. In fig. 9, there are three different types of spaces because space is defined in terms of its content. Space in FM has dynamic content. Activities (stages) and their connections (flows) in space established a system (flowsystem) of representation.

Note that on the FM map, it is possible to depict triggering events. For example, the receptionist triggers the security guard of the presence of a suspicious person (see Fig. 10). This cannot be represented in physical maps. Also note that a physical map can be one of the spheres in the FM map (see Fig. 11).

Conclusion

The paper has introduced a sample FM representation that can form a base for a security system for IT department. The generality of the method can be applied to the design of any physical security project. The resultant design seems to be suitable for security operations, training, and planning. Accordingly, FM can be updated continuously to be used in security operations, training, and planning in contrast to a single picture of physical maps.

References

[1] Bozidar Spirovski, Datacenter Physical Security Blueprint, Information Security Short TakesBlg. http://www.shortinfosec.net/2008/04/datacenter-physical-security-blueprint.html

[2] Suzanne Niles, Physical Security in Mission Critical Facilities, Schneider Electric White Paper 82, Revision 2, (No Date). http://www.apcmedia.com/salestools/SADE-5TNRPL/SADE-5TNRPL_R2_EN.pdf

[3] Don Philpott & Shuki Einstein, The Integrated Physical Security Handbook, The Counter Terrorist magazine, June/July 2015. http://thecounterterroristmag.com/pdf/IntegratedPhysicalSecurityHandbook.pdf

[4] Carol Woodbury, Security Blueprint, February 2003, http://www.ibmsystemsmag.com/aix/administrator/security/Security-Blueprint/

[5] Zachary James Alach, Mapping the elements of physical security towards the creation of a holistic physical security model, Master thesis, Edith Cowan University, May 2007. http://ro.ecu.edu.au/cgi/viewcontent.cgi?article=1001&context=theses

[6] Cisco Systems, Cisco Physical Security Operations Manager, Release 6.1, January 31, 2013. http://www.cisco.com/c/dam/en/us/td/docs/security/physical_security/video_surveillance/psom/6_1/user_guide/user.pdf

[7] S. Al-Fedaghi, "Schematic Approach to Information Services Reconfiguration," International Journal of Engineering Business Management, vol. 7, No. 3, 2015.

[8] S. Al-Fedaghi, "High-Level Representation of Time in Diagrammatic Specification," 2015 International Conference on Soft Computing and Software Engineering (SCSE'15), University of California at Berkeley (UC Berkeley), USA, 5–6 Mach 2015.

[9] S. Al-Fedaghi, Schematizing Proofs based on Flow of Truth Values in Logic, IEEE International Conference on Systems, Man, and Cybernetics (IEEE SMC 2013), October 13-16, Manchester, UK.

SESSION

E-GOVERNMENT, ECONOMICAL IMPACTS, TOOLS, AND RELATED ISSUES

Chair(s)

TBA

Guidelines for Transparency Implementation in Brazilian Municipalities based on Apiúna's Case

Larissa Mariany Freiberger Pereira [1]**, Everton Ricardo do Nascimento** [1]**, Denilson Sell** [1]**, José Leomar Todesco** [1]**, Paulo Mauricio Selig** [1]**, Guilherme Bertoni Machado** [1]

[1]Graduate Program in Engineering and Knowledge Management, Federal University of Santa Catarina, Florianópolis, Santa Catarina, Brazil

Abstract - *Public transparency has been imposed by law to all Brazilian public entities, but it is noticeable the difficulty that they face to implement it. The General Comptroller's Office in Brazil has developed a methodology (Brazil Transparent Scale - EBT) to quantify public transparency in various Brazilian public entities and a large part of them were evaluated with relatively low scores. The municipality of Apiúna, located in the interior of Santa Catarina state, got maximum score in the two editions of EBT. In this sense, this paper proposes eight guidelines to assist other Brazilian municipalities in transparency implementation process, based on Apiúna's case. The research was conducted through semi-structured interviews with key stakeholders in the transparency implementation process in Apiúna. Through these interviews, we identified factors that were important for the city to obtain success and, from them, the guidelines had been developed.*

Keywords: Public transparency, Brazilian municipalities, transparency law, information access law

1   Introduction

Several concepts of the term "transparency" had been built over time, but a very widespread and accepted concept in the Public Administration's World was proposed by [1]. According to the authors, on page 03, "transparency describes the increased flow of timely and reliable economic, social, and political information […]".

Based on [2] we could say that in the public organizational context, transparency allows people to have a clear view about government business processes, reducing the possibility of information failure and providing accountability, thereby increasing the reliability of management.

In Brazil, government agencies have been motivated to implement public transparency initiatives some time ago, as illustrated on Figure 1. On May 27, 2009 the Complementary Law No. 131, also known as Transparency Law, came into force.

The Transparency Law [3], determined that Federal Government, the States, the Federal District and the Municipalities made public its budgetary and financial information in detail and in real time.

In September 2011, Brazil, with other seven countries, founded the Open Government Partnership (OGP), which, according to [4] is a "multilateral initiative that aims to secure concrete commitments from governments to promote transparency, empower citizen, fight corruption, and harness new technologies to strengthen governance".

On November 18, 2011 was enacted by Federal Government the Law No. 12.527, also known as Information Access Law (LAI). The law [5] determined that Federal Government, the States, the Federal District and the Municipalities, as well as public foundations, public enterprises, joint-stock companies and other entities controlled directly or indirectly by government should make public their information through Information and Communication Technologies (ICTs), independent request. It is valid to Legislative, Executive and Judiciary Branches, as well as the Brazilian Government Agency for Law Enforcement and Prosecution of Crimes (MPU).
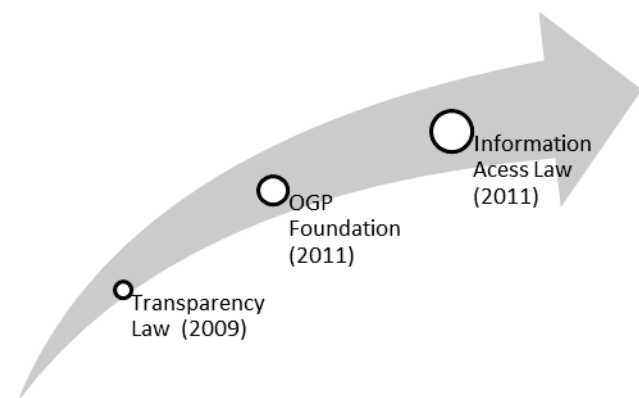

Figure 1.Actions to Promote Transparency in Brazil

Despite those legal actions to promote transparency, government entities face serious difficulties to comply with

the laws. The General Comptroller's Office in Brazil (CGU) developed a methodology named Brazil Transparent Scale (EBT) to quantify public transparency in states and municipalities, as well as the Federal District.

The EBT Methodology evaluated the government entities based on points related to LAI Regulation (adequacy of LAI in a specific context) and Passive Transparency, including elements such as "Exposure of legislation on the rated site", "Regulation of Citizen Information Service (SIC)", "Existence of e-SIC (the Internet service)", "Existence of Regulation Law", and others.

In its first edition the EBT evaluated 465 municipalities with less than 50,000 inhabitants, 27 capital cities, 26 states, as well as the Federal District.

According to [6], the evaluation of municipalities was made from three requests for access information of important social areas (health, education and social assistance) and one request for access information based on the regulation of LAI in the municipality.

The final report of EBT, in its first edition, was released on May 15, 2015, in Brasília, to celebrate three years of validity of LAI in the country. However, despite that, the results were pretty worrying: 310 evaluated municipalities (corresponding to 63% of the total) had no point. The situation is even more alarming when observing the average grade of municipalities: approximately 1.35 point in a scale to goes up to 10.

Apiúna, a town in the interior of Santa Catarina state, with just over 10,000 inhabitants had 10 points, the maximum possible score and, because of that, ranked first in EBT.

The methodology was applied again, in its second edition and its final report was released on November 20, 2015. In its second edition, the EBT evaluated 1,559 municipalities with less than 50,000 inhabitants, 27 capital cities, 26 states, as well as the Federal District.

At this time, 789 evaluated municipalities (49,71%) had no score. Apiúna continued to rank first, being classified once more as the most transparent city in Brazil.

In this context, this paper present a research conducted through semi-structured interviews with key stakeholders who contributed to the public transparency implementation process in Apiúna. After, based on this case, we proposed eight guidelines that can guide other municipalities in conducting the transparency implementation process. To propose these guidelines, we needed to understand how the transparency implementation process occurred in Apiúna, as well as identify the factors and important aspects that led to the success and completion of this process.

2   Methodological Procedures

This is a scientific research, since it deals with the issue from a theoretical bias, seeking to move forward and contribute to the knowledge construction of the research topic. This methodological approach, as said by [7], considers the problem in an emerging way. In other words, the problem should actually arise in the field to be researched.

The research was conducted in three stages, namely: Data Collection, Data Analysis and Interpretation and Guidelines Development.

2.1   Data Collection

The data collection stage was conducted from an interview script that would allow the collection of relevant information in the context of public transparency. Thereby, it was possible to raise the actors and important factors that led Apiúna to be considered the most transparent city in Brazil by the General Comptroller's Office.

Based on the perceived challenges to the implementation process of public transparency, the script was structured based on the following questions: (1) How was the implementation of public transparency process in the town? (2) What are the perceived impacts according to the managers and citizens perspectives from this process? (3) Who participated in the public transparency implementation process in the municipality? (4) What has changed, in public governance context, after the public transparency implementation in the municipality? (5) What were the internal and external factors that contributed to the success of this process?

After completion of the interview script, the first respondents were defined. Through phone calls and e-mails exchanges, it was possible to schedule interviews with the Comptroller of Apiúna and the Municipal Secretary of Management, which were the initial stakeholders at the time of the interviews. During the interviews, we identified, from the initial respondents, three actors who played important role in the transparency implementation process in the municipality: the Mayor's Executive Assistant, the Municipal Secretary of Articulation and the Mayor himself.

We emphasize that the semi-structured interview allows the collection of various relevant information regarding the public transparency implementation process in Apiúna through informal conversations. We believe that through a rigid and inflexible interview script we would not get the amount of information obtained from semi-structured interview script.

The interviews happened all over a single day, generating a total of more than three and half hours of recording, occurred at the beginning of August 2015.

2.2 Data Analysis and Interpretation

After the interviews, it was initiated the data analysis and interpretation. According to [8], in page 16, "the idea of analysis suggests some kind of transformation. You start with some qualitative data collection (often voluminous) and then process them through analytical procedures until they become a clear, understandable, careful, reliable and even original analysis".

At this stage, initially, efforts were focused on the interviews' transcriptions, in order to systematize data, thereby facilitating their subsequent analysis.

Here we emphasize that the transcription task was divided into two steps: (1) the transcription of interviews itself and (2) transcription's validation.

In this sense, we defined that the researcher who made the transcription of any interview could not work on the validation of this material. This was done to guarantee the quality and impartiality of the material, avoiding interpretations at this time of the research.

Finalized the transcriptions, the complete reading of resulting material was done and, due to the large volume of data, we began the coding task.

According to [7], on page 186, "coding is the process of organizing the material into chunks or segments of text before bringing meaning to information". About that, [7] said, still on page 186, that coding task "involves taking text data or pictures gathered during data collection, segmenting sentences (or paragraphs) or images into categories, and labeling those categories with a term, often a term based in the actual language of the participant (called an in vivo term)".

After the data coding we opted to organize data in a table structured as a matrix. At the top of matrix were listed all the issues or codes identified in the previous step and in the left part of the matrix we described the stakeholders interviewed. Data were organized according to the subject to which it referred and the informant who reported it.

Developed the matrix, we started to work in data interpretation. We emphasize that the very tool used to organize data (Data Matrix) assists in the interpretation of them, since the data were visually arranged and organized, making easier the comparison of stakeholders' ideas and speeches.

In the interpretation stage, we could observe some important aspects of implementation of public transparency in Apiúna, as the mayor's initiative in this process. Here we emphasize that there is no way to implement public transparency if the manager does not understand the importance of this process to promote an efficient management.

2.3 Guidelines Development

At the end of the data analysis and interpretation stage, it was possible to identify factors that were crucial for the implementation of public transparency in Apiúna. Because it is a lived experience, it was observed that not all the identified factors could be generalized, becoming guidelines for the public transparency implementation in other municipalities.

In this sense, it was necessary verify factors identified from data interpretation that could be generalized, becoming guidelines and forwent those that had been identified from particularities of Apiúna's process.

3 Guidelines to assist Brazilian Municipalities in the Public Transparency Implementation Process

We present, below, eight guidelines for public transparency implementation in Brazilian cities developed from the experience of Apiúna, the most transparent municipality in Brazil, according to EBT.

3.1 The main motivation to start the public transparency implementation process in municipalities must come from the mayor

It is vital that the initial motivation for the implementation of public transparency in the municipalities must come from the mayor. The Comptroller of Apiúna told us that the staff involved in the public transparency implementation "[...] have the role to guide him [the mayor], but who manages is the mayor. He is the one who gives orders, who manages [...] ".

3.2 It is necessary to have someone responsible for leading the public transparency implementation process

As in any project, it is very important that someone take the lead in this public transparency implementation process in the municipality. This person will hardly be the mayor, since it is necessary to have availability to engage in the activities that this process demands.

In Apiúna's case, this leading figure was the Comptroller, as emphasized the Municipal Secretary of Management: "[…] we had a person who was ahead [of the process], the Comptroller, which sought to identify what the law was demanding, worked on adaptations of the information system, but, in the end, the group worked together. Someone has to lead the process, otherwise you do not get to anywhere".

The Municipal Secretary of Articulation said that the Comptroller was responsible for motivating and supporting the mayor when important decisions that influenced directly to the effectively implementation of public transparency in the municipality must be made.

In this regard, we also understand that the person responsible for leading the public transparency implementation process in the municipality should be a statutory employee, in order to ensure continuity of work even in the midst of change management. Of course, in a context of change management, if the mayor is not interested in the implementation of public transparency, the project must languish.

However if, even in the midst of change of municipal management, the new manager understand the importance of the implementation of public transparency in the municipality, it is important that continuity be given to this process, so the participation of a statutory employee in leading this process becomes so important. That kind of employee remains in managing even if the mayor is replaced because of elections.

3.3 The mayor shall compose a competent and committed team to implement public transparency in the municipality

Here we emphasize that the composition of a competent and committed team with the public transparency implementation process is required.

In Apiúna the team proved to be reliable and, because of that, gained autonomy to perform the necessary actions to implement public transparency. Thereby, this relationship of trust gave autonomy to the team to work and reduced bureaucracy in the public transparency implementation process.

In short, the team autonomy in this process should be considered, since the mayor is unlikely to closely monitor all detailed actions that permeate the public transparency implementation process. Thus, the team must have autonomy to execute more technical and specific actions and should appeal to the mayor especially on strategic business issues of this process.

3.4 Municipalities should participate proactively and join the associations of municipalities, encouraging the collaborative work to implement transparency

A very important factor that contributed to the success in the public transparency implementation process in Apiúna was the participation of the municipality in the Association of Municipalities of "Médio Vale do Itajaí" (AMMVI). The AMMVI was composed by 14 municipalities that started a study group. In their meetings, they used to discuss strategies for implement public transparency in their municipalities.

The Comptroller of Apiúna said that AMMVI "is a very active association" and the actions taken by it were central to succeed in the public transparency implementation process in Apiúna.

He told that the study group arose from the need of transparency implementation in Brazilian municipalities. In 2012 it was initiated the meetings and it has started the process of law regulations implementation. Municipalities, through AMMVI, had meetings with members of Brazilian Government Agency for Law Enforcement and Prosecution of Crimes, who assisted them in that task.

We understand that this relationship between municipalities and the association is extremely important, since the municipalities could share their experiences in the public transparency implementation process with the association and the association, on the other hand, helps municipalities in this process from the experiences lived by other municipalities.

It is also important to note that, in general, the associations of municipalities have direct access to the Brazilian Government Agency for Law Enforcement and Prosecution of Crimes and other federal agencies, providing, thus, a communication channel between these agencies and municipalities.

3.5 Municipalities must regulate the law that promotes transparency

The regulation of LAI by municipalities is recommended by the General Comptroller's Office in Brazil, since the legislation approved locally "sets the law general precepts to the specific entity reality", according to [9], in page 6.

In other words, the federal legislation provides a general law that should be applied to any public entity of the federation. However it is important and necessary that each entity

(municipalities, states, federal district and federal entities) regulates the LAI to make it suitable to its own reality.

This aspect is so relevant in public transparency implementation process that own General Comptroller's Office in Brazil evaluates through EBT how the LAI was regulated by the municipality.

Here, it is noteworthy that the associations of municipalities have a fundamental role in supporting municipalities to regulate the LAI. In this regard, the association of municipalities acts as a consultant of the municipalities in this process and, consequently, the municipalities themselves end up helping each other in these formal issues of transparency implementation process.

3.6   Information Systems must be appropriate to the current legislation, meeting the specifications laid out in the LAI regulation

Another key factor for transparency being effectively implemented in municipalities is the adequacy of information systems used by municipalities to the legislation.

The Municipal Secretary of Articulation of Apiúna told that information systems play an important role in the public transparency implementation process.

In Apiúna, they needed to work with two different information systems for a while because the first one they used does not meet the provisions of the law and needed to be adapted. This task took some time and the needs of municipality were supplied with a second information system that met the legal requirements not met by the first one.

From this year Apiúna hopes work with just one information system, the first one they have already using since this must already meet all municipality needs to meet the LAI regulation.

Here, we emphasize that the information system is important to the public transparency implementation. Without it, transparency cannot be implemented. However, this is not a sufficient resource for the effectiveness of transparency implementation process.

3.7   The team that leads the transparency implementation process in the municipality must turn their efforts to promote a cultural change in management

In the transparency implementation process in municipalities, it is important the adequacy of civil

employees to the new reality, since the internal processes must be changed in order to clarify the actions of public administration.

In Apiúna's case the Mayor's Executive Assistant said that civil employees did not have the habit of keeping the system with updated data and if this is not done, there is no promotion of public transparency.

Civil employees who make up the management must understand that in the context of public transparency is required that the data be entered in the system in real time. They equally should be reliable and express the reality of management in order to ensure their availability and reliability. We understand that cultural changes are not easy, but they are necessary, especially in this context.

3.8   The municipality should seek to work together with the Brazilian Government Agency for Law Enforcement and Prosecution of Crimes

In Apiúna's case, the Brazilian Government Agency for Law Enforcement and Prosecution of Crimes had requested the municipalities in the region that they make transparent their data and government actions, facilitating its access and meeting LAI provisions.

In this sense, the very Brazilian Government Agency for Law Enforcement and Prosecution of Crimes requested mayors to sign a Conduct Adjustment Term (TAC).

According to the Brazilian Government Agency for Law Enforcement and Prosecution of Crimes [9], Conduct Adjustment Term are "documents signed by parties to undertaken, towards a member of the Brazilian Government Agency for Law Enforcement and Prosecution of Crimes, to fulfill certain conditions in order to solve the problem that they are causing or compensate already caused damages".

Before TAC was sent to the mayors, the member of the Brazilian Government Agency for Law Enforcement and Prosecution of Crimes told them what the requirements in TAC were.

This fact accelerated the transparency implementation process in Apiúna, since the mayor already knew about what would be requested by the Brazilian Government Agency for Law Enforcement and Prosecution of Crimes.

The Comptroller of Apiúna told about the key role that the Brazilian Government Agency for Law Enforcement and Prosecution of Crimes exercised by informing for mayors the requirements contained in TAC.

He told that the noncompliance of TAC results in fine for mayors and municipalities. So, in Apiúna's case, the mayors was forced to accomplish the LAI, the Transparency Law and the TAC.

The Brazilian Government Agency for Law Enforcement and Prosecution of Crimes has interest that the Transparency Law and LAI are fulfilled as far as the municipalities, so that the fines are not effective. In this sense, a good relationship between mayors and the Brazilian Government Agency for Law Enforcement and Prosecution of Crimes can significantly advance the transparency implementation process.

4   Conclusions

The transparency implementation in public administration in Brazilian municipalities, although required by law, has not been effectively carried out by many of these public entities as shown by the General Comptroller's Office in Brazil (CGU) by Brazil Transparent Scale (EBT) methodology developed by CGU itself to quantify the level of transparency implemented in municipalities, states and the Federal District.

Apiúna is a Brazilian municipality, located in the state of Santa Catarina. The town got maximum score (ten) in the two editions of the EBT and was classified as the most transparent municipality in the country. Through semi-structured interviews with key players in the consolidation of transparency implementation process in the municipality, it was possible to identify important factors that led to the success of the city.

From the experience lived by Apiúna it was possible to develop eight guidelines that assist other municipalities in the transparency implementation. These guidelines do not guarantee the success of the transparency implementation process, but can assist mayors and their staff in conducting this, especially in cities where there is no initiative in this regard.

5   References

[1] Vishwanath, Tara; Kaufmann, Daniel. Towards transparency in finance and governance. Available at SSRN 258978, 1999.

[2] Aló, Claudia Cappelli. (2009). Uma abordagem para transparência em processos organizacionais utilizando aspectos (Unpublished doctoral thesis). Pontifícia Universidade Católica, Rio de Janeiro, Brazil.

[3] Brazil. Lei complementar nº 131, de 27 de maio de 2009. Acrescenta dispositivos à Lei Complementar nº 101, de 4 de maio de 2000, que estabelece normas de finanças públicas voltadas para a responsabilidade na gestão fiscal e dá outras providências, a fim de determinar a disponibilização, em tempo real, de informações pormenorizadas sobre a execução orçamentária e financeira da União, dos Estados, do Distrito Federal e dos Municípios. (2009). Available: http://www.planalto.gov.br/ccivil_03/leis/lcp/lcp131.htm [Accessed 08 June 2015].

[4] Open Government Partnership (OGP). What is the open government partnership? Disponível em: < http://www.opengovpartnership.org/about>. Acesso em: 09 de out. 2015.

[5] Brazil. Lei nº 12.527, de 18 de novembro de 2011. Regula o acesso a informações previsto no inciso XXXIII do art. 5o, no inciso II do § 3o do art. 37 e no § 2o do art. 216 da Constituição Federal; altera a Lei no 8.112, de 11 de dezembro de 1990; revoga a Lei no 11.111, de 5 de maio de 2005, e dispositivos da Lei no 8.159, de 8 de janeiro de 1991; e dá outras providências. (2011). Available: http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2011/lei/l12527.htm [Accessed 08 June 2015].

[6] Controladoria-Geral da União (CGU). Metodologia. 2015. Available: http://www.cgu.gov.br/assuntos/transparencia-publica/escala-brasil-transparente/metodologia [Acessed 09 October 2015].

[7] Creswell, John W. Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications, 2013.

[8] Gibbs, Graham. Análise de dados qualitativos: coleção pesquisa qualitativa. Bookman, 2009.

[9] Controladoria-Geral da União (CGU). Guia técnico de regulamentação da Lei de Acesso à Informação em municípios e checklist. Brasília: 2013. Available: http://www.cgu.gov.br/Publicacoes/transparencia-publica/brasil-transparente/arquivos/guia_checklist.pdf [Acessed 04 February 2016].

Economic Impact of Telework in Japan

Hodaka NAKANISHI
Technology Transfer Center, Teikyo University, Tokyo, Japan

Abstract - *In this paper, the relation between the effects of telework and the change of GDP factors are examined and modeled. The impact of telework is analyzed for each GDP factor (labor input, capital input, labor productivity, capital productivity and TFP). Telework activate the economy mainly through the increase of labor input, the improvement of labor productivity, and the improvement of capital productivity. The change of labor input is calculated. 980,000 female will have a chance to start working if the compatibility of work and child rearing is realized and M-shaped curve is cancelled by telework. The increase is equivalent to growth of 1.5% of labor force. From the report of telework promoting companies, many companies recognize the improvement of labor productivity as an effect of telework. Further research is needed to understand the total impact of telework on the economy quantitatively by the analysis of every factors of GDP.*

Keywords: telework, economic effect, productivity, labor input

1. Introduction

The Japanese economy is stagnant for a long period. Low labor productivity is pointed out as one of the causes of the economic stagnation. Labor productivity (GDP divided by the number of employees) of Japan is $72,994 in 2014 and is 21th out of 34 countries of Organization for Economic Co-operation and Development [1]. In order to improve labor productivity, the change of work style is needed and telework is expected as a key to the change.

Effects of telework are discussed by many previous studies. The studies extend to work-life balance (e.g. Kenjoh (2011) [2]), perception of employees (e.g. Cooper and Kurland (2002) [3]), environment and energy (e.g. Henderson and Mokhatarian (1994) [4], Nakanishi (2015) [5]), productivity of firms (e.g. Dutcher and Jabs (2012) [6], Bloom (2014) [7]), and so on, but the impact of telework on economy is not well discussed. In Japan, the national government implements "hometown telework" project to vitalize local economy. In the project, companies are introduced to rural areas by preparing teleworking environment. Several companies are attracted to the towns or cities and some employees work with telework during the project, but its effect on the area's economy is not clear.

Does telework really activate the economy? How does telework make the economy active? Will telework increase productivity and labor input? This paper examines the influence of telework on the economy.

The term "Telework" is defined by European Union as: *Telework is a form of organizing and/or performing work, using information technology, in the context of an employment contract/relationship, where work, which could also be performed at the employers premises, is carried out away from those premises on a regular basis* [8]. This definition is broader comparing to the definition by the Ministry of Land, Infrastructure, Transport and Tourism of Japan (MLIT) which requires at least 8 hours per week to recognize as telework. In this paper, the definition of telework is "a new style of individual work using information technology without a limitation of space and time." This definition is broader than that of MLIT and that of EU as well. It includes nomad work (working anywhere with ICT) and crowd sourcing in addition to the general meaning of telework.

In the next chapter, the effects of telework are examined and are related to the factors of GDP (Gross Domestic Product). Economic impact model of telework is proposed based on the relation between telework effects and GDP factors. In chapter 3, quantitative influence of telework is calculated on each factor and qualitative influence of telework is examined from the reports of telework promoting companies which won *telework award 2015*. In chapter 4, the impact of telework on economic development is analyzed and concluded in chapter 5.

2. Framework of Economic impact model of telework

The GDP growth can be explained by labor input, capital input and total-factor productivity (TFP) with the Cobb-Douglas production function.

$Q = e^{\beta 1} K^{\beta 2} L^{\beta 3} A^{\beta 4}$

$\log Q = \beta_1 + \beta_2 \log K + \beta_3 \log L + \beta_4 \log A$

where Q is production, L is labor input, K is capital input, and A is TFP

TFP includes labor productivity, capital productivity and other technological development issues such as efficient use of energy, innovative management, and so on. Thus, the GDP growth rate can be explained with following factors: labor input, capital input, labor productivity, capital productivity and other technological development issues such as improvement of energy efficiency and innovation of science and technology.

Telework has various kind of impact. Ministry of Internal Affairs and Communications (MIC) of Japan pointed out eight effects of telework (Table 1) [9]. Each

effect relates to above GDP factors. Telework contributes to the development of economy through various paths as follows:

(1) MIC states that telework can be *effective solutions to an era of lower birth rate and an aged society*. Telework provides the chance to work to a person who is difficult to commute such as a person who is caring for children or family members, who is handicapped, or who is aged. The Japanese government expects that birth rate will increase if child rearing and work becomes compatible and bringing up children becomes easier by the introduction of telework. Telework also provides a job to the people who live in a rural area where they are hard to find a job. Consequently, telework will contribute to increase the labor input.

(2) Telework contributes to *improvement work life balance* of employees. As telework creates more time for employees with their family, employee's job satisfaction is expected to increase. Telework will also create more time for enlightening themselves. Telework is therefore expected to increase labor productivity.

(3) MIC expects that telework *promotes regional revitalization*. If people can get a job by telework in rural areas where the business conditions are not good and it is difficult to find a job, people will go back to their hometown from cities where they live. These people are called the U-turn. The increase of the U-turn brings the increase of labor input of the area. If start-ups increase in the rural areas by telework, the number of employees will increase and labor input will increase as well.

(4) MIC states that telework has the effect of *gathering competent employees and improving productivity*. For the company which introduces telework, excellent human resources can work from the whole country or from all over the world without geographical restriction. The labor productivity of the company will rise by gathering excellent work force with telework.

(5) MIC states that telework *improved business efficiency and Customer satisfaction* because telework enables businesses to visit clients more often, to devote more time to each visit, and to be faster and more flexible in addressing client needs. If they can save time for travelling or time for meeting, labor productivity will increase significantly.

(6) Telework is an important item of *business continuity plan (BCP) in emergency*. MIC points out that telework enables rapid response to emergency situations resulting from disasters and that telework helps ensure the business and service continuity in an emergency. Even when employees cannot commute to their office in case of large earthquake or pandemic, companies can continue their business with telework. As the risk of a business stop can be avoided and the reliability of

the company will improve, productivity of the company will increase. TFP of national economy will rise by the improvement of the each company's productivity.

(7) Telework is said to *reduce environmental load*. As employees do not have to commute, the frequency of vehicle use decreases and the consumption of gasoline drops. The use of public transportation such as train and buses will also decreases. The emission of carbon dioxide is expected to be decreased. As a result, energy efficiency improves by telework and TFP will rise.

(8) MIC indicates that telework reduces office cost. If the office space is reduced by telework, rent of the office will be saved and the use of paper in the office will also be saved. That makes capital productivity increase. Moreover, saving commuting allowance and saving time for moving, the efficiency of the business increase and TFP will also increase. By the improvement of business reform such as electronic meeting, computerization of sanction and reconsideration of workflow, TFP will also increase.

Table 1 Effects of telework pointed out by MIC [9]

(1) Effective solutions to an era of lower birth rate and an aged society ➢ Contributes to increase in the population of employees
(2) Improvement of work life balance
(3) Promotes regional revitalization ➢ Regional revitalization through the U-turn etc., starting up business in rural areas
(4) Gathering competent employees, Improving productivity
(5) Improved business efficiency and Customer satisfaction
(6) Business continuity plan (BCP) in emergency
(7) Reduces environmental load
(8) Cost Reduction ➢ Reduction in office cost such as space and paper and moving time and traffic cost

Telework has the effect of increment of capital input in addition to the effects above. If telework prevails, introduction of information and communication equipment was advanced in an office and in a place where they telework. Improvement of communication infrastructure such as broadband network makes progress either. Although capital input is not the direct effect of telework, telework induces the investment for ITC equipment or infrastructure of networks.

As mentioned above, telework has various effects and each effect has influence on factors of GDP and finally on GDP as a whole. The relation between the implementation of telework and the change of GDP is modeled and shown in Fig.1. Numbers in the parenthesis in Fig.1 are the number of the items of Table 1.
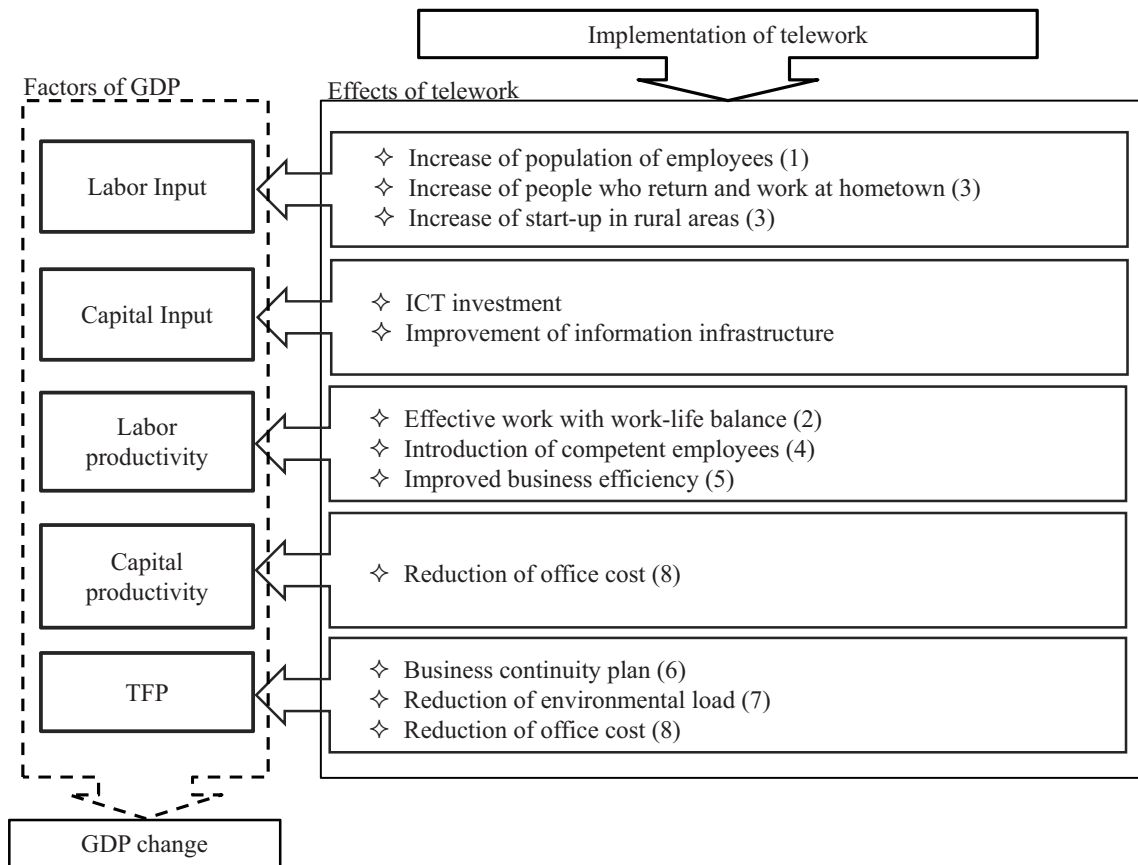
Fig. 1 Economic impact model of Telework

3. Analysis by GDP factor

In this chapter, the effect of telework is analyzed for each GDP factor. The quantitative effect of the telework is calculated and the qualitative effect of telework is examined based on the report of 11 companies which won *telework award 2015*. These companies introduce and implement telework aggressively. They were selected by the committee in Japan Telework Association.

3.1. Labor input

By the introduction of telework, a person who has difficulties in commuting such as a female of child-rearing generation, a person who is nursing his/her family members, a senior citizen and a person with disabilities may have a chance to work. In Japan, the population of 25-year-old to 44-year-old female who is child-rearing generation is 16.4 million in 2013[10]. But labor force participation rate of females from 25 to 35-year old is relatively low. This situation is called M-shaped curve. The M-shaped curve is formed because females of this age group quit their job for marriage and childbearing [11]. The number of females who are not job-hunting owing to childbearing or child care reaches 1.13 million [12]. The preparation of environment for the females to continue their careers during child-rearing

period is an important issue in Japan. In fact, National Governor's Association proposes that canceling the causes of M-shaped curve and expanding the chance for females can be an effective strategy for the activation of local economy [13].

The number of the person who needs supporting care is 5.06 million [14]. The preparation of working environment for the people who care their family is also necessary. As telework is an effective method for the compatibility of child rearing or family caring and work, telework is expected to reduce the number of persons who quits their job owing to child care or family care. The introduction of telework is therefore an important strategy to increase labor force.

Based on the data of Labor Force Survey of Japan, the author calculated the increase of labor input by the increase of female labor force participation rate with telework by two ways. The first calculation is the effect of not leaving the company and keeping working during the time of child rearing by telework. Supposing that the 30 to 44-year-old female whose labor force participation rate falls didn't leave the job by child care and childbearing, and that the labor force participation rate remained in the same level (75-78%) as the age bracket before (25 years old-29 years old) and behind (45 years old-49 years old), labor input will increase by 980,000 comparing to the labor force in 2012.

The second calculation is the effect of further

expansion of telework. The author supposed that the working environment becomes the same between male and female and the labor force participation rate of female becomes the same as that of male by the introduction of telework while labor force participation rate of female is now lower than that of male. If labor force participation rate of female (25-year-old to 64-year-old) increase to the same rate as that of male, the labor force will increase by 8.55million comparing to the labor force in 2012.

The similar calculation is done by National Governor's Association [13]. According to the proposal, when child rearing can be compatible with work and when an M-shaped curve is canceled, about 550,000 female do not have to quit their job and can keep working. In addition, if work and home compatibility were achieved and motivation of female rises, labor force participation rate of female is expected to increases to the same level as that of male. In this case, 9.38 million female can start working in total.

Based on the author's calculation above and the estimation of National Governor's Association, labor input of 550,000 to 980,000 people will increase if work and child rearing become compatible by telework. This number is equivalent to 0.8-1.5 % of labor force in 2012 (65 million people). Moreover, a working environment improves and labor force participation rate of female rises to the same level as that of male, labor input may increase to 8.55-9.38 million people. Even though work and child rearing are compatible actually, not all of the female want to work. But 3.3 million people of female among non-labor force population hopes for start working based on the Labour Force Survey in 2012. When work and family compatibility is achieved by the introduction of telework, and these 3.3 million people start working, the labor force equivalent to 4.7% of labor force in 2012 (64.9 million people) will be a new labor input. The effect on revitalization of economy is very large.

Telework is also thought to increase an employment chance in rural area, and has the effect on activation of regional economy. The ratio of active job offers to job seekers of rural area tends to be low compared to a national average in Japan. For example, Okinawa (0.84), Kagoshima (0.87), Kochi (0.93) and Aomori (0.91) have a low ratio of job offers to job seekers. The ratio of autonomous bodies in rural region is lower than a national average (1.20) by the statistics of 2015 [15]. If telework is spread and the employment environment of the area becomes better, and if the ratio of job offers to job seekers of the autonomous bodies lower than the national average becomes the same ratio of job offers to job seekers as a national average, 208,000 people increase in the number of job opening of these autonomous bodies. This number is equivalent to 8.8% of total job opening in 2015.

In the report of telework promoting companies which won *telework award 2015*, some of them mentioned the effect on job creation [16]. Tatsumi Corporation which is a construction consultant company

reports that telework creates employment of more than 100 persons. Job Support Power Co., Ltd. which is a company of service industry reports that an employment chance of visually handicapped person was created by telework. Crowd Works Co., Ltd. which is a crowd sourcing company contracted with the registered workers about 2.8 billion yen per year. The effect of telework on job creation is realized in telework promoting companies [16].

3.2. Capital Input

In order to prepare the environment for telework, investment for information and communication technology is necessary. Telework has investment effect to the information infrastructure and to the information equipment. Multiplier effect of ICT investment is estimated as 1.984 while that of investment in general is 1.190 [17]. The preparation of telework environment has larger influence on economy. The scale of the investment varies depending on the form of the telework. In case of work from home and telework at a telework center, ICT equipment is needed both in the office and at home where they telework. In case of telework with mobile devices, the mobile devices are necessary as many as teleworkers. The communication environment such as wireless LAN and Wi-Fi networks is also needed as social infrastructure.

As these effects are not related to the increase of productivity or profits of firms directly, none of telework promoting companies listed the fact as an effect of telework in the companies' report [16]. However, every company invested for the introduction of telework. For example, ANA (All Nippon Airways) introduced more than 13,000 tablet-type devices for 4 years (Table 2) and the introduction requires the investment for the preparation of communication environment of the company.

Table 2 Introduction of tablet-type devices in ANA [16]

year	The number of devices	Object person
2012	6,000	Cabin crews
2013	2,900	Service crews and technicians
2014	1,000	Check-in counter staffs
2015	3,400	All technicians

3.3. Labor productivity

An opinion of the relation between telework and labor productivity is divided. There are a lot of literatures that assert labor productivity will increase by the introduction of telework, but some others say that the productivity falls by telework. Bailey & Kurland (2002) pointed out that many of the literature which reported the increase of labor productivity were based on self-report data and might be biased to claim success [18]. They also pointed out the possibility that teleworkers confused the improvement of productivity with the increase of the

amount of labor as teleworkers work longer at home when telework. Bloom (2014) mentioned that the change of productivity depends on the type of the task [7].

Although many literatures conclude that the productivity will increase by telework, the number of firms which introduced telework in Japan is small. They don't believe that telework brings positive effects for them. By the Communications Usage Trend Survey in 2013, only 9.1% of firms introduce telework at the end of 2013 [19]. The reasons why telework do not prevail are communication trouble, a fear of information leakage, difficulty in management, difficulty in customer correspondence, difficulty in evaluating employees, introduction cost, and so on.

Many companies which win the Telework award

2015 states that the labor productivity improved by telework [16]. As for the factors of increase of labor productivity, they pointed out effective use of time, increase of the amount of labor, improvement of quality of services, employment of excellent human resources, improvement of working environment, and so on (Table 3). Increase of the amount of time might be due to the long hour of work as Bailey & Kurland (2002) pointed out. But Toda (2016) estimated with web research that working hour was longer 3-6% in flexible work (discretionary work) and that the wages rose 20-30% at the same time [20]. The estimation tells that working hours does not increase so much as the labor increases.

Table 3 Effects of telework on labor productivity reported by telework promoting companies [16]

Telework promotion company	Comments by telework promoting companies
Saga Prefectural Government (local government)	· Commuting time was reduced. · Making a business trip report was reduced for 1 hour from 2 hours. · The number of mail exchange has increased from 10 to 30 per month.
Recruit Marketing Partners Co., Ltd. (information and communication service)	· About 60% of employees feel that the performance of work has improved because of the reduction of moving hours and deliberate action. · About 45% of employees say that they can shorten working hour because they can concentrate on the work and they can reduce moving ours. · Meeting hours reduced by 23%.
NTT Com CHEO (outsourcing service)	· Excellent human resources have settled.
All Nippon Airways Co., Ltd. (airline company)	· Communication becomes active.
Toshima City Office (local government)	· Processing time for a question from a resident and application reduced. · As staffs who are not in the office could deal with a customer, service of the city improved. · Preparation time for meeting reduced. · Communication between staffs became active. · Decision making became faster.
Oracle Corporation Japan (information and communication service)	· An experienced engineer could be employed.
NEC Networks & System Integration Corporation (system integrator)	· Time of employee was saved. · Speed of communication increased. · Quality of work was improved.
Infoteria Corporation (software company)	· Consumption of physical strength can be reduced by teleworking on a heat wave day. · Employees have time to spare.
Net One Systems Co., Ltd. (information and communication service)	· Employee's satisfaction improved. · An average overtime reduced from 33hours per month to 27 hours.

3.4. Capital productivity

When a company prepares a satellite office in the area of inexpensive land value and closes an office in the urban area of the same size, it is possible for the company to reduce the office rent. It may take additional cost for network communication, but the additional cost might be small because the company usually uses network in its office of urban area already. But preparing

satellite offices and keeping an office in an urban area at the same time, the office cost will rise by the introduction of telework. If the decrease of office size in the urban area is smaller than the increase of the size of satellite office, it is necessary to compare the total rent to determine the change of the office cost.

When teleworking at home, there will be no additional cost equivalent to new rent for satellite office to the company. The office cost will be reduced in

proportion to the reduction of office size. If employees bore the electric bill, the waterworks charge and equipment prices, companies can save the cost which companies should bears. But it is not fare if employees bore the cost which company should bear and the capital productivity rose. Whether the capital productivity rises by telework depends on the way of telework.

Three of telework promoting companies mentioned effects of telework which improve capital productivity [16]. All Nippon Airways Co., Ltd. states that it saved 100 million yen in 2014 by the introduction of 1000 tablet-type devices for airport check-in counter staffs, computerization of manuals, and a shift to a paperless system. It also saved 1 billion yen a year by the introduction of "crowd voice communication," an extension smartphone system, as a replacement of PBX (Private Branch eXchange). Toshima City Office reduced paper by 3680fm from 9200fm and saved its space 1192 square meters. The reduction of the space is equivalent to the construction cost of 417 million yen. The introduction of Lync reduced telecommunication cost by 16 million yen in 2015. Net One Systems Co., Ltd., an information and communication company, saved 150 million yen of investment in equipment and 380 million yen of running cost a year. It also introduced paperless system.

3.5. TFP

Total Factor Productivity is a factor of production other than labor and capital. The increase of TFP is brought by improvement of technology. Technological progress related to telework includes reduction of commuting cost and energy cost, reduction of the risk of business suspension, reduction of transaction cost by a reform of business process such as computerization of sanction and abolition of a meeting. Whether energy consumption will decrease or increase depends on how the telework is implemented [5]. Therefore, it is not clear the impact of telework on TFP.

Two of telework promoting companies mentioned some effects of telework which improve TFP [16]. Tatsumi Corporation, which is a construction consulting company, says that telework lowered the cost of clients and that the sales of the company increased. Net One Systems Co., Ltd., which is an information and communication company, says that the effect amount to 1.7 billion yen a year by the reduction of risk and the improvement of productivity.

4. The impact of Telework on GDP

The impact of telework is examined for every factors of GDP. The impact of telework on labor input is calculated. Labor input will increase by 980,000 people if work and child-rearing becomes compatible and female labor force participation rate is improved by the spread of telework. The increase is equivalent to growth of 1.5% of labor force. Labor input will increase by 210,000 people if the employment situation in rural area

is improved by telework.

Telework promoting companies do not recognize capital input as the effect of telework. However, many companies introduced ICT equipment. Economic impact of telework on capital input through the increase of ICT investment is large.

In order to grasp the impact of telework on the economic growth of company level, the reports of telework promoting companies which won *telework award 2015* are analyzed. The 11 companies reported 34 comments concerning telework effects on GDP factors. Among these comments, the number of comments concerning labor productivity (21 comments) is the largest and 61.8%of all comments. The second largest comment is concerning capital productivity (7 comments). It is 20.6%of total comments.
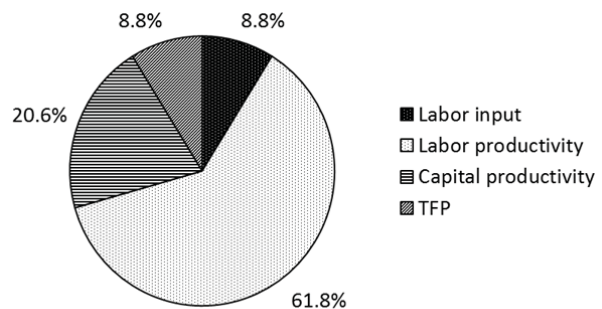

Fig. 2 Company's recognition of telework effect on GDP

It depends on the way of teleworking whether capital productivity increase or not. As an effect of telework on TFP, the reduction of business cost and commuting cost is expected.

5. Conclusion

Telework has a positive impact on the economy. Telework activate the economy mainly through the increase of labor input, the improvement of labor productivity, and the increase of capital productivity.

The increase of labor input can be estimated statistically. However, it is difficult to differentiate the increase of labor productivity and the increase of working hours. The improvement of labor productivity can be a result of long hour working. The increase of capital productivity depends on the way of teleworking. The effects on TFP are not clear because it also depends on how the telework is implemented.

Only a few factors of GDP can be estimated quantitatively, thus the total effect of telework is not estimated clearly. The result of this paper is derived from the studies in Japan, but it can be applied to other developed countries as well. Further research is necessary to indicate overall economic impact by the estimation of each GDP parameter.

6. Acknowledgements

7. References

[1] Japan Productivity Center (2015), *Trend of Producivity of Japan 2015* (Nippon no seisansei no doukou)(in Japanese), Chapter 3. http://www.jpc-net.jp/annual_trend/annual_trend2015_3.pdf (retrieved on Mar.21, 2016)

[2] Kenjoh (2011), Work Life Balance in the Netherlands: Flexible working hours and a flexible working place, *RIETI Discussion Paper Series* 11-J-030.

[3] Cooper and Kurland (2002), Telecommuting, professional isolation, and employee development in public and private organizations, *Journal of Organizational Behavior*, 23, 511-532.

[4] Henderson and Mokhtarian (1994), Impacts of Center-Based Telecommuting on Travel and Emissions: Analysis of the Puget Sound Demonstration Project, *Transportation Research Part D*, Vol.1, No.1, pp.29-45.

[5] Nakanishi (2015), Does Telework Really Save Energy?, *International Management Review*, Vol.11, No.2.

[6] Dutcher and Jabs (2012), Does Team Telecommuting Affect Productivity? An Experiment, *MPRA Paper* No.41594. https://mpra.ub.uni-muenchen.de/41594/ (retrieved on Jan.13, 2016)

[7] Bloom (2014), To Raise Productivity, Let More Employees Work from Home, *Harvard Business Review*, the January–February 2014 Issue. https://hbr.org/2014/01/to-raise-productivity-let-more-employees-work-from-home# (retrieved on Mar.21, 2016)

[8] European Foundation for the Improvement of Living and Working Conditions (2010), *Telework in the European Union*.

[9] Ministry of Internal Affairs and Communications (2011), *Efforts to Promote Telework in Japan*, Information Application Promotion Office, MIC, September 8, 2011. http://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/presentation/pdf/110908_1.pdf (Retrieved on March 13, 2016)

[10] Statistics Bureau (2014), *Population and Percentage distribution by Age (5-Year Age Group) and Sex*, Population Estimates 2013, Statistics Bureau, Ministry of Internal Affairs and Communications. http://www.e-stat.go.jp/SG1/estat/Xlsdl.do?sinfid=000024032524 (retrieved on Mar.21, 2016)

[11] Gender Equality Bureau Cabinet Office (2015), *White Paper on Gender Equality 2013* (Danjo kyodo sankaku hakusyo) (in Japanese). http://www.gender.go.jp/about_danjo/whitepaper/h25/zentai/html/honpen/b1_s00_02.html (retrieved on Mar.21, 2016)

[12] Statistics Bureau (2015), *The situation of labour force of female and elderly person*, Statistics Bureau, Ministry of Internal Affairs and Communications, Statistics Topics No.74, http://www.stat.go.jp/data/shugyou/topics/topi740.htm (retrieved on Mar.21, 2016)

[13] National Governor's Association (2012), *The proposal for the economic development by the enhancement of participation of Women*. (in Japanese)

[14] Cabinet office (2013), *Kourei Syakai Hakusyo 2013* (Annual Report on the Aging Society: 2013)(in Japanese)

[15] Ministry of Health, Labour and Welfare (2016), *Ippan Syokugyou Syoukai joukyou* (The situation of general employment placement) http://www.e-stat.go.jp/SG1/estat/Xlsdl.do?sinfid=000031377633

[16] Japan Telework Association (2016), *Casebook - Telework award 2015*

[17] Ministry of Internal Affairs and Communications (2013a), *2013 WHITE PAPER Information and Communications in Japan*. (in Japanese)

[18] Bailey & Kurland (2002), A review of telework research: findings, new directions, and lessons for the study of modern work, *Journal of Organizational Behavior*, Vol.23, pp.383-400.

[19] Ministry of Internal Affairs and Communications (2013b), *Communications Usage Trend Survey in 2013*, http://www.soumu.go.jp/johotsusintokei/statistics/pdf/HR201300_002.pdf（Retrieved on March 4, 2016）

[20] Toda (2016), Working Hour System and Work Styles among Regular Workers: Evidence from a 2014 RIETI survey on diversified work styles of regular workers and non-regular workers, *RIETI Discussion Paper Series* 16-J-008

The New Mexico Pit Rules Mapping Portal

Tongjun Ruan, Robert Balch

Reservoir Evaluation and Advanced Computational Group

Of Petroleum Recovery Research Center, New Mexico Tech., Socorro, NM, 87801 USA

Abstract: *This paper presents the development of a Web-based GIS application which is developed with open source GIS software to quickly generate application forms and associated mapped data for any proposed well/pit location in New Mexico, allowing producers to generate stronger applications in relatively short periods of time, and at the same time giving regulators an online tool, utilizing all of their required data sources, to more quickly verify applicant data and process applications. Results of this We-based GIS application have beneficially impacted small producers by providing both a template for generation of pit applications, a vehicle for justifying exceptions to the Pit Rule, and by demonstrating effective cooperation between producers and government.*

Keyword: GIS; Open Source; New Mexico Pi t Rules;

1   Introduction

In July 2008 the New Mexico Oil Conservation Division (NMOCD) changed regulations to sur- face waste management rules regulating pits, closed loop systems, below-grade tanks and sumps used in connection with oil and gas operations, resulting in new "Pit Rules."[1]   With adoption of these regulations, New Mexico's small producers experienced an increased level of expense for drilling and were also exposed to significant financial risk due to a more complex, time-consuming,   and hence expensive application process and increases in need for and expense of remediation and re-permitting at both new and existing well sites.

Since 2007 stronger pit rules have been enacted in Colorado and are under consideration in Texas and other western states, so this is not simply a New Mexico issue.

The primary direct impacts of the new rules were: reduction or elimination of the use of surface pits in SE New Mexico (Permian Basin) and limitation of their use in NW New Mexico (San Juan Basin); requirement (in most cases) of the use of more expensive closed-loop drilling systems and costly haul-off of waste; and implementation of a new form C-144. The new form required extensive use of georeferenced data and associated map attachments and generally created a significant increase in application preparation time for the applicant and for review and verification time by the regulatory agency.

While all producers in New Mexico faced these increased costs, small producers with limited specialized staff and less ability to absorb substantial unexpected expenses were most strongly affected. To address this problem we proposed to generate software and maps, utilizing open source GIS software, that would allow quick generation of C-144 forms and associated mapped data for any proposed well/pit location in New Mexico, allowing producers to generate stronger applications in relatively short periods of time, and at the same time giving regulators an online tool, utilizing all of their required data sources, to more quickly verify applicant data and process applications.

2   Technologies Used

The Pit Rules Mapping Portal was constructed using primarily open source software with a core focus on GIS Technologies. Open source software allows for shared development, does not require software licensing or usage fees, and simplifies contractual implementation of any project software into future or parallel work done at other institutions and companies. Primary features of open source design that were useful for this project were the ability to design and code custom components, such as map printing, which were not otherwise available with commercial GIS software, and the ability to use publicly maintained databases that do not inherently support desired features.

The New Mexico Pit Rules Mapping Portal is a Web-based application with three-tier architecture and three primary components. Table 1 describes

software components by function and use in the project. The three primary components of the system are:

1. A database for tile-cached, collected, and digitized data, which are stored in a PostgreSQL/PostGIS database system on a Linux Server at the PRRC.

2. An Interactive GIS with integrated data stored in postgreSQL/postGIS and Mapserver/Mapfish/Openlayer/EXT. JavaScript provides an interactive GIS system, which allows users to generate maps online based on their input latitude and longitude pairs for part-10 and part-17 of Form C-144.

3. Automated Form C-144: Form C-144 is a five-page form with 25 categories and more than 100 questions. To automate it online required coding significant interactive action/operations between the user and the application form. Form C-144 is displayed and operated by the user on the client/user side (a browser window using Firefox, Internet Explorer, or Chrome, for example) and was developed using PHP, Java and JavaScript based on EXTJS with additional AJAX and HTML codes.

3 Hardware and Software

The New Mexico Pit Rules Mapping Portal Server consists of hardware and software :

Hardware: A Dell Server with 2xX5570 Xeon Processor (two quad core processors) with 32GB RAM, 5 x146GB RAID hard drive.

 Software: Redhat EL v5.5, PostgreSQL, PostGIS,Apache v2.2,Apache-Tomcat v5.5, MapServer v5.5, Mapfish v1.1,Openlayer v2.0,EXTJS v2.1, PHP v5.2,Java v6.0 and FPDF (a PHP class which allows to generate PDF files with pure PHP).

4 The framework of the Pit Rule Mapping Portal

Figure 1 shows the general framework of the Pit Rules project architecture showing both Client and Server side software components and communication paths. Clients can access the software using a variety of available browsers, and HTML and JavaScript code communicates their interactions to the database server using multiple pathways depending on the type of data requested or the application being used: webservers, map servers, and application servers. The server processes the data or request and returns the appropriate information, software sub-

component or map to the client's browser.

Often software will be developed with a three-layer structure consisting of a Presentation Layer, a Business Layer, and a Data Layer.

Figure 1. Pit Rule Mapping Portal framework.

 The increasing use of web browsers and demand for supplying interactive and dynamic information requires a modification of the development into a three-tier system instead, where each of the three common components is treated separately. This allows better organization of code from disparate software and personnel, faster debugging, and increases in run time efficiency with multiple communication paths open simultaneously. An important additional feature of this design is that software in each tier can be tested, modified, or altered without impacting the other tiers since the interfaces that allow communication between tiers remains the same. Figure 2 shows the tier-based architecture for the Mapping Portal with semi-automated C-144 forms. Detailed descriptions of each tier are provided in following subsections.

Figure 2. Three-tiered architecture of mapping portal.

4.1 Tier 1 (Presentation Tier):

The presentation tier of the Pit Rules Mapping Portal is an interactive interface written in JavaScript and running on a JavaScript engine (JavaScript Interpreter) embedded in the user's browser. It allows the user to perform several operations: obtain an account by registering; log in to an existing account; manage user's profile; create new C-144 applications; open, save/save as/delete/download an existing application; fill in data for the C-144 Form (text and map generation); review that data and generated maps online with user's browser; and export the C-144 form and generated maps as PDF files. Key feature classes include:

1.Registration - Allows a new user to register and setup a name and password.
2.Login - Allow registered users to login with their userIDs and passwords.
3.User Profile - Registered users can modify or update their information.
4.Form C-144 – Allows the user to Create, Open, Save, Save As, Delete and Download applications (Form C-144) in PDF format. Also allow users to fill in form online and create required maps for subsections 10 and 17 by switching to an interactive GIS panel.
5.Interactive GIS - Allow the user to zoom in/out, go to any location by inputting Township-Range-Section, Address, zip code or latitude-longitude coordinates. A query feature allows searches within certain distance from the marked location. Print (copy or cut) a map with an input location as center and related/selected features intoa PDF file for the user to review/download.

      The Registration/Login/Profile/Form C-144 forms are implemented with JavaScript with EXTJS. The Interactive Maps are implemented with JavaScript using MapFish/EXTJS.

4.2 Tier 2 (Business Tier):

      There are five sections of the Mapping Portal that interact and mediate between Tier 1 and Tier 3. The task of the business tier is to interactively collect data from the user and process the data or query to the appropriate sections of Tier 3. The five major processes are:

1. **Registration/login process --** Implemented with PHP
2. **Profile process** -- Implemented with PHP
3. **Form C-144 process** -- Implemented with PHP

and MapServer
4. **Maps process** -- Implemented with MapServer and Java Servlets
5.   **PDF form generator --** Implemented with PHP based on the FPDF package.

4.3 Tier 3 (Data Tier):

Tier 3 is the data layer that represents the database of geology and geographical features of New Mexico, user data (profiles and Form C-144 saved data) on the PostgreSQL/PostGIS Server and project generated map data files as well as data connections or tile caches from external server such as Google maps, USGS, University of New Mexico (UNM), and others. The data Tier also manages PHP codes for Sections 1, 2, 3, and 5 in Tier 2 and controls allaccess to data and map data files from Tier 2 software. The Java Servlets for printing maps (Section 4 code in Tier 2) access map data in PostgreSQL/PostGIS through Java Database Connectivity (JDBC).

5. Implementation

   In Figure 3 the left panel allows data selection, the right top panel provides tools, the right center panel displays mapped features, and the bottom panel provides additional information.

   The data selection panel, which was implemented with EXTJS, is expanded in Figure 4 showing four distinct functions. The first function is to display mapped data relevant to C-144 attachments. Map layers are divided into base layers and overlays. Only one base map may be selected at a time, while multiple overlays can be drawn on top of a single base layer. An example of this is shown in Figure 5, where the New Mexico geologic map is overlain upon topographic data.
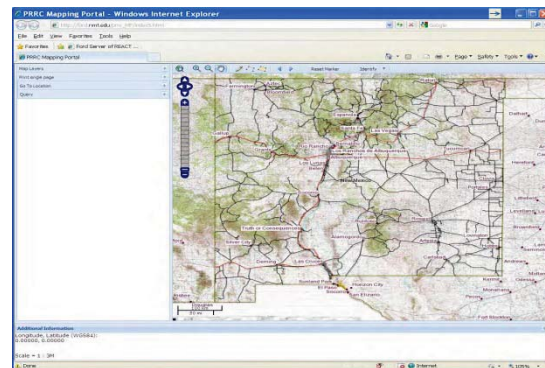

Figure 3. The Pit Rule Mapping Portal.

5.1 Map Layers

Map layers are as follows with the first four representing the base layers:

1. No Base Layer – Only overlain maps are is played
2. USGS TOPO – US Geologic Survey topographic maps are is played 2005/06 Aerial (RGIS) – aerial photos for New Mexico are displayed
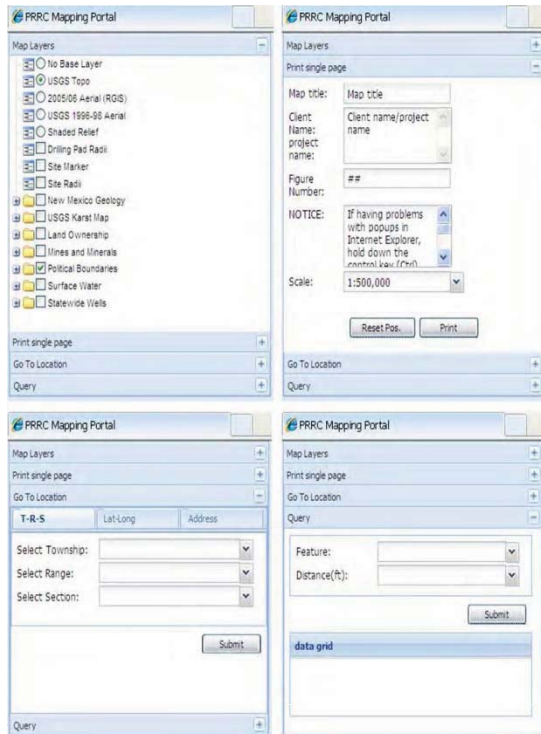
3. Shaded Relief – A digital terrain model is displayed
4. Drilling Pad Radii – C-144 distances drawn as rectangles from average drilling pad
5. Site Marker – shows selected site location on the map
6. Site Radii – C-144 distances drawn as circles from the site marker
7. New Mexico Geology – Geologic map of New Mexico
8. USGS Karst Map – USGS Karst Terrain map
9. Land Ownership – Land Ownership
10. Mines and Minerals – Surface and subsurface mines
11. Political Boundaries – Roads, counties, cities and Land Grid
12. Surface Water – Streams, rovers, ponds, lakes, reservoirs, playas, swamps, springs, etc
13. Statewide Wells – OSE water wells, USGS groundwater data, and oil and gas wells

Figure 4. Expanded Data Panels. Upper Left shows map layers, upper right shows Print feature, lower left shows the location tool, and lower right shows the query feature.

Figure 5 New Mexico geologic map overlain on topographic data. Also shown are political boundaries, major cities and roads.

5.2 Print single page

The **Print single page** panel can be used to generate PDF printouts for any generated map. When the Print panel is selected the user is presented with boxes for a title, Client name, Figure Number, and Scale. A yellow, moveable box appears on the screen, centered on the site location, which shows the area that will be converted to a PDF when the print button is selected. Figure 6 shows an active map panel and Figure 7 shows the resulting map.

Figure 4 (lower left) shows the **Go to Location** panel. The user can enter locations as an address, latitude and longitude or in township-section-range format by selecting the appropriate tab.

Figure 6. Active Map Panel. Users can enter personalized information for the captions, and the movable yellow area represents the map image. In this case the site is within 1000 ft of

surface water, which is overlain on aerial photo data.

When the location is entered the map will zoom into that location at a scale that is appropriate for generating C-144 attachments.

Figure 7. PDF image generated using the Print single page panel.

5.3 Query

The **Query** panel allows searching the OSE and USGS water data for features within a specified distance. Figure 8 shows a shaded relief map base layer with pad radii, OSE water wells, oil and gas wells, surface water and the New Mexico Land grid as overlays. Note that the water well data shows depth to groundwater and date measured. Water wells within 1000 ft have been queried and are listed in a table in the **Query** panel. The query feature is also available using the tool bar menu **Identify** feature, which allows the user to drag a box on the screen and query the feature contained within that area. When the **Identify** feature is used the query results pop up on the screen. In this example the same five water wells have been queried.

Figure 8. Query and Identify features. Tabulated water well data was extracted from the OSE database using both the Query and the

Identify features. Also shown are water wells (blue squares), oil and gas wells (orange circles), surface water (blue lines), and the New Mexico land grid (brown lines and labels).

6 Results for the New Mexico Pit Rule Mapping Portal with Form C-144

In order to utilize the digitized C-144 form a user would select **Pit Rules Mapping Portal With Form C-144** at the entry page. Since the C-144 form utilizes a database to store maps and forms for each user, a simple login procedure is used to ensure that data is easily and correctly stored and retrieved. Therefore a login is required and if the user has not previously registered with the system a request for profile information pop-up query will be initiated. After the user fills in required information the login will be processed and a modified version of the mapping portal will be initiated (Figure 9) which has three separate tabs: **Profile**, which allows the user to modify their registration data; **Forms,** which allows the user to manage their existing applications and create new applications; and **Map**, which provides access to the mapping portion of the Pit Rule Mapping Portal.

In the **Forms** tab, user application data is stored in folders by year and month. Any appli- cations started in November of 2011, for example, would reside in a folder named "2011-11". Users can reopen a previous application to continue, or revise maps, or create a new application. When a new application is initiated users can give any name they desire, such as API, well name, or unit number. After the application is opened users have access to an interactive version of the C-144 form and can enter baseline information such as OGRID number (operator ID code) well location, company name, and other basic information. They can also create maps in sections 10 and 17 for required attachments. Each siting criteria has two associated buttons: **Create Map,** which opens the **Map** tab and automatically zooms to the applications location and turns on appropriate layers for determining the status of the location with respect to the criteria; and a button labeled **Attached 10-X,** which is a placeholder for the map name users will supply when they save the map. This second button allows retrievable of previously examined and stored maps. Additional options within the Form tab are **Save**, **Save As**, **Download**, and **Reset**.

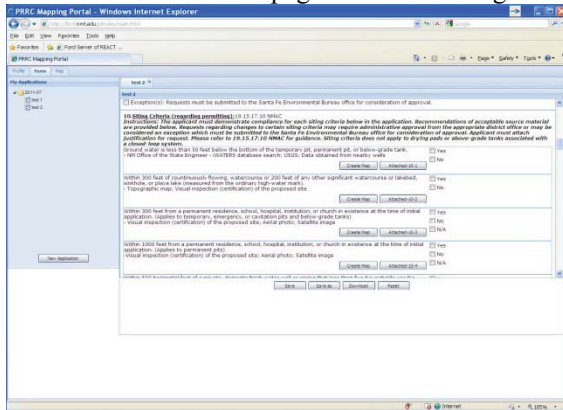Features of the forms page are shown in Figure 9.

Figure 9. Interface for Pit Rule Mapping Portal with Form C-144. Section 10 with interac- tive map generation is shown in this example.
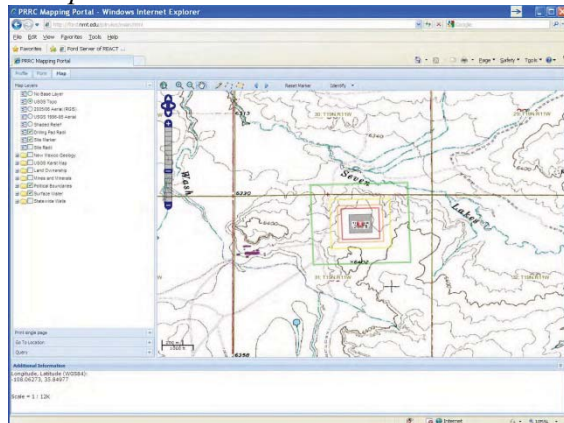

Figure 10. Sample of an automatically generated map for siting criteria 10-2. This example demonstrates that the site is greater than 500 feet from any surface water channels.

Figure 10 shows an automatically generated map showing proximity to surface water. The topographic sheet base layer has been set, and overlays for **Site Marker**, **Pad Radii**, **Political Boundaries** and **Surface Water** have been turned on. This map can be saved to the form and/or printed using the **Print Single Page** panel as demonstrated in Figures 6–7. User- generated maps and forms are stored indefinitely on servers at the PRRC in case adjustments or additions need to be made to successfully complete a C-144 form.

7 Conclusion

The New Mexico Pit Rules Mapping Portal , a Web-based GIS application, has been successfully developed with open source GIS software to quickly and automatically generate application forms and associated mapped data for any proposed well/pit location in New Mexico, allowing producers to generate stronger applications in relatively short periods of time, and at the same time giving regulators an online tool, utilizing all of their required data sources, to more quickly verify applicant data and process applications. Results of this We-based GIS application have beneficially impacted small producers by providing both a template for generation of pit applications

8 References

1. Robert Balch , Tongjun Ruan, "Reducing Impact of New Mexico New Pit Rules On Small Producers", 2011
2. PostgreSQL v9.0 Manual, 2014
3. PostGis v2.2.3 manual, 2015
4. http://mapserver.org/,2012
5. http://mapfish.org/,2012
6. http://openlayers.org/,2012
7. http://www.ext.net/,2012
8. http://www.sencha.com/extjs, 2015
9. http://ajaxian.com/by/topic/ajax,2015
10. http://www.commonjs.org/,2015
11. http://java.com/en/,2015
12. http://tomcat.apache.org/,2015
13. http://www.php.net/,2015
14. http://www.fpdf.org/,2015

Collaborative systems & Shared Economy (Uberization): Principles & Case Study

Bertrand David[1]**, René Chalon**[1]**, Chuantao Yin**[2]

[1]University of Lyon, CNRS, Ecole Centrale de Lyon, LIRIS, UMR5205,Lyon, France
[2]Sino-French Engineering School, Beihang University, Beijing, China

Abstract - *In the paper we analyze the characteristics of collaborative systems & the characteristics of shared economy supporting systems. Uberization as present in many applications: Airbnb, Uber, BlablaCar, AMAP, circular economy, etc. needs cooperative system support. We examine this approach from the point of view of ICT and, more specifically, HMI (Human Machine Interaction) and CSCW (Computer Supported Cooperative Work) and indicate what must be added to collaborative systems to support uberization. The paper also shows how to identify appropriate collaborative models and how to add new uberization services to obtain an uberization supporting platform. A case of design of a collaborative application for Carbon Free Parcel Distribution will also be presented, and corresponding intermediation algorithms discussed.*

Keywords: Collaborative system; shared economy; uberization; platform; intermediation

1　Introduction

In many activities, individual work (personal or at corporate level), with protection and confidentiality, is progressively evolving towards a more open position. Collaboration & cooperation, and sharing of data and equipment, lay down new bases for product design, production and functioning in a large scope of professional activities. CSCW is known as a multidisciplinary approach to study and propose appropriate approaches for collaboration & cooperation. An integrated system is designed to organize all activities in a consistent and coordinated manner by providing all stakeholders with access to the necessary information. The cooperative / collaborative system is intended to allow a group of people to carry out their activities appropriately (simultaneously or sequentially, in distributed, subcontracting, co-contracting or outsourcing modes). Shared economy is an important field in which integration and collaboration models, architectures, techniques and technologies are able to play a major role in promoting it and facilitating its deployment. We then study in this paper this impact of integration and collaboration systems on shared economy and present a case study treating the problem of carbon free parcel distribution.

2　II.　State of the art & examples

2.1　CSCW History and Evolution

CSCW [1] (Computer Supported Cooperative Work) is a field of interactive systems that aims to allow multiple stakeholders to cooperate through a computerized system to perform cooperatively tasks of different natures (design, management, production, research, etc.). The design of such systems is relatively complex because it is not limited to individual activities but focuses on the cooperative work of several stakeholders who can undertake cooperation, coordination and communication according to the definition originally proposed by Ellis [2] and reworked by several other authors. This cooperative work can be undertaken in several cooperative situations initially characterized by Johansen and improved by Ellis [3]. At present, these CSCW systems are becoming increasingly mobile, context-aware and proactive. We named these systems "cooperative capillary systems" (CCS) [4], by analogy with the network of blood vessels. The purpose of the capillary cooperative system is "to extend the capabilities provided by the cooperative work tools in the ramifications of increasingly fine ramifications, which can operate not only on fixed workstations but also and in particular on wearable computers." These systems naturally become pervasive (integrated in the environment), proactive and ubiquitous. Our ultimate goal is to allow stakeholders to move in an augmented reality environment (mixture of physical and digital objects and tools) and to apply the concept of ambient intelligence (AmI), the Internet of Things (IoT) [5] and to spot oriented treatments (Location-Based Services - LBS) [6].

2.2　Wikinomics

Several books [7, 8, 9] by D. Tapscott and co-authors explained progressively the main principles of cooperation using Wiki metaphors and leading to Web 2.0 and its utilizations in different industrial fields. This author identified five main principles of networked intelligence: collaboration, openness, sharing, integrity and interdependence. Shared economy is a human activity that seeks to generate public value and is based on new forms of work organization. It is based on a more horizontal organization, with sharing of goods, spaces and tools and preferring usage to ownership.

2.3   Uberization

The term "uberization" is a neologism popularized by Maurice Lévy after an interview with the Financial Times in December 2014. The term originates from the Uber company that has globally popularized passenger cars with driver, thus competing directly with taxis. The features of this service are almost real time, pooling of resources and the small percentage of heavy infrastructure (offices, support services, etc.) in the cost of service.

Some of the services mentioned are participanting to the uberization of economy, with following examples: Airbnb, Booking.com or Amazon.

The neologism of uberization is generally used to refer to the phenomenon whereby a start-up or a new economic model related to the digital economy threatens to replace an old economic model. It speaks about uberization by analogy with the two models, Uber and Uber Pop, which are currently challenging traditional Cab activity. The car share BlaBlaCar company, initially created in France, is another uberized model for transportation sharing.

2.4   Collaborative   and   shared   economy examples

The collaborative/shared economy is a human activity that seeks to generate public value and is based on new forms of work organization. It is based on a more horizontal organization, with sharing of goods, spaces and tools (usage rather than ownership), the organization of citizens' 'networks' or communities and, generally, intermediation by internet platforms.

The collaborative/shared economy is understood in a broad sense, including collaborative consumption (AMAP couchsurfing, carpooling etc.) but also shared lifestyles (coworking, colocation, collective housing), shared finance (crowdfunding, ready to silver peer-to-peer, alternative currencies), contributory output (digital manufacturing, DIY, Fablabs, 3D printers, maker spaces) and free culture.

It assumes different forms (sharing economy, service economy whose including circular economy, economy of solutions, peer-to-peer economics) according to the types of goods and services concerned or proposed (consumer empowerment, eco-effectiveness).

This kind of economy is placed in a context of mistrust of institutional actors in the traditional capitalist system and in an economic crisis context, as well as in an ethical and environmental context.

Its rise is due to the use of new technologies to improve the collective/shared creativity and productivity. It also responds to the desire of green practices and more friendly social relations.

3   CSCW versus Uberization

CSCW is historically based on the collaboration and cooperation between several actors (identified or anonymous) [10]. They can work locally (at the same place) or at a distance (in different locations). They can work synchronically (at the same time) or asynchronously (at different times). During this collaboration they share data, which can be modified by each of them, and the work organization can be based on a process definition (called workflow), which takes into account the role of the different actors, their activities (tasks) and corresponding data operations (read only, creation, edition, etc.). This collaboration can be either short-term oriented (a short period of time to solve a problem) or, and mainly, long-term oriented (long-term well organized processes such as design, development or long-life support with a relatively stable set of actors. Main components of the 3C model (Communication – Collaboration – Coordination) are fundamental for important groupware systems like CAD/CAM [11].

Uberization is defined as cooperation between consumers and providers using a cooperation/sharing platform. In this context consumers and providers are individuals (proposing and requesting use of a service). In the transportation case, the user - consumer – traveler tries to find a vehicle with driver that could take him/her to their destination. The platform is used to find a vehicle, which is located not far from the consumer's (client's) geographical location and available to make this trip. The 3C model is not fully used in uberized activities (UA), as communication is limited to one of each part of the system: one consumer – one provider. Coordination & collaboration are also limited mainly to a short-term process of negotiation of common activity and its accomplishment.

Compared (Table 1) to CSCW applications, collaboration in uberized applications is mainly short-term oriented and limited to establishing a relationship between provider and consumer intermediated by the platform. Access to shared data is privileged, and the process aspect (workflow) is limited to a short period and a limited number of steps.

We can observe that UA can use all main components and services proposed by CSCW and associated software (groupware). However, it is important to observe that new services are mandatory for uberization. These services can constitute an intermediation platform, which is able to manage the relationship between, usually, a pair of actors (provider and consumer) who are compatible in relation with an expected profile or objective. The intermediation platform has at its disposal a large amount of information either in real time or collected in the past and is able, by appropriate selection techniques and algorithms, to select and propose one or more

potential answers which are proposed to the client (consumer) to refine and find an appropriate solution.

3.1   Architectures

Collaborative system architecture is generically organized in three layers [10]:

- Distributed System Model: System and network services layer
- Groupware Infrastructure Model: Generic collaborative services layer
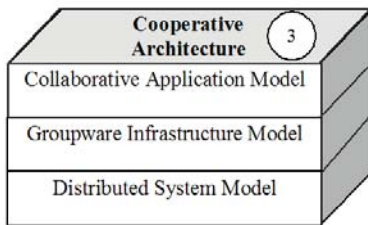- Collaborative Application Model: HCI, sensors and specific application layer

Figure 1.   CSCW Platform Architecture

Table 1. Comparison of CSCW and Uberized Applications (UA)

Characteristics	CSCW	Uberized applications
Mobility	Possible	Possible
Stationarity	Possible	Possible
Data sharing	Large	Large
Process supporting	Large	Limited
Communication between actors	Large	Limited (often 1 : 1)
Intermediation	Limited via platform between known actors	Fundamental via platform to find appropriate actors
Synchronous communication	Dominant	Very occasional
Asynchronous communication	Important	Dominant
Data complexity	Important	Reduced
Data volume	Not necessarily large	Large
Process complexity	High	Reduced
Main activity	Collaboration	Establishment of relationship

Data selection	Occasional	Fundamental
Data mining	Occasional	Fundamental
Provider evaluation	Exceptional	Fundamental
Platform Intermediation	Between identified actors	To find actors

For Uberised Applications the system architecture is not yet clearly defined. For Sangeet Paul Choudary, who is the creator of Platform Thinking [12], his platform architecture is mainly based on Magnet, Toolbox and Matchmaker (Fig. 2). It is producer- and consumer-oriented allowing them to seed collaborations.

3.2   Crosspollination between groupware and uberware

If we observe a Collaborative Platform in more detail, we can see that it is able to support the vast majority of Uberized Application needs. It is thus more appropriate to create a UA Platform by upgrading a Collaborative Platform than to develop a UA Platform from scratch. As we see in (Fig. 3), a Collaborative Platform is able to manage at the first level: distribution and mobility; at the second level: generic services for user identification and management, data identification, user-related access rules and main application generic services, and at the third level: appropriate Human Computer User Interfaces, sensor management and specific applications.

Figure 2.   S. P. Choudary Platform Thinking Architecture [13]

If we observe a Collaborative Platform in more detail, we can see that it is able to support the vast majority of Uberized Application needs. It is thus more appropriate to create a UA Platform by upgrading a Collaborative Platform than to develop a UA Platform from scratch. As we see in (Fig. 3) a Collaborative Platform is able to manage at the first level: distribution and mobility; at the second level: generic services for user identification and management, data identification, user-related access rules and main application

generic services, and at the third level: appropriate Human Computer User Interfaces, sensor management and specific applications.
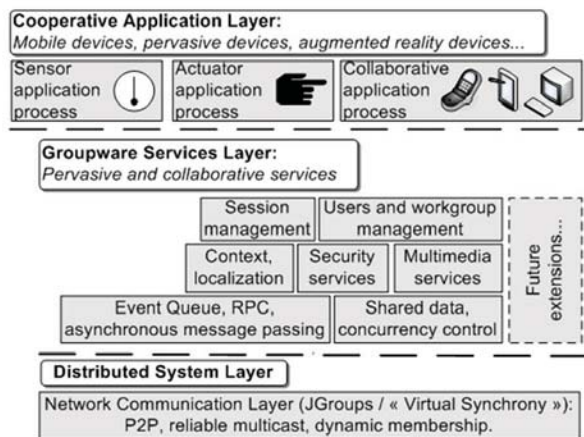

Figure 3.   In-depth CSCW Platform Architecture

What is mainly missing is related to the principal Uberized Application specificity, which is related to what Choudary calls Matchmaker [12]. This kind of intermediation is not natural in "classical" Collaborative Systems for Design, manufacturing, etc. [11], in which the actors are clearly identified at the beginning of the process and still the same. In Uberized applications such as Airbnb (rent lodging) and BlaBlaCar (car sharing), the main goal is to match consumer objectives (geographical location, stay period and apartment characteristics for Airbnb; geographical location, trip target, date and number of passengers for BlaBlaCar) and manage the selection process and the transaction outcome. This kind of service is not natural and fundamental in Collaborative Systems, but is in Uberized Systems. It is important to provide appropriate intermediation services based on Big Data and data mining algorithms.

3.3   Intermediation platform or service

Intermediation platforms connect people, services and even things in ways that have been unthinkable until now. Search engines provide relevant references for people searching for information. Social networks connect users in their environment. Carpooling systems link drivers and passengers using the same routes. Intermediation platforms use big data to fuel the services they offer. All these services are evolving extremely quickly but are almost unnoticed.

All intermediation platforms essentially rely on the same structure. To begin with, they collect huge amounts of data which can come from the outside world (e.g., web pages for search engines) or be hosted by the platform (e.g., social networks). However, they are never produced by the platform itself but rather, by the people, services or things around it.

These primary data are then indexed and transformed to extract information that fuels the primary services offered.

The activities of users on platforms generate secondary data. These secondary data essentially consist of traces which the platform generally has exclusive rights to, and allow the platform to create secondary services. A key example of this is the precise profiling of users, which permits personalized and customized services: personal assistants trace users as they go about their day-to-day activities, not only online but also in the physical world through the use of geo-localization or quantified-self means.

We studied and proposed a method of intermediation based on an algorithm for Community Detection based on Hierarchical Clustering (CDHC Algorithm). The CDHC Algorithm first creates initial communities from global central vertices, and then expands the initial communities layer by layer according to the link strength of vertices and communities, before finally merging some very small communities into large communities [14].

4   Carbon free parcel distribution case study

Parcel distribution is a very important activity, time consuming, and a source of pollution and traffic jams, mainly in large cities. Large distribution companies very often subcontract to small ones to perform this unprofitable activity. Several reasons account for this non-profitability: access to downtown is complicated by circulation constraints, traffic jam problems, lack of parking availability and also the limited presence of destinataires. This problem is increased by the number of distributors with a relatively small number of parcels to distribute, thus generating increased traffic problems in the same district. A variety of solutions were tested in several cities: identification of distributors for each district, thus reducing the number of vehicles entering each district and increasing the volume of distributed parcels. From a collaborative economy point of view, a more original and effective approach, which is carbon free, is based on the use of existing movements of persons and vehicles to take advantage of these existing trips to have them carry out parcel transportation. We propose to examine three of the different working situations that we have identified: the first is based on public city transportation users, the second relies on supermarket clients and the third is based on a closed network of small craftsmen.

4.1   Public city transportation based parcel distribution

In a large city like Paris, Lyon or Beijing, it is possible to imagine high speed transportation of letters and small parcels by the users of this public transportation (buses, trams and subway). The process is based on identification of

segments defined by start and destination public transportation stations, identification start date and time (availability of the parcel at start station) and expected destination time (availability of the parcel at destination station). The next step is to find a transporter, a city transportation user, who is "interested" in carrying out this transportation. This requires a list, at their disposal, of potential transporters with their history of movement on the city transportation network. A tool can determine potential transporters with appropriate profiles (segment used, in the proposed time interval and transportation conditions such as parcel weight and transportation remuneration. A preliminary contact with this identified transporter is established to validate this transaction.

In this case two different solutions can be used for the exchange of parcels at start and destination stations. The first is based on physical exchange between the persons involved in transportation, between sender and transporter first, then between transporter and recipient. The second solution is based on an asynchronous approach using technological support for parcel exchange based on box-lockers located at each city transportation station and electronic key access, which is shared, respectively, between sender and transporter and transporter and recipient. In this case there may be a delay between deposit and withdrawal at each extremity of the segment. This solution is efficient and flexible (no need for synchronous presence of two actors at each segment point. It is also interesting from a security point of view, integrating delivery traceability. In the first case, a scanning of the parcel must be introduced in order to allow its follow-up.

4.2   Market clients based parcel distribution

Another possible approach for carbon free distribution is based on market clients who are neighbors of the client waiting for his/her parcel at home. There are several possibilities: first, the source of the parcel can be the market shop or internet shop, where the addressed person (client) ordered, purchased his parcel. Internet purchase can be connected with delivery in the market shop. Secondly, the process of discovery of a transporter who is a neighbor of the final client (recipient) can also be studied at the higher level, in the shopping mall which is a collection of market shops, with a larger list of potential transporters, persons located near recipients and interested in transportation commission. Traceability is also required by scanning at departure and arrival (delivery to recipient).

4.3   Parcel and object distribution between members of a network of small craftsmen

Small craftsmen work on different sites. Their activities mainly consist of studying the work to be performed (discussion with the client), choosing and purchasing the appropriate elements in DIY stores, and when necessary, transportation to the work site, where the work can be performed. This intermediate activity of choosing, supplying and transportation is a time-consuming activity which could be reduced by more appropriate organization. If the craftsman knows exactly what he needs, he can order by internet and, when necessary, ask a colleague of the network of craftsmen, who is working near his current work site, to transport the objects to him.

In this case, it is also important to find a colleague who is in contact with the same DIY store and who is currently working near his work site. Of course, appropriate authorizations must be established between actors and the relevant store to be able to trace all purchases and deliveries.

4.4   Main specifications

We studied with ECPk Beihang University students the first case of parcel distribution based on public city transportation in Beijing in which we expected to use the subway. We also expected that in each subway station a box-locker is provided to act as a support of the asynchronous buffer between sender & transporter and transporter & recipient. We give in (Fig. 4) the Case Diagram of the asynchronous solution based on box-lockers, in (Fig. 5) the Case diagram of the synchronous solution based on direct exchange of the parcel between persons (sender & transporter and transporter & recipient). In Fig. 6 we give the Sequence Diagram of the asynchronous solution and in Fig. 7 the Sequence Diagram of the synchronous solution. Due to lack of space, we are not able to give more information.

4.5   Intermediation method proposed

In our first case using public transportation based parcel distribution, it is mandatory to discover potential travelers who are interested in this activity. They must explicitly declare to be interested and subscribe to a collaboration agreement. In this way they can be tracked by the system based either on smartphone tracking or public transportation ticket tracking. The data collected are used to find a set of potential transporters, compatible with start and finish subway stations and offering temporal compatibility with sender and recipient timing. This compatibility must be strict in the case of the synchronous solution (physical exchange between actors) but is less so for the asynchronous solution using the box-locker buffer. In two other cases, "market clients" and "network of small craftsmen", the set of potential transporters is more limited, and potential intermediation algorithms can be less sophisticated and less efficient.

The community detection study can be applied in the intermediation method to help find the sets of transporters who have either temporal or spatial compatibility. After the users' data have been collected and analyzed, we can try to build a complex network of transporters. Then, the problem is transformed into the detection of communities in which the transporters have similar properties. The proposed CDHC

Algorithm is an efficient method for carrying out community detection in complex networks.
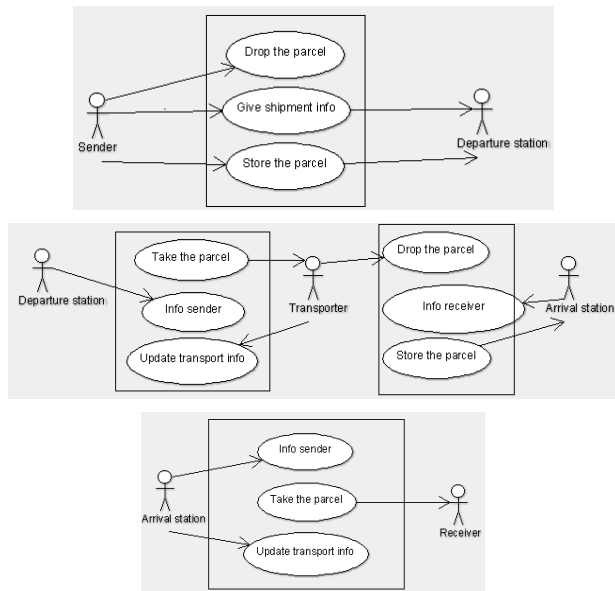

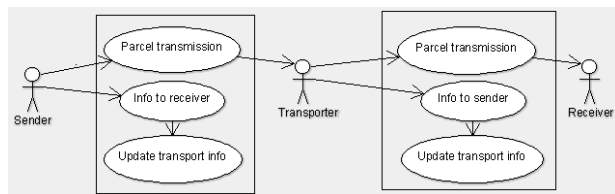Figure 4.   Case Diagram of asynchronous solution

Figure 5.   Case Diagram of the synchronous solution

One city has one or more centres and is expanded layer by layer around the centres. The closer to the centre the layer, the denser the connections to the layer. Inspired by the hierarchical structure of cities, a community of transporters should have one or more global central nodes and should be expanded layer by layer around the global central nodes. The nodes in layer p are mainly connected by nodes in layer p+1 and layer p-1. The connection number of one node with other nodes is known as its degree. Community detection of CDHC (Community Detection based on Hierarchical Clustering) includes initializing communities, expanding communities, merging small communities and choosing the best result.

Figure 6.   Sequence Diagram of the asynchronous solution

Figure 7.   Sequence Diagram of the synchronous solution

In the first step of initializing communities, we first sort all the nodes by degree in descending order and then choose k nodes with maximal degree as global central nodes. Then, the node with the maximal degree is assigned to the first community and is marked as the first community's central node. For each node of the remaining k-1 global central nodes, its similarity with each initialized community's central node is calculated. If there is a similarity greater than a given threshold, the node is assigned to the community maximizing the similarity; otherwise, a new community is initialized, assigned to the new community and marked as the new community's central node.

After finishing the process of initializing communities, we need to expand these communities. The process of expanding communities includes marking node level and calculating link strength. All the global central nodes are marked as the first level. If a node is connected to the first level and is not yet marked, its level is marked as two. By repeating this we can mark all the node levels, if we assume that the network is connected. Starting from each level two node, the link strength between the node and each community is calculated. Then, the node is assigned to the community with the maximal link strength, until the nodes of each level have been assigned to communities.
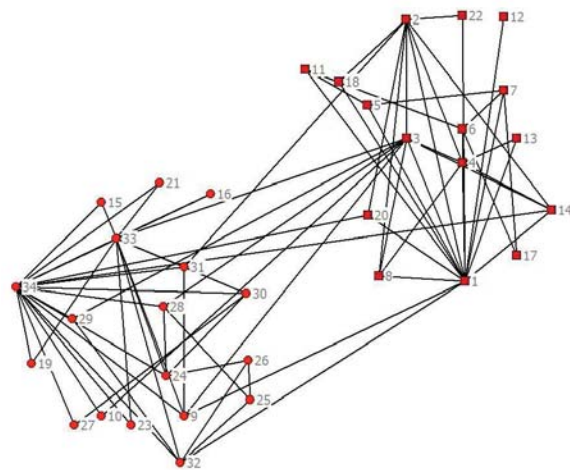

Figure 8.   Communities detected for the Zachary Karate football club

The communities have now been detected, in which the nodes have strong connections and good similarities. The final step

is to merge some small communities into large ones. Different community detection solutions with similarity threshold could be evaluated by extensive modularity, and the best solution found. We conducted some experiments on peoples' network datasets, and the result showed that the algorithm is very effective. Fig. 8 shows a community detection experiment conducted with 34 members of the Zachary Karate football club (US, 1970s).

5   Conclusion

In this paper we compared Collaborative System and Uberized Application principles and system architectures. We found major functional and architectural similarities between these two domains and supports and pointed out the differences either in characteristics, by a comparative table, or in architectures. We suggested increasing the Collaborative System by the addition of intermediation tools, to find appropriate persons, locations or things in order to create target goals of rental for Airbnb, drivers for car sharing for BlaBlaCar and transportation travelers for our parcels. Via this intermediation tool, a Collaborative System can be used in an Uberized Application.

Of course our study and presentation was scientifically, technically and technologically oriented. It was not in the scope of this paper to judge this problem from an economic or a political point of view [15, 16, 17, 18, 19, 20].

6   Acknowledgements

7   References

[1]   Andriessen, J.H.E. (2003). Working with Groupware: Understanding and Evaluating Collaboration Technology. Springer, CSCW Series, .

[2]   Ellis, C., Wainer, J. (1994). A conceptual model of Groupware, In Proceedings of CSCW'94, ACM Press, 79–88.

[3]   Ellis, C., Gibbs, S.J., Rein, G.L. (1991). Groupware: some issues and experiences. In Communications of the ACM, vol. 34, n° 1, 38–58.

[4]   David, B., Chalon, R., Vaisman, G., Delotte, O. (2003). Capillary CSCW. In Proceedings of HCI International, Crète, 2003.

[5]   L. Atzori, A. Iera and G. Morabito. The Internet of Things: A survey. Computer Networks 54 (2010) 2787-2805

[6]   Jiang B.,Yao X. Location--based Services and GIS In perspective. Computer Environment Urban Syst (2006), doi:10.1016/j.compenvurbsys.2006.02.003

[7]   Tapscott Don, Williams Anthony. Wikinomics – How mass collaboration changes everything. Penguin 2008

[8]   Tapscott Don. Grown Up Digital – how the next generation is changing your world. McGrawHill 2009

[9]   Tapscott Don, Williams Anthony. Macrowikinomics – new solutions for a connected planet. Penguin 2012

[10] David, B., Chalon, R., Delotte, O., Masserey, G., Imbert, M. (2006). ORCHESTRA: formalism to express mobile cooperative applications. In Book Series Lecture Notes in Computer Science, Vol. 4154, Springer, 163-178.

[11] B. David, R. Chalon. Situated Cooperative Work in engineering: How put together predictable and repeatable behaviors with creativity and agility. CSCWD 2015, Italy May 2015

[12] S. P.Choudary: "Platform Thinking, The New Rules of Business in a Networked World", http://platformed.info/

[13] S. P. Choudary, G. Parker and M. Van Alstyne: "Outlook 2014: Platforms are Eating the World", http://www.wired.com/2013/12/outlook-2014-platforms-eating-world/

[14] Chuantao Yin, Shuaibing Zhu, Hui Chen, Bingxue Zhang, and Bertrand David. Research Article: A Method for Community Detection of Complex Networks Based on Hierarchical Clustering. Hindawi Publishing Corporation International Journal of Distributed Sensor Networks, Volume 2015, Article ID 849140, 9 pages, http://dx.doi.org/10.1155/2015/849140

[15] Duthoit Aurélie. Petit manuel d'économie collaborative à l'usage des entreprises. Eyrolles, 2015

[16] Filippova Diana. OuiShare Société Collaborative – la fin des hiérarchies. Rue de l'échiquier, 2015

[17] Lietaert Matthieu. Homo cooperans 2.0 – Changeons de cap vers l'économie collaborative. Couleur livres 2015

[18] Rifkin Jeremy. La troisième révolution industrielle – comment le pouvoir latéral va transformer l'énergie, l'économie et le monde. Babel, 2012

[19] Rifkin Jeremy. La nouvelle société du coût marginal zéro : L'internet des objets, l'émergence des communaux collaboratifs et l'éclipse du capitalisme. Les liens qui libèrent, 2014

[20] Serieyx Hervé, Azoulay Hervé. Face à la complexité : Mettez du réseau dans vos pyramides – Penser, organiser, vitre la structure en réseau. Village mondial, 1996

SESSION

SECURITY ISSUES AND PRIVACY

Chair(s)

TBA

Privacy Perceptions in Biometrics Operations

Kevin J. Chan
International Center for Biometric Research
Department of Technology Leadership and Innovation,
Purdue University
West Lafayette, Indiana, USA
kjchan@purdue.edu

Stephen J. Elliott, Ph.D.
International Center for Biometric Research
Department of Technology Leadership and Innovation,
Purdue University
West Lafayette, Indiana, USA
elliott@purdue.edu

Abstract— **This paper summarizes the perceptions of 304 individuals on issues relating to privacy in biometric technology administered by the International Center for Biometric Research of Purdue University. The results are in line with previous consumer surveying done by the ICBR in 2007. There were, however, changes in perception regarding biometric use for counter-terrorism and banking security. Results showed strong support for the use of biometric technology for counter-terrorism and banking security while other privacy concerns such as hacking and data storage vulnerability did not show significant change. Noticeably, the use and general understanding of biometric technology does not show significant change.**

Keywords— biometrics, privacy, security, globalization, biopolitics, terrorism

I. Introduction

Transitioning to the new millennium, the issue of privacy has been a salient issue in the biometric industry. The shifts in the debate over privacy show important trends within biometrics, and highlights how this continuously developing field outruns most legislation [1]. The expanding global market has created new and imaginative challenges, where businesses and governments have to embrace new ideas and prepare for new threats without de facto laws in place [2].

Globalization has expanded integration and connection, and the advent of the internet and digital information processing has accelerated this expansion in contemporary times. Globalization has created a need for improvement of an archaic process, identification and verification[3][4]. This renaissance in personal identification is not only a response to an increased tempo of living, but also a new age of dynamic deception. No event shows this better than 9/11, when terrorists circumvented the aging passport system.

II. What is Biometrics?

Biometrics is the interdisciplinary science of personal identification through measurable and unique features intrinsic to each individual [5]. In present times, three modalities have dominated the market: face recognition, fingerprinting, and iris recognition. With the constant innovative nature of biometrics, we will continue to see more modalities being developed.

Biometrics has been used as an identification tool in the earliest eras of mankind. Hand geometry prints were used to mark cave dwellings [6], faces of monarchs used as authoritative seals, and fingerprints were a means to catalog criminals. In contemporary times, biometric identification has expanded with the global market, finding function in customs and border control, real-time recognition, security and defense, and even banking. Biometric users tend to be those with large budgets, such as government agencies and large public corporations. Biometric providers are more dynamic in composition, ranging from small mobile app developers to high budget consulting firms [7].

The process of biometric identification can be further detailed in the General Biometric Model [8]. The model shows how information is extracted, processed, and stored for use. The concern for privacy is connected to biometric data, its use and purpose, and how defined or undefined the rules regarding. Data storage itself is a market that is constantly evolving and redefining itself. Data storage in tandem with something as personal as biometrics can often lead to privacy concerns.

III. Privacy in Biometrics

A. Pre-9/11 and the growing Function Creep

In the early Pre-9/11 1990s, the world was feeling the first effects of the digital market. Globalization is becoming faster and larger, and the need for faster transfer and transport is growing exponentially. Within this period, the distance between Louisiana and London is no longer significant. Technology is outrunning legislation, and the new solutions cause some success and struggle. Governments are utilizing biometric solutions before societal malcontents can react, but at the same time the solutions perform in a way that governments struggles to adapt.

The threat of biometric function creep arises as more and more interest is developed [5]. The fear that a new form of discrimination or criminalization is imagined [3][9]. The zero-sum model of privacy and security, traditionally applied to legislation, is now applied to biometrics [1][10][11]. People are general accepting of biometrics use for simple verification and identification, but fear that biometric systems may become too invasive with expansion.

Function creep continues to grow as a result of developments of data density [12]. Whereas before a string of bytes mere represents fingerprint features extracted from a finger scan, the same string can be read as a whole biography [9][13]. This development on biometric technology and function creep further widens the gap between technology and legislation. Now the law has to define whether this creep constitutes an invasion of privacy.

B. Post-9/11 and Risk Assessment Changes

In the Post-9/11 Era, the paradigm shifts from should biometrics be used, to what is biometrics becoming. Globalization has created a multi-dimensional view of global security, but an aging mathematical model of risk is still in use [1]. The reliance on information and data has grown, as a new digital war is being waged. This new digital battlefield can also affect ordinary citizens, as they are mandated to reveal their identity.

The right to anonymity, or at least the right to selectively reveal oneself, has now changed with the growing field of biometrics and the War on Terror [14]. The 2014 case of The Commonwealth of Virginia v. Baust, Judge Frucci held that fingerprints are not protected under the Fifth Amendment clause of self-incrimination [15]. This legal holding is yet another issue of defining what is and what is not our private selves. As a result of the Post-9/11 growth in biometric use, consumer and customer concerns started to catch up with the market. Privacy advocates have expanded their concerns about data safety and function creep, property rights of biometric data and anonymity [16].

C. Future of the Biometric Industry

In the last few year, touchless biometrics was no longer limited to short range iris and face recognition. Biometrics is making appearances in more than just laptops and access hardware; they are in mobile hardware and software development [17][18]. But these developments come with more concerns, as identification can be done discretely without the individual's consent.

IV. PAST SURVEYS

In the 2007 survey by Elliott et al., 43% felt biometrics threatened personal privacy. In terms of security, only 5% of respondents thought that biometrics was easy to fool, and 46% thought criminals would steal body parts to circumvent biometrics [19].

Ponemon's 2006 Unisys survey shows that banking institutions are perceived the most trusted when it comes to biometric identification systems. Police and tax services are perceived as the least trusted. Ponemon's survey highlights a clear division among public and private sector use of biometrics and their consumer comfort levels [20].

Furnell et al.'s 2007 survey showed that 30% were extremely concerned about biometric data being stolen, and another 26% very concerned, and 22% moderately concerned. Furnell's survey does show some similarity with Elliott's in regards to fooling biometrics, as only 6% thought biometrics were very easy to cheat, and no respondents said biometrics were extremely easy to cheat. Furnell and Ponemon both addressed private and public entities using biometrics. Furnell's results are different, in that they show no entity with favorable results, as 38% are not at all confident in private entities and 39% for public entities [21].

V. METHODOLOGY

The survey ran through two alliterations, with the second survey having slight modifications. The first survey was conducted over a 22-day period from January 7th to the 21st, in 2013. The second survey was done over a 15-day period from November 23rd to December 7th, 2014.

Questions from the first survey focused on general biometric knowledge, exposure and use of biometric technology, and attitudes towards biometrics systems and implementers. Fifty-two questions were generated covering general interest and knowledge of biometric technology of the public at large, and also provide a base for comparison to the second survey.

The second survey was conducted a year after the first, with the goal to see if there have been any perception changes. Sixty-two questions were generated and covered the same topics as the last one. The same questions asked again but with subtle rewording will reveal how deeply thought out and how strong the conviction is regarding the position taken. This variant rewording is to validate the survey answer to observe answer alignment. If answers to the same question show a significant difference, then the public may not be solidly positioned from a particular perspective.

VI. SURVEY PARTICIPANTS

For the first survey a total of 200 surveys were returned. In regards to gender, 51% were female and 49% were male. In regards to education, most were in college or have been awarded a Bachelor's degree, 40% and 29% respectively. In regards to age, most were in between 25 to 54 year olds. The three biggest age groups were 45-54 at 25%, 35-44 at 22%, and 25-34 at 20%. 62% of the respondents were located in urban areas, while only 38% were located in rural areas. Table I shows the detailed breakdown of demographics of both alliterations.

RESPONDENTS' DEMOGRAPHICS

		Percent 1	Percent 2
Education	Some Highschool	2	4
	Highschool/GED	18	24
	Some College	40	35
	Bachelor's	29	25
	Master's	8	9
	Doctorate	3	2
	Post-Doctorate	0	0
	Other	1	2
Age	18-24	8	12
	25-34	20	27
	35-44	22	18
	45-54	25	13
	55-59	9	10
	60-64	9	9
	65+	15	13
Residence Characteristics	Urban	62	62
	Rural	38	38

The second alliteration, a total of 104 surveys were returned. In regards to gender, it was an even female to male split. The two surveys had similar results to education, age composition, and predominantly urban residents. Table II shows the detailed breakdown of demographics of the second alliteration.

VII. SURVEY ORGANIZATION
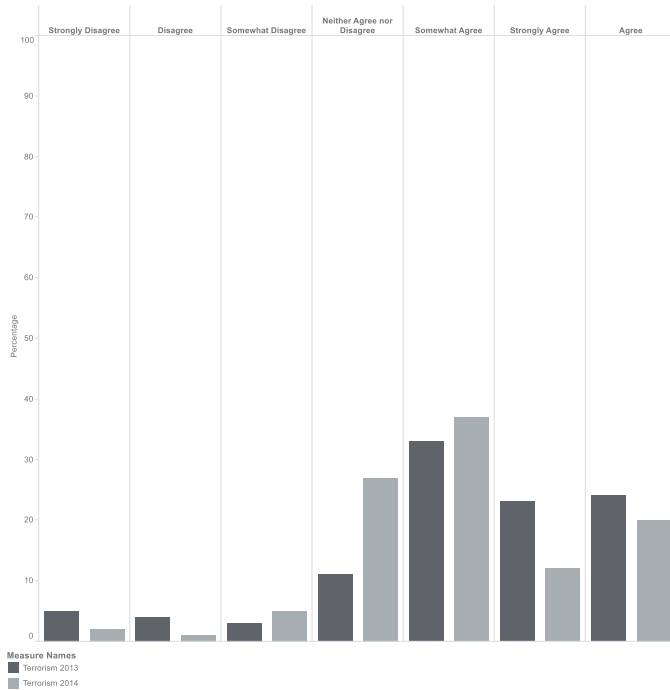
A. *Biometrics and the War on Terror*

Figure 1. The perception of biometric technology effectiveness and terrorism.

The two surveys show that there is little change in regards to the public perception of biometric and its role in the War on Terror. Most seem to agree that biometrics contributes to the war effort, and this does not seem to change much over the course of a year.

When asked a reworded variant of this same question, as shown in Figure 2, we see a very different distribution of responses. In the second alliteration the statement of biometrics having little effect on the war was presented, 38.62% were neutral, while 29.8% disagreed and 31.73% agreed. This may show that respondents do not take biometrics as a salient issue in the War on Terror, or it could be something as simple as misinterpretation of the variant question.

Figure 2. Variant question of biometric technology effectiveness and terrorism.

The reworded variant is an antithesis question to the original, and it would be expected that a similar distribution, but mirrored in the opposite spectrum would be observed. The data does not reflect this, as the variant's distribution is normally centered on the neutral position. There is still significant difference between the two results (p-value<0.001) in a right-tailed t-test of means, but we can observe from the graphical representation that this may still need further investigation.

The data shows that, over the course of a year, there have been no significant changes in the perception of biometric technology and its use in the War on Terror. Furthermore, with the added data from the variant question, we can observe that biometric technology use is not a salient issue in overall geopolitics as described by Muller (2008).

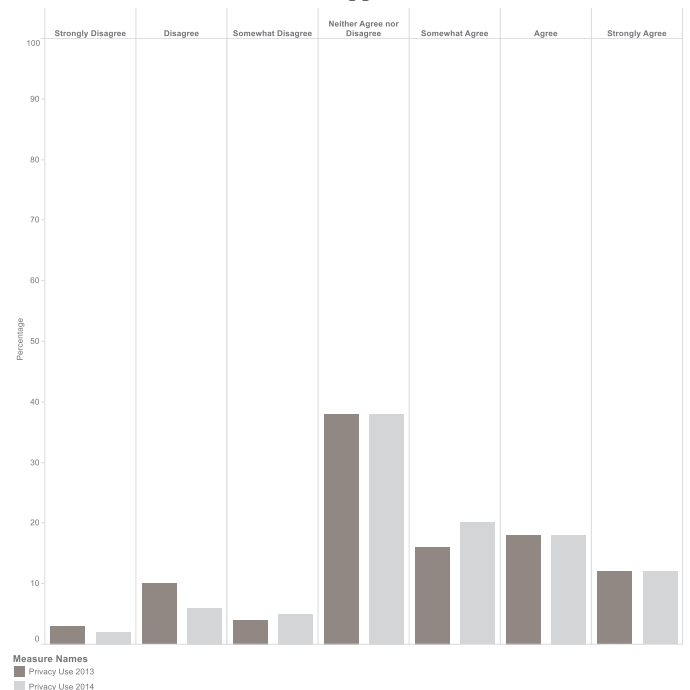### B. *Biometrics used in Civil Applications*

Figure 3. The perception of privacy when using a biometric device.

The survey presents a statement regarding using biometric technology in a private setting. There seems to be little change over the year. The data shows evidence that the public at large desires privacy when interacting with a biometric system. This phenomenon could be explained by Parker (2010) and Zadok (2010) analysis of the perception of selectively revealing one's self. This sense of anonymity is not necessarily an act of deception, but rather a preservation of control in terms of individual identity.
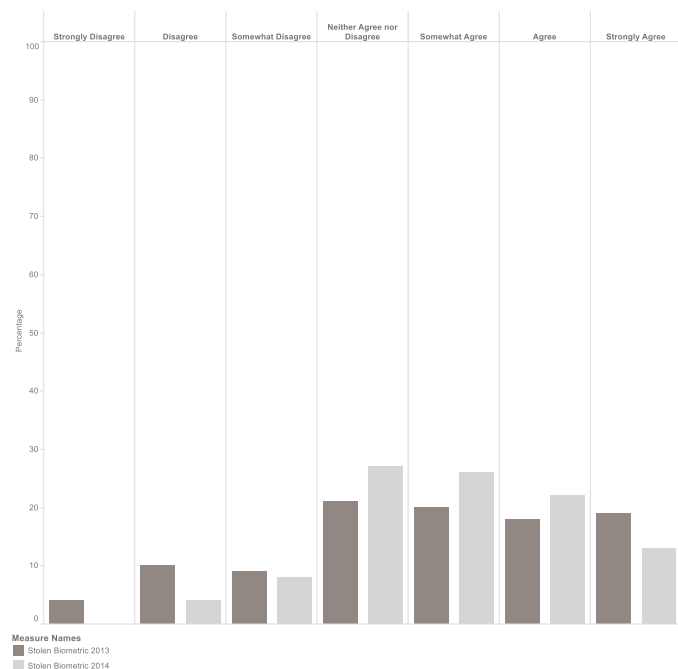

Figure 4A. The perception of biometric data being stolen.

When asked about biometric data being stolen, both alliterations showed that the public at large is concerned. Though the second alliteration shows more respondents concerned about biometric data theft, the change is not significant. This issue of biometric data being stolen or compromised was raised by Cavoukian et al., and has continued to dominate the industry landscape in biometrics. The alliterations suggest that this issue will remain salient, or increase in saliency with the current paradigm. Figure 3 shows the responses from both alliterations.

In relation to past surveys, the results gathered in these two alliterations show a low percentage concerned with biometric data being stolen. Furnell et al.'s 2007 survey showed that 78% were anywhere from moderately concerned to very concerned. The first alliteration showed that only 57% agreed that there was a concern, and 61% for the second alliteration.

The second alliteration also presented a statement regarding the security risk of biometric data. The 46.15% majority felt neutral about security risks of biometric data, while 31.73% felt that it was low and 22.11% felt it was high. Figure 4A shows the distribution of the responses.

When asked about hacking biometric data to steal identity, the data shows that 34.61% agree it is possible, 38.46% remained neutral, while 26.92% disagree. It is interesting to note that although Figure 4A does not seem to show many responses perceiving a risk of biometric data being stolen, both

Figures 4A and 4C do. When a two-tailed t-test is done, we do not see a significant difference between the results of the two questions.
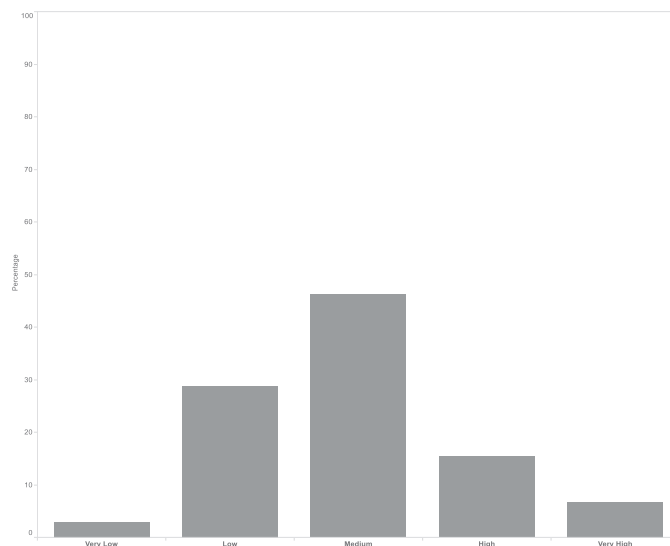

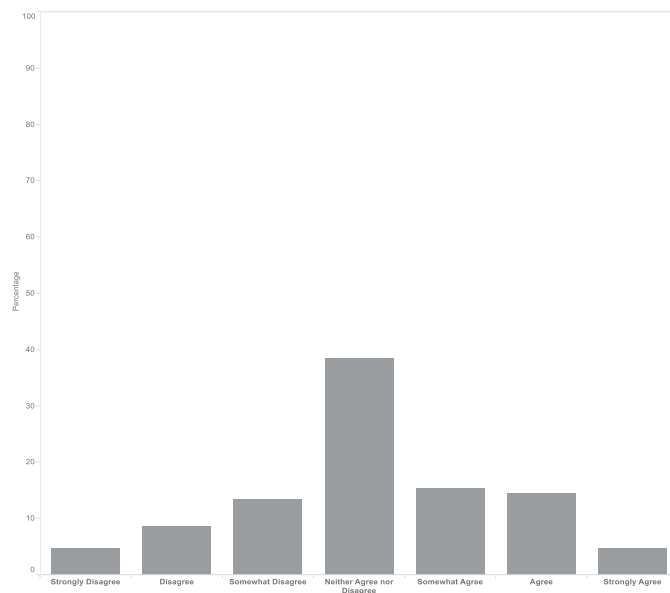Figure 4B. The perception of weakness in biometric data storage.

Figure 4C. The perception of hacking biometric data for identity theft.

Biometric utilization in law enforcement was also explored in the second alliteration of the survey. The topics of Stop & Identify statutes and police requests for biometric presentations were raised. When presented with the statement that police requests for biometric presentations were an invasion of privacy, 26.92% disagreed while 45.19% agreed. When presented with the statement that Stop & Identify statutes are not an invasion of privacy, 24.04% disagreed while 45.2% agreed.

The data shows that almost half the respondents think police request for biometrics an invasion of privacy, but the same number think that Stop & Identify is not an invasion of privacy. It is interesting to note, that many will present an identification document to law enforcement officials without hesitation, even though that act in and of itself is a basic

biometric identification scheme. A police officer looking at a driver's license photo and comparing it to a driver is the same as a 1:1 verification of any face recognition system, only without the increased processing performance of digital algorithms [12].
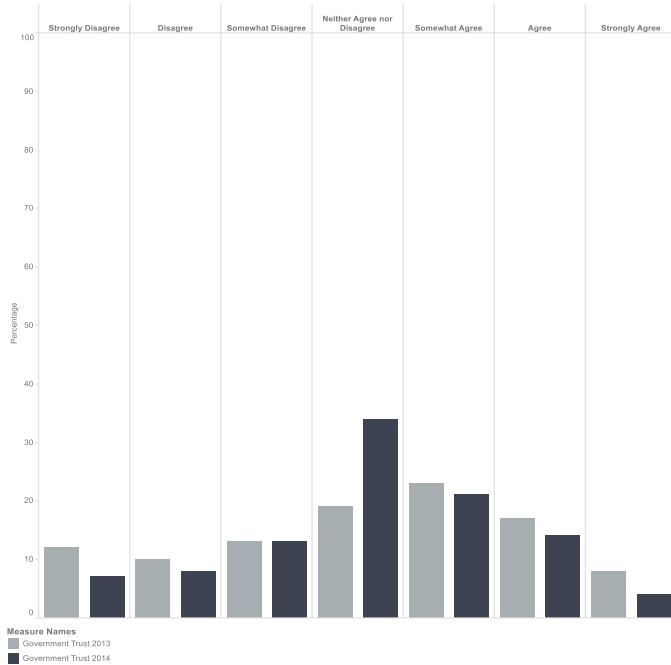
C. Custody of Biometric Data

Figure 5. The perception of government custody over biometric data.

The data shows evidence that the public at large is still divided on the idea of letting the government use and maintain biometric systems. The second alliteration does show responses leaving the peripherals to join the neutral position, but this change is far from significant.

Figure 6. The perception of third party custody over biometric data.

The data shows evidence that the public at large trust third parties at similar levels to the government. The changes in perception within a year is far from significant. When comparing the two statements against each other, government vs. third parties, the changes are also not significant in the first and second alliteration.

The second alliteration features two variant questions regarding third party custody of biometric data. Figure 8 is the antithesis question to Figure 6. When comparing the responses of the two questions, we see that there is a significant change. It is expected that with an antithesis question, the distributions should be similar, but mirrored in the opposite spectrum. The data shows that the original question has a normal distribution with a center in the neutral position, while the antithesis variant has a heavier distribution in the agreeing position.
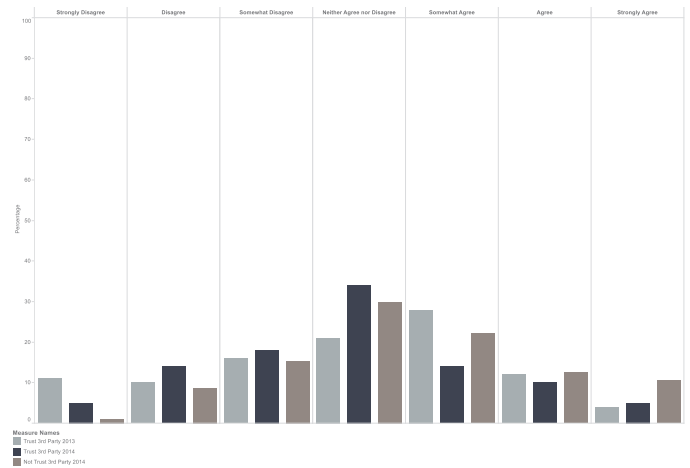

Figure 7. Variant question of third party custody over biometric data.

The second variant question was just a finite version of the first variant question. It was used to address Ponemon's Unisys observations on banking corporations and biometric use. In Figure 8, we can see that it coincides with Ponemon's findings, that banks are still trusted when it came to their use of biometric technology. A majority of 57.69% would not have much concern when using a biometric recognition service provided by a bank.
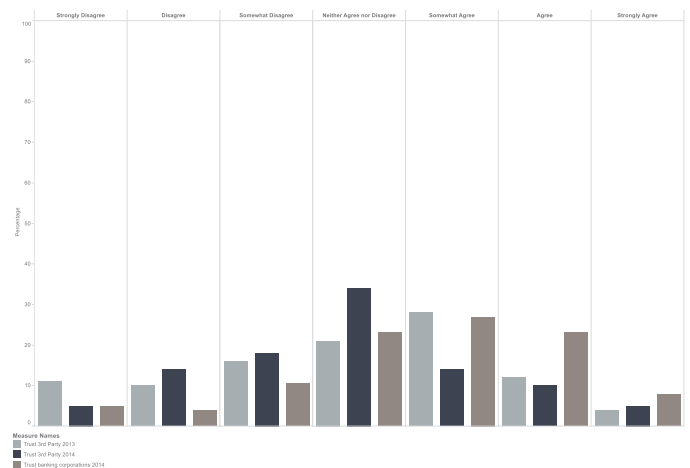

Figure 8. Variant question of third parties, specifically banking entities.

A right-tailed significance test was done comparing the second variant question with the original, and yielded very

significant results. This leads to a clear cleavage in perception between banks and other non-government entities. A replication study of Ponemon's Unisys survey could reveal more of this cleavage.

When presented with a statement specifically regarding the government use of biometrics to circumvent civil rights, 33.66% felt that the risk was high or very high. Figure 9 shows the distribution of that data.

Figure 9. The perception of fear and government use of biometrics.

Like much of the data in this subsection, the distribution is normal and centered around the neutral. It may be that the public at large does not consider biometric technology a salient issue in government affairs. When reviewing law enforcement custody of biometric data, discontent comes along the lines of abuse of authority, which is not necessarily an abuse of biometric technology [16]. When reviewing border security custody of biometric data, it has been long established that the salient issue is systematic discrimination, which is mutually exclusive from biometric technology [4][9].

VIII.   DISCUSSION OF RESULTS AND FUTURE WORK

The data shows evidence of small changes between both alliterations, but the change is not significant. It appears that within a year, not much will change in the perception of biometric technology. Even with the increasing number of cellphones with biometric locks, there seems to be no increase of biometric use.

Though the results do not show changes, it provides a conventional comparison within the year. This can provide a foundation for future market and enterprise researchers to develop meaningful business intelligence. The two alliterations highlights what is salient and what is redundant. Future surveyors can field new questions that can potentially yield information-rich responses, and avoid the information-poor results that the ICBR encountered.

STATISTICAL SUMMARY

	P-value
Face Recognition Usage	0.122
Fingerprint Recognition Usage	0.166
Iris Recognition Usage	0.880
Perception of biometric effectiveness on terrorism	0.139
Perception of biometric ineffectiveness on terrorism	<0.001
Perception of privacy when using biometrics	0.434
Perception that biometric data being stolen	0.219
Perception of government data custody	0.963
Perception of third party data custody	0.701

	Percent Agree
Biometrics has little effect on terrorism	31.73%
Biometrics can be easily hacked	34.61%
There is a security risk with biometrics	22.11%
I would use biometrics in banking	57.69%
I would not trust biometrics in public corporations	45.20%

For future studies, it would be more beneficial to sift the questions into finer detail. An issue that arose in this study was the immense and intricate workings of privacy policy and biometrics, as many times standards and rules are passed ad hoc due to the constant advancements in the biometric industry [5]. This ad hoc and on the go arrangement in governing of biometric technology can cause distinct cleavages of biometric perception. The data shows that the public at large is more welcoming to biometric technology being used for the purpose of counter-terrorism and banking security, but lukewarm to trusting entities with such technology.

In the future, researchers should limit biometric privacy perceptions to something distinct and finite, such as privacy perceptions in the War on Terror or privacy perception public corporations. It can be observed in the two alliterations that a general blanketing survey for privacy perceptions may not offer the most clarity. Covering so many topics, the two surveys cannot divulge deeper into any particular. Variant questions also show some problems as they are subject to misinterpretation, but nevertheless are needed to observe the nature of human responses.

The ICBR will administer another survey on the same subject in the future, but is also interested to see what other researchers and institutions develop. Validity can be strengthened by multiple sources contributing to the same surveying. A third alliteration conducted by the same source may encounter threats like maturation, mortality, and multiple-surveying interference. With other researchers contributing to the subject, there would be a firmer face and content validity.

References

[1] Zureik, E., & Hindle, K. (2004). Governance, security and technology: the case of biometrics. Studies in Political Economy, 73.

[2] Chang, P. F. (2010). Interdisciplinary approaches to determine the social impacts of biotechnology. In Ethics and Policy of Biometrics (pp. 115-120). Springer Berlin Heidelberg.

[3] Amoore, L. (2006). Biometric borders: Governing mobilities in the war on terror. Political geography, 25(3), 336-351.

[4] Van der Ploeg, I. (1999). The illegal body:Eurodac'and the politics of biometric identification. Ethics and Information Technology, 1(4), 295-302.

[5] Woodward, J. D. (1997). Biometrics: Privacy's foe or privacy's friend?. Proceedings of the IEEE, 85(9), 1480-1492.

[6] Sidlauskas, D. P., & Tamer, S. (2008). Hand geometry recognition. In Handbook of Biometrics (pp. 91-107). Springer US.

[7] Ashbourn J. (2000): Biometric. Advanced Identity Verification. The Complete Guide. Springer, Berlin Heidelberg New York.

[8] Elliott, S. J., & Kukula, E. P. (2010, April). A definitional framework for the human/biometric sensor interaction model. In SPIE Defense, Security, and Sensing (pp. 76670H-76670H). International Society for Optics and Photonics.

[9] Van der Ploeg, I. (1999). Written on the body: biometrics and identity. ACM SIGCAS Computers and Society, 29(1), 37-44.

[10] Sutrop, M. (2010). Ethical issues in governing biometric technologies. In Ethics and Policy of Biometrics (pp. 102-114). Springer Berlin Heidelberg.

[11] Acquisti, A. (2010). From the economics to the behavioral economics of privacy: a note. In Ethics and Policy of Biometrics (pp. 23-26). Springer Berlin Heidelberg.

[12] Mordini, E., & Massari, S. (2008). Body, biometrics and identity. Bioethics, 22(9), 488-498.

[13] Mordini, E. (2009). Ethics and Policy of biometrics. In Handbook of Remote Biometrics (pp. 293-309). Springer London.

[14] Parker, T. (2010). Are we protected? The adequacy of existing legal frameworks for protecting privacy in the biometric age. In Ethics and Policy of Biometrics (pp. 40-46). Springer Berlin Heidelberg.

[15] Commonwealth of Virginia v. David Charles Baust, CR14-1439 (Second Judicial Circuit October 28, 2014).

[16] Zadok, E. A. (2010). Legislative and Ethical Questions regarding DNA and Other Forensic" Biometric" Databases. In Ethics and Policy of Biometrics (pp. 27-39). Springer Berlin Heidelberg.

[17] Cavoukian, A., Snijder, M., Stoianov, A., & Chibba, M. (2010). Privacy and biometrics for authentication purposes: a discussion of untraceable biometrics and biometric encryption. In Ethics and Policy of Biometrics (pp. 14-22). Springer Berlin Heidelberg.

[18] Hefferman, S., & OmniPerception, C. E. O. (2011). biometric. Biometric Technology Today.

[19] Elliott, S. J., Massie, S. A., & Sutton, M. J. (2007, June). The perception of biometric technology: A survey. In Automatic Identification Advanced Technologies, 2007 IEEE Workshop on (pp. 259-264). IEEE.

[20] L. Ponemon, "Global study on the public's perceptions about identity management," submitted for publication by Unisys Corporation, April 26, 2006, retrieved on December 28, 2006.

[21] Furnell, S., & Evangelatos, K. (2007). Public awareness and perceptions of biometrics. Computer Fraud & Security, 2007(1), 8-13.

[22] Muller, B. J. (2008). Securing the political imagination: Popular culture, the security dispositif and the biometric state. Security Dialogue, 39(2-3),199-220.

A Novel Network Flow Watermark Embedding Model for Efficient Detection of Stepping-stone Intrusion Based on Entropy

Yonghong Chen[1], **Shan Wang**[2]
[1]*College of Computer Science and Technology, Huaqiao University, Xiamen, China*
[2]*College of Computer Science and Technology, Huaqiao University, Xiamen, China*

Abstract - *Network flow watermarking schemes have been used to detect stepping stones, which including watermark embedding scheme and detection scheme. Among them, watermark embedding scheme plays a vital part in a watermarking scheme. Most existing watermark embedding schemes are based on using a randomly select the operation time interval and then generated watermark sequence in carrier flow. However, the randomness of watermark operating may cause watermark easily exposed to attacks. We herein propose a novel watermark embedding scheme based on entropy (NWESBE) to solve this problem. We firstly pre-process the carrier traffic by using entropy analysis and then determine optimum time intervals for embedding watermark. Secondly, we randomly embed watermark in these determined time intervals. Our analytical and empirical results demonstrate that our proposed scheme is robust for embedded watermark to timing perturbation, while invisible to attacks. And also it can greatly improve the detection rate and requiring fewer observation packet.*

Keywords: Network Flow Watermark; Entropy; Stepping-stone Intrusion Detection; Active Traffic Analysis

1 Introduction

In order to hide identity, Internet attackers commonly relay their traffic through a number of compromised hosts, called stepping stones [1]. Detecting such hosts is an important problem in computer security [2]. There are a lot of researches on the detection method of stepping stone, but most of it is passive traffic analysis method. More recently, comparing with traditional approaches [3-5], an active approach called watermarking has been more considered [6], with higher accuracy and detection efficiency, which traffic characteristic of an incoming flow are actively perturbed as they traverse some router to create a distinct pattern, which can later be recognized in outgoing flows.

A watermarking scheme is composed of the watermark embedding module and the detection module. The watermark embedding module is responsible for embedding the watermark by modulating the target flow. It not only affects the robustness and invisibility of embedded watermark, but also directly affects detection efficiency of the corresponding detection module. Therefore, a watermark embedding scheme

plays a vital part in a watermarking scheme. Recently, many watermark embedding schemes have been proposed. ICBW [7], DICBW [8], IBW [9], where watermark embedding by manipulating packet counts of preselected interval pairs. In [10-12], authors developed packet-based watermarking by inflating or deflating an inter-packet delay (IPD). References [13-15] provided based on speed of traffic watermark embedding schemes. Among them, most existing watermark embedding schemes subdivide the network flow into short fixed-length intervals and perform transformative operations on an entire interval of packets for the purpose of modifying flow characteristics [16]. Unfortunately, the operation time interval is determined randomly, with the uncertainty of traffic information, such watermark embedding techniques will cause watermark easily expose to attackers and resulting in watermark effective weakened. We herein propose a novel watermark embedding scheme based on entropy (NWESBE) to solve this problem.

Entropy is the description of uncertainty of the random variable in information theory, which can be used as a metric of the amount of information [17]. In this paper, we firstly sample a fixed time interval T and statistic the packet bit entropy in per T, and then determine appropriate time interval for embedding watermark by comparing with the determined entropy threshold. It is well know that the greater entropy value of variables, indicating the greater the random degree of the variable, that is the greater the amount of contained information. We select time interval containing a large amount of information, namely a large entropy value to manipulate the inter-packet delays. Therefore, watermark information can be ignored when a few special watermark all are embedded in the time interval of a large amount of traffic information instead of the time interval of uncertain information.

The contribution of this paper is to use entropy to pre-process the carrier flow qualitatively and quantitatively, and select the appropriate time interval instead of the random selection of time interval to embed watermark information. Analytical and experimental results show that our proposed NWESBE is very effective, which not only can improve the invisibility and robustness of embedded watermark, but also can directly affect detection rate of watermark and detection efficiency of a watermarking scheme, with requiring fewer observation packets.

The rest of this paper is arranged as follows. In Section 2, we design a novel watermark embedding scheme, called NWESBE. Experimental results and discussion are given in Section 3. Finally, this paper is concluded in Section 4.

2   A Novel Network Flow Watermarking Model

In this section, we present a design of the NWESBE network watermark embedding scheme, which is an innovation of previous research work about network watermark embedding scheme.

2.1   Background of entropy

The definition of entropy is assumed to be, herein, the one introduced into the information theory [18], which describes entropy as a measure of the degree of uncertainty of a given random variable [19]. In this content, the entropy value is greater, indicating that the more amount of information transmitted by the variable of information source. Conversely, the smaller the entropy value, indicating that the amount of information that the variable transmission source is less. Therefore, entropy can be used as a metric for the amount of information, can effectively response the distribution of information content of network traffic.

The formal description of Entropy is given by expression (1) and denoted by $H(x)$ where x represents the number of values in the observation pool, and $p(x_i)$ denotes the probability of occurrence of a given value x_i,

$$H(X) = -\sum_{i=1}^{n} p(x_i) log p(x_i) \tag{1}$$

2.2   A novel watermark embedding scheme

We take advantage of the entropy in information theory and watermark generated based on inter-packet delays (IPD) to propose our watermark embedding scheme. In our watermark embedding scheme, mainly including two key steps.

Step 1: Determine the appropriate time period for embedding watermark

In our approach, we first acquire carrier flow and real-time calculate bit entropy of per packet within the unit time interval. The concrete calculation procedures are as follows:

(1) The probability of packet size $P_{i,j}$ is given by

$$P_{i,j} = \frac{p\_size(i,j)}{p\_size\_sum(i)} \tag{2}$$

Where $p\_size(i,j)$ denotes per packet size in a time interval T, $p\_size\_sum(i)$ denotes the sum of packet size in this time interval.

(2) According to formula (1), we can get the bit entropy of packet within the unit time interval：

$$H_i = -\sum_{j=1}^{N_i} p_{i,j} log p_{i,j} \tag{3}$$

(3) In this paper, we derive the appropriate time interval for embedding watermark by finding the entropy value that it can reflect the amount of information. The particular entropy value is selected by the following equation (4). If H_i satisfies equation (4), there is an appropriate time interval, which showing the large amount of information content.

$$H_i > H_{threshold} \tag{4}$$

Where $H_{threshold}$ denotes entropy threshold. We using a statistical method involving the mean to obtain an entropy threshold before embedding watermark.

Step 2: Watermark generating

From Step 1, we obtain the appropriate time interval for watermark embedding. Then we will embed watermark in this time interval. The way of generating watermark information similar to the RAINBOW [6] watermark embedding scheme, which insert a watermark value by delaying some packets.

Suppose that the determined time interval from the carrier flow with the packet timing information $\{t_1^u, t_2^u, ..., t_n^u\}$. Before embedding watermark, the inter-packet delays (IPDS) of the carrier flow $T_i^u = t_{i+1}^u - t_i^u$. The watermark is subsequently embedded by delaying the packets by an amount such that the IPD of ith watermarked packet is $\{T_i^w = T_i^u + w_i\}$. At the same time, we record the IPDS sequence of watermarked packets in a database, used as a special pattern for detecting stepping stone intrusion by comparing with the time delay pattern from the watermark detector.

The watermark components $\{w_i\}_{i=1}^n$ take values $\mp a$ with equal probability:

$$w_i = \begin{cases} +a & w \cdot p \cdot \dfrac{1}{2} \\ -a & w \cdot p \cdot \dfrac{1}{2} \end{cases} \tag{5}$$

The value a is chosen to be small enough so that the artificial jitter caused by watermark embedding is invisible to ordinary users and attackers. We present our watermark embedding scheme in Fig.1.
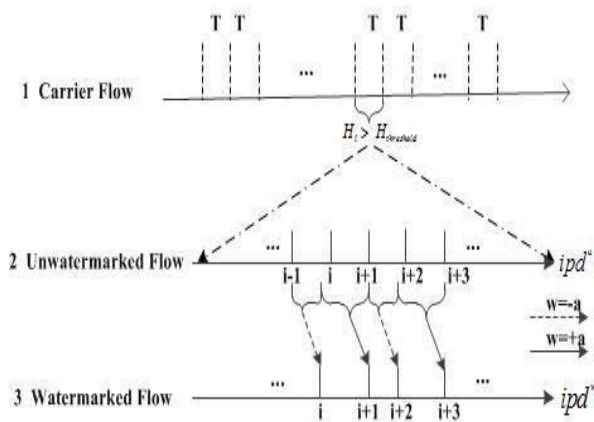
Fig.1 NWESBE watermark embedding scheme

2.3   Watermark detecting

The watermark detection works is a non-blind manner and therefore the detector had access to the database where the watermarked flow are recorded. Similar to the RAINBOW detector, normalized correlation as a detection scheme for watermark. First, we receive a flow detector subtracts its inter-packet delays (IPD). Then calculated correlation metric by comparing with the IPD pattern from the database and the detector decide whether the candidate flows is watermarked. Finally the detector decide whether the two flows are linked or not, so as to determine whether the host is a stepping-stone. A normalized correlation is defined as：

$$N(a, b) = \frac{<a, b>}{\|a\| \cdot \|b\|} = \frac{\sum_{i=1}^{n} a_i b_i}{\sqrt{(\sum_{i=1}^{n} a_i^2)(\sum_{i=1}^{n} b_i^2)}} \tag{6}$$

3   Experimental result and analysis

In this section, we display our experimental results after applying our proposed watermark embedding scheme. We implemented a real-time watermark scheme consist of four sections as shown in Fig.2 to evaluate the performance of the novel watermark embedding scheme and compare the results with the previous work [11]. We simulated the RAINBOW and NWESBE schemes in NS2 platform [20].

In our experiments, the network flows are generated at the *Client* by injecting real dataset "The CAIDA Anonymized Internet Traces 2015" [21] into the NS2. Then watermark information was embedded at the *Watermarker*. The watermarked flow was perturbed with random delays at *Perturber* to simulate the timing perturbation. The *Detector* extracted the watermark from the received flow. The same set of experiments was conducted to test the RAINBOW watermark embedding scheme, which is recently a good watermark scheme. We choose average used packet numbers, detection rate, invisibility and robustness of watermark as measures to consistently compare watermark embedding scheme *Watermarker*.

There needs to be mentioned is that we have done a lot of repeated experiments, each experiment is run for more than 20 times. The experimental data obtained in this paper are the average of the 20 times repeated experiments. In the following, we evaluate the performance of the proposed watermark embedding schemes by detection rate, Robustness against timing perturbation, invisibility of watermark and expenditure of time.
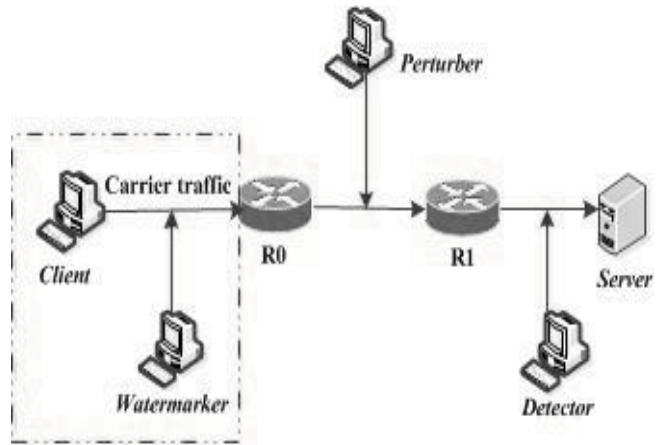

Fig.2 Experiment setup

3.1   Accuracy without timing perturbation

This experiment measured the detection rate of our proposed method and RAINBOW (recently an advanced watermarking scheme), respectively, without timing perturbation. The result in Fig.3 shows that the watermark detection rate of the RAINBOW watermark embedding scheme and NWESBE watermark embedding scheme change as the embedded watermark length increases. And the final watermark detection result using the RAINBOW scheme has great randomness, reflecting in the unstable watermark detection rate, while the watermark detection result using the NWESBE scheme is relatively stable. From Fig.3, compared to the RAINBOW, our proposed scheme to achieve higher watermark detection rate at same experiment sets. It means that using entropy to determine the appropriate time interval can guarantee the validity of embedded watermark and improve the accuracy of watermark detection. Hence, we can know that there is a significant advantage in using entropy to embed watermark over the RAINBOW under ideal conditions.
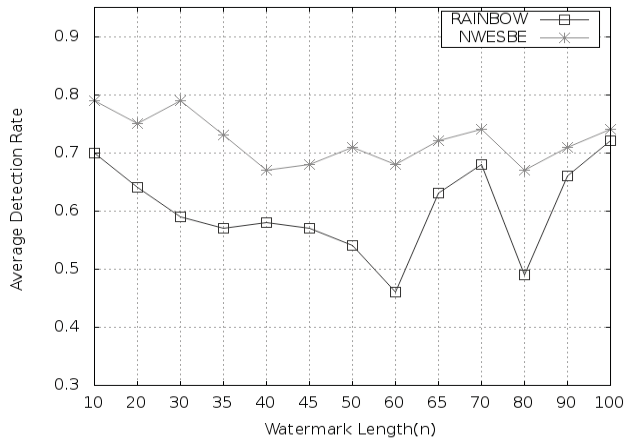
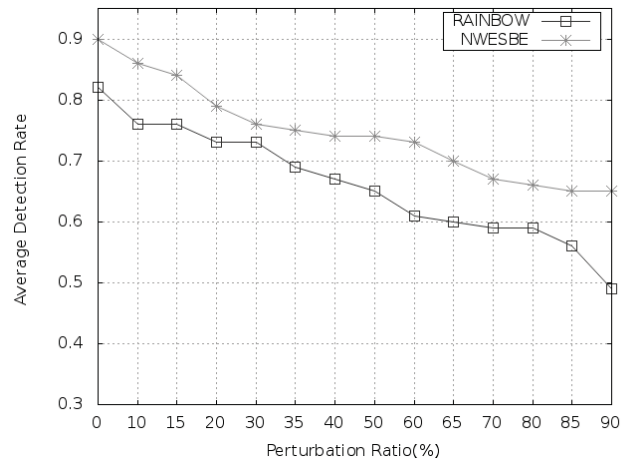Fig. 3 Detection rate comparison between the two watermark embedding schemes

Fig. 4   A comparison of detection rate under timing perturbation

3.2   Robustness against timing perturbation

We also observe that active robustness is likely to be impossible to achieve at the same time. To demonstrate the robustness of our method against active time perturbation, which was modeled using uniformly random delays, we measured the detection rates of the NWESBE and RAINBOW, respectively, for different perturbation ratio as shown in Fig.4. From Fig.4, with the increase of perturbation ratio, the watermark detection rate based on two different watermark embedding method presenting a trend of downward, indicating that the robustness of watermark is affected by the timing perturbation. But, compared to the RAINBOW, the NWESBE scheme always achieve higher detection rate in the same perturbation ratio condition. Therefore, in our watermark embedding scheme, watermark are more resilient to an adversary who actively tries to remove them from the carrier flow, which they still alive after the interference by timing perturbation. We select the time interval contained a large amount of information for embedding watermark in our scheme. By this way, we find that watermark will introduce little distortion, in that they will not significantly impact the performance of the flows. The analysis results illustrated that the NWESBE based entropy analysis for watermark embedding is more robust against timing perturbation compared with the RAINBOW scheme.

3.3   Average number of packets used

Given a fixed detection rate (80%), Fig.5 gives a comparison of the packet numbers needed by the two watermark embedding methods as watermark length increase, which including 20 times repeated experiments. Compared to the RAINBOW, when fixed same watermark length, the NWESBE scheme only requires less than 10000 packets to achieve same detection rate, while the RAINBOW requires far more than 10000 packets under the same watermark detection framework.
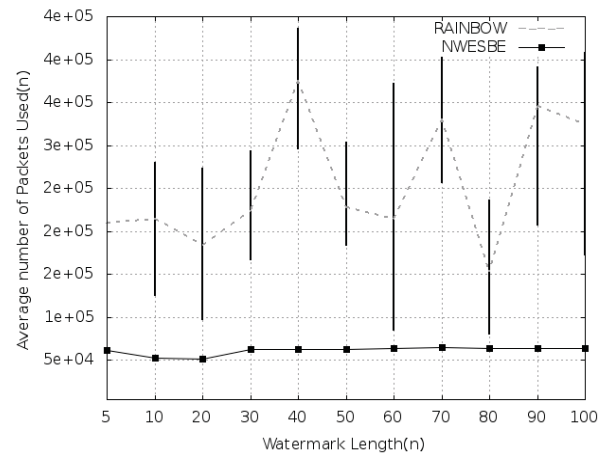

Fig. 5 Average number of packets under watermark length

From Fig.5, we also found that average number of packets required changes fluctuate widely as the change of the watermark length if watermark are embedded using the RAINBOW scheme, while it maintains a steady state using the NWESBE scheme. The result demonstrates that the randomness of watermark embedding may increase the burden of the watermark detection module and reduce the efficiency of detection.

Table 1 demonstrates that the average number of packets needed by the two watermark embedding methods, with achieved different detection rate. We can see that there is a significant advantage in using our proposed scheme, which seems to reduce packet number up to 60% compared to RAINBOW. The results show that RAINBOW requires longer observation duration leading to low efficiency of detecting stepping stones. Therefore, our proposed scheme are more efficient, with shorter observation periods necessary.

Table 1: Average number of packets required under achieved same detection rate

Detection rate	Average number of packets used	
	NWEBSBE	RAINBOW
20	78476	232970
40	63058	314474
60	63538	300164
80	64195	298934
100	63402	451946

3.4   Invisibility of watermark

Watermark are embedded in the time interval of randomly selected by the RAINBOW scheme, which may result in the exposure of the embedded watermark and causing the attacker to malicious operation of the watermark. We propose a watermark embedding scheme that selecting the appropriate time interval with a large amount of information by using entropy to preprocess the carrier flow before embedding watermark. In our scheme, all watermark information are embedded in the larger amount of information and watermark information almost can be ignored, compared to RAINBOW, the embedded watermark can only introduce minute changes to the carrier flow, which ensuring invisibility of the embedded watermark.

4   Conclusions and future work

In this paper, we propose a novel watermark embedding scheme by using entropy to determine time intervals of watermark operating, which can help to detect intrusions in the network more accurately and efficiently.

The essence of our proposed method is to hide information in the network flow characteristics. In our watermark embedding scheme, all watermark information will be embedded in these time intervals of a large amount of information by using entropy preprocessing the carrier flow instead of embedding in the time interval of randomly determined. Experiments confirm that our proposed watermark embedding technology is effective and can help watermarking scheme more effectively detect stepping-stone intrusion.

Entropy presents different forms in different scenarios, our future work is to apply different forms of entropy to the watermarking schemes, thus providing more effective watermarking scheme.

Acknowledgement

5   References

[1]   Houmansadr A, Borisov N. "SWIRL: A Scalable Watermark to Detect Correlated Network Flows." *NDSS*. 2011.

[2]   Yang J, Woolbright D. Correlating TCP/IP Packet Contexts to Detect Stepping-stone Intrusion [J]. Computers & Security, 2011, 30(6): 538-546.

[3]   Huadong Wang, Jiang Zhong, Ang Li, Network Intrusion Detection Based on Artificial Immune Clustering [J], Journal of Information and Computational Science, 10(10), 2013, 3003-3012

[4]   Laia Q, Linb Y., A Novel Network Intrusion Detection System Based on Bayesian Inference: IDS-BI [J], Journal of Information and Computational Science, 12(11), 2015, 4369-4376

[5]   Xie K, Yang Y, Zhang L, et al. Research of Hierarchical Intrusion Detection Model Based on Discrete Cellular Neural Networks [J], Journal of Information and Computational Science, 10(17), 2013, 5569-5578

[6]   Houmansadr A, Borisov N. Towards Improving Network Flow Watermarks Using the Repeat-accumulate Codes [C], IEEE/ACM Transactions on Networking, Acoustics, Speech and Signal Processing (ICASSP), 2011 IEEE International Conference on, IEEE, 2011, 1852-1855

[7]   Luo J, Wang X, Yang M. An Interval Centroid Based Spread Spectrum Watermarking Scheme for Multi-flow Traceback [J], Journal of Network and Computer Applications, 35(1), 2012, 60-71

[8]   Wang X, Luo J, Yang M. A Double Interval Centroid-based Watermark for Network Flow Traceback [C], Computer Supported Cooperative Work in Design (CSCWD), 14th International Conference on, IEEE, 2010, 146-151

[9]   Pyun Y J, Park Y, Reeves D S, Interval-based Flow Watermarking for Tracing Interactive Traffic [J], Computer Networks, 56(5), 2012, 1646-1665

[10]   Wang X, Chen S, Jajodia S, Network Flow Watermarking Attack on Low-latency Anonymous Communication Systems [C], Security and Privacy, SP' 07, IEEE Symposium on, IEEE, 2007, 116-130

[11] Houmansadr, A., Kiyavash, N., Borisov, N., Non-blind Watermarking of Network Flows, IEEE/ACM Transactions on Networking (TON), 22(4), 2014, 1232-1244

[12] Gong, X., Rodrigues, M., Kiyavash, N., Invisible Flow Watermarks for Channels with Dependent Substitution, Deletion, and Bursty Insertion Errors [J], Information Forensics and Security, IEEE Transactions on, 8(11), 2013, 1850-1859

[13] Huang J, Pan X, Fu X, Long PN Code based DSSS Watermarking [C], INFOCOM, 2011 Proceedings IEEE, IEEE, 2011, 2426-2434

[14] Yu W, Fu X, Graham S, DSSS-based Flow Marking Technique for Invisible traceback [C], Security and Privacy, SP' 07, IEEE Symposium on, IEEE, 2007, 18-32

[15] Jia, W., Tso, F. P., Ling, Z., Fu, X., Xuan, D., Yu, W., Blind Detection of Spread Spectrum Flow Watermarks [J], Security and Communication Networks, 6(3), 2013, 257-274

[16] Wang X, Yang M, Luo J., A Novel Sequential Watermark Detection Model for Efficient Traceback of Secret Network Attack Flows [J], Journal of Network and Computer Applications, 36(6), 2013, 1660-1670

[17] Ma, X., Chen, Y., DDoS Detection Method Based on Chaos Analysis of Network Traffic Entropy [J], Communications Letters, IEEE, 18(1), 2014, 114-117

[18] Shannon C E., A mathematical theory of communication [J], ACM SIGMOBILE Mobile Computing and Communications Review, 5(1), 2001, 3-55

[19] Gomes J V P, Inácio P R M, Freire M M, et al. Analysis of Peer-to-peer Traffic Using a Behavioural Method Based on Entropy [C], Performance, Computing and Communications Conference, 2008, IPCCC 2008, IEEE International. IEEE, 2008, 201-208

[20] Issariyakul T, Hossain E. Introduction to Network Simulator NS2, Springer Science & Business Media, 2011

[21] The CAIDA UCSD Anonymized Internet Traces 2015, Downloadable from http://www.caida.

[22] The CAIDA UCSD Anonymized Internet Traces 2015, Downloadable   from http://www.caida.org/data/passive/passive_2015_dataset.xml/

Review of Security and Privacy Issues in e-Commerce

Mehrdad Ghayoumi

University of Art
Tehran, Iran
mehrdad@ghayoumi.com

Abstract—**Privacy- the control over one's personal data – and security-the struggled access to the data by unauthorized other, are two critical problems for e-commerce consumers. Without either, consumers will not visit or shop at a site, nor can sites function effectively without considering both. This paper reviews the review for privacy and security respectively. We study privacy from social psychological, organizational, technical, and economic perspectives.**

Keywords— Privacy, Security, E-Commerce, Issues, Thechnology, Society.

I. INTRODUCTION

General and public communication, and the benefits of information technologies are rapidly changing our society, economy, and the way we are doing business and in the general our life. Digital business (e-Commerce) means doing business electronically, both within enterprises and externally, using computer networks or telecommunications. The current state of e-commerce is a good example that the supporting technology has not yet reached its full potential. In 1999 Forrester Research predicted a volume of US$ 184 billion of US online retail sales in 2004 [1] whereas the actual value is only approximately US$ 69 billion [2], representing a big gap of almost 167 %. One of the major reasons for the gap between predicted value and actual development that has been suggested by the research community and backed by many studies is simply the lack of trust, privacy and security in digital business. There are many software which try to increase the human securities such as biometric software [47]. A complete review is here[48].

In order for digital business to reach its full potential the obvious conclusion is that either companies involved need to increase the level of confidence and trust provided by them to their customers or technologies need to be created having strong built-in features to protect the individuals' privacy and the security of the digital business transaction[3], [4]. As much as the privacy and security goes higher the usage and the user number goes higher and going to this way, save the energy and time. It can be affected on many thing even on the all types of the energy. This can be even effect on the environment and the green earth. Even assume we have not this and the users does not use it too much, then it make the wasting too much [5].

There are many architecture for satisfying the privacy and security in digital business especially in the e-Commerce. They discussed a dynamic interface that applies Role Based Access Control (RBAC) policies as the output of policy analysis and limits the amount of information that users have access to according to the policies defined for roles. And presenting a dynamic model that adjusts users' security policies based on the level of trust that they hold and use machine learning beside the trust manager component that helps the system to adapt itself, learn from the user's behavior and recognize access patterns based on the similar access requests and not only limit the illegitimate access, but also predict and prevent potential malicious and questionable accesses. [24, 25 and 26].

The growth of Internet usage in some countries is also raising concerns about privacy. The qualities that make computer networks such powerful tools for improving efficiency and living standards also give them amazing power to collect, store, or distribute medical data, financial data, and other personal or biographical information. Many individuals and consumer groups are calling for new privacy safeguards for the Internet and other computer networks. Personal information that may be of interest to businesses or people with malevolent aims is generated whenever people surf the Internet.

Companies, for example, are able to learn a great deal about web surfers who visit their websites. Using tracking devices known as "cookies," companies are able to track purchases and gather personal data. They can use this information to target their marketing efforts at individual consumers or groups of consumers. While some may welcome increased attention to their consumer needs, others may consider it an invasion of their privacy. There is also growing concern about what on-line and conventional stores do with the purchasing or personal data they collect during transactions. Under pressure from consumers, some stores have recently begun to develop privacy policies, but consumer groups say many of these policies fall short [9].

Finally, patients and consumer want to set rules for the sharing of personal medical data. In each of these areas, it will be difficult to slowdown a balance between protecting privacy and ensuring a flow of information and data that can improve quality of life. The same Internet-based tools that can improve education, health, and governance can also cause considerable damage when used for purposes of theft or fraud.

Companies and individual computer users are being increasingly affected by computer viruses and schemes to steal

data or computer identities [10]. Companies are spending enormous amounts of time and money to protect their networks and their data. Recent polls suggest that two thirds of American companies have experienced some form of "cyber-disruption."[11].

In this paper we are discussing the major issues involved. We will start with a general discussion on trust issues, followed by a discussion on the general meaning of privacy and privacy enforcing technologies and will conclude with the current major fields related to providing the security of the underlying technical infrastructures for digital business [17],[18].

The rest of the paper is organized as follows. Security concept, such as technology and social issues are present in the Section 2. Section 3 demonstrates an overall in privacy and technologies and issues. Economic issues in general are presented in Section 4 and the last section concludes the paper.

II. SECURITY

Security is a major concern for e-commerce sites and their clients. Users fear the loss of their financial and secured personal data, and e-commerce sites fear the financial losses associated with break-ins and any other types such this [15]. E-commerce security is the protection of e-commerce assets from unauthorized access, use, alteration, or destruction. Here we mention to the 6 dimensions of e-commerce security:

- **Integrity:** prevention against unauthorized data modification
- **Nonrepudiation:** prevention against any one party from reneging on an agreement after the fact
- **Authenticity:** authentication of data source
- **Confidentiality:** protection against unauthorized data disclosure
- **Privacy:** provision of data control and disclosure
- **Availability:** prevention against data delays or removal

A. Security Technologies

There are many technologies, including cryptographic solutions that can ease the above weaknesses. For a more complete description of each technology, see [13], [16]. In the mass media, the most visible security technologies are the encryption algorithms. For a general introduction to these technologies see [21], [27]; a popularization can be found in [28]. Two classic textbooks are [22], [29], and encyclopedic compendia include [31].

Public key infrastructure (PKI) systems are one such encryption technology [23]. Important PKI-based secure protocols include the retail mechanism Secure Socket Layer (SSL) [32], [33] and the interbank standard suite, ANSI X9 [6], [34]. The PKI is a flexible key-distribution system in which every participant carries two cryptographic keys, one for encryption and one for decryption; together these two keys make up what is called an asymmetric key pair [35], [36]. The encrypting key is published to the world and is called the

participant's public key. The decrypting key is called the private key. The system is characterized by mathematical elegance, efficient scaling features, and theoretically based security guarantees. A performance advantage of PKI is that it does not require a centralized, highly available intermediary for every secured transaction; however, this also makes it difficult to know when another party's key has been stolen or otherwise compromised. As such, PKI often requires a centralized, highly available intermediary for key management, and especially for prompt notification about revoked key-pairs [37]. This issue, the revocation problem, is still unsolved [38], despite the best effort to date [39].

A digital signature is the salient application of public-key cryptography, and is an analog of a handwritten signature. A digital signature is a cryptographic tag that only one author can calculate; the tag can be combined with any kind of data that the author might create; and the tag's validity can be checked by anyone who can access the data. This combination of authored content with the author's identity serves the same purpose as applying one's signature to a paper document; a digital signature can be used to sign contracts, to provide authenticity of an electronic distribution, or to prove identity for access.

B. Social and Organizational Issues in Security

Security, however, is not just a matter of technology; implementing technology without the proper organizational processes will not solve security problems [27]. There are a number of critical social and organizational issues with security. The first is that the weak link in security is often users or employees and the second is software engineering management, or managing how security technology is deployed. The third is the development of adequate organizational processes for risk management, separation of duties, and development of security policies, access control, and security assurance. The ability for hackers to obtain critical authenticity data is well known; it is often called "social engineering". There is research work on understanding user's mental models and motivations, but little on how to deal with the problem. Even keeping up-to-date with all security advisories and security patches is difficult, arguing that merchants should be conservative about undertaking complicated, heterogeneous deployments [30].

III. PRIVACY

Privacy is a serious issue in electronic commerce, no matter what source one examines. Fisher [40] reported "Forty-one percent of Web buyers surveyed last year by Forrester Research of Cambridge, Mass., said they have contacted a site to be taken off their databases because they felt that the organization used their information unwisely."

A Business Week/Harris Poll found that over forty percent of online shoppers were very concerned over the use of personal information, and 57% wanted some sort of laws regulating how personal information is collected and used [41]. Similarly, Culnan [42] argued that privacy concerns were a critical reason why people do not go online and provide false

information online. Why this concern about privacy? The answer is simple. As of 1998, the FTC found that the majority of online businesses "had failed to adopt even the most fundamental elements of fair information practices. Indeed, relatively few consumers believe that they have very much control over how personal information, revealed online, is used or sold by businesses.

The combination of current business practices, consumer fears, and media pressure has combined to make privacy a potent problem for electronic commerce. Tackling privacy, however, is no easy matter. If nothing else, privacy discussions often turn heated very quickly. Some people consider privacy to be a fundamental right; others consider it to be a tradable commodity.

Detailed arguments about the historical progression of privacy can be found, for example, in [43]. We have these types of the privacy:

- **Privacy of the person:** It encompasses the right to keep body functions and body characteristics private;

- **Privacy of behavior and action:** It includes sensitive issues such as sexual preferences and habits, political activities and religious practices;

- **Privacy of communication:** It aims to avoid the interception of communications, including mail interception, the use of bugs, directional microphones, telephone or wireless communication interception or recording and access to email messages;

- **Privacy of data and image**: It includes concerns about making sure that individuals' data is not automatically available to other individuals and organizations and that people can "exercise a substantial degree of control over that data and its use";

- **Privacy of thoughts and feelings**: It refers to the right not to share their thoughts or feelings or to have those thoughts or feelings revealed. Individuals should have the right to think whatever they like;

- **Privacy of location and space**: It means individuals have the right to move about in public or semi-public space without being identified, tracked or monitored;

- **Privacy of association**: It is concerned with people's right to associate with whomever they wish, without being monitored.

There are some security requirements:

- Authentication of merchant and consumer
- Confidentiality of data
- Integrity of data
- Non-repudiation

A. *Privacy Technologies*

Clark [19] divides the technologies in question into 4 groups. Clarke argues there are technologies used for surveillance, the technologies for forming agreements about the release of private data, the technologies for labeling and trust, and privacy-enhancing technologies (PETs). The technologies for surveillance and for data capture are used by companies for business purposes, but they have the side effect of endangering personal privacy. These include generating data trails, data warehousing and data mining, and biometrics. Many of these technical mechanisms can lead to consumer profiles that "are no longer based only on the individual's dealings with a single organization, because their data is shared by multiple merchant. Balancing these tracking mechanisms are privacy enhancing technologies (PETs), which attempt to defeat or neutralize the surveillance or tracking technologies. Basic PETs include cookie managers and personal firewalls.

A new area of research includes the so-called labeling protocols, such as the MIT/World Wide Web Consortium's Platform for Privacy Preferences (P3P) [20, 21, and 22]. P3P allows sites to describe their data handling policies and permits users to describe their preferences for releasing private data. Other technologies, such as those to help users understand predetermined terms or even contract related fraud, will also emerge. Ackerman and Cranor [1] outline one such technology.

If we would like to talk about the security of site some major point can be consider such as:

- Choose a secure ecommerce platform.

- Use a secure connection for online checkout--and make sure you are PCI compliant.

- Don't store sensitive data.

- Employ an address and card verification system.

- Require strong passwords.

- Set up system alerts for suspicious activity.

- Layer your security.

- Provide security training to employees.

- Use tracking numbers for all orders.

- Monitor your site regularly and make sure whoever is hosting it is, too.

- Perform regular PCI scans.

- Patch your systems.

- Make sure you have a DDoS protection and mitigation service.

- Consider a fraud management service. "Fraud does happen".

- Make sure you or whoever is hosting your site is backing it up and has a disaster recovery plan.

B. *Social and Business Issues in Privacy*

Privacy as a business issue is extremely sensitive to changes in the surrounding context. Changes in people's anticipations or in regulatory governance can dramatically alter business issues

and possibilities. Below is an overview of the research and business issues. This will include the consumers' concerns, technical issues, and regulatory attempts to improve privacy concerns. In this examination, our attempt is not to predict what will happen or should happen, but to present issues to guide further research and business activity. Clearly, there are many business opportunities in the changing technical environment.

The use of digital systems allows data capture at a much larger rate and scope than previously; e-commerce sites could potentially collect an immense amount of data about personal preferences, patterns of information search and use, and the like about consumers, especially if aggregated across sites. Not only is it easier than ever to collect the data, it is also much easier to search these data. New computational techniques allow data mining for buying patterns and other personal trends.

These data can be used to personalize a customer's e-commerce experience, augment an organization's customer support, or improve a customer's specific e-site experience. From the viewpoint of customers, many e-commerce sites have done irrational things with their customers' data. Consumers' opinions in this have been confirmed by media stories of particularly privacy failures and public relations nightmares. Broadly speaking, consumers are just confirmed in their opinions by the media. As mentioned, few consumers trust companies to keep their data private.

In one survey, 92% of respondents indicated that even when companies promised to keep personal data private, they would not actually do so. Culnan and Armstrong [44] make the argument that customers have two types of privacy concerns. First, they are concerned over unauthorized access to personal data because of security breaches or the lack of internal controls. Second, consumers are concerned about the risk of secondary use. This includes sharing with third parties who were not part of the transaction in which the customer related his or her personal data. It also includes the combination of a consumers' transaction data and other personal data to create a profile.

Smith, Milberg, and Burke [45] raise two additional concerns based on Delphi studies, general concerns about personal data being collected and concerns over one's inability to correct any errors. A persistent finding, over several decades, is that it is fruitful to consider US consumers not as a general block but as consisting of 3 groups: privacy fundamentalists, the pragmatic majority, and the marginally concerned.

These groupings have been consistent across studies. In Ackerman et al., [1] these groups were 17%, 56%, and 27% of the sample respectively. In [1], the concerns of pragmatists were often significantly reduced by the presence of privacy protection measures such as privacy laws or privacy policies on Web sites Another interesting finding, also quite persistent, is that there is a large gap between most people's stated preferences and their actual behavior. While this is often the case in social studies [12], it is of particular interest here.

IV. Economic Issues

The above presented security either as a technical authoritative or as a set of social and organizational issues; however, it must be stressed that security for both user and site needs an analysis with the proper weighing of potential risk. More importantly, as Anderson points out, security engineering is a matter of control and power as well as access [7, 8]. Security mechanisms can be used to manage compatibility and attempt to control network effects governing the adoption of new or potentially replacing technologies [46].

V. Conclusion

In summary, privacy and security are still ongoing research. There have been some exciting and important findings, however, in the last five years that stand key consequences for e-commerce sites and clients. Privacy is now understood, by many, to be a social structure with potentials the largest consideration. Yet, privacy is also considered a public issue by controllers, who have nonetheless largely allowed technology to unfold to date. Security is now understood to be largely imperfect. Important technical developments have been deployed in the last ten years; however, it is clear that organizational policies may play as an important a role in site security. Looking for the security and privacy issues and try to solve them are the main concern for most companies and organization which the most important things which they have is their information and they vulnerable. Here, we had a brief review on its issues and present some solutions.

References

[1] Ackerman, Mark S., Lorrie Cranor, and Joseph Reagle., Privacy in E-Commerce: Examining User Scenarios and Privacy Preferences. Proceedings of the ACM Conference in Electronic Commerce: 1-8,1999.

[2] Ackerman, Mark S., Trevor Darrell, and Daniel J. Weitzner., Privacy in Context. HumanComputer Interaction, 16 (2-4): 167-176,2002.

[3] Adams, Anne, and Martina Angela Sasse., Users Are Not the Enemy. Communications of the ACM, 42 (12): 40-46,1999.

[4] Adams, C., and S. Farrell., Internet X.509 Public Key Infrastructure certificate management protocols. Internet RFC 2510,1999.

[5] Adams, C., P. Sylvester, M. Zolotarev, and R Zuccherato. , Internet X.509 Public Key Infrastructure data validation and certification server protocols. Internet RFC 3029,2001.

[6] American National Standards Institute., Accredited Standards Committee X9 Working Draft: Public Key Cryptography for the Financial Services Industry: Management of Symmetric Algorithm Keys Using Diffie-Hellman. ANSI X9.42-1993.

[7] Anderson, Ross., Why Cryptosystems Fail. Communications of the ACM, 37 (11): 32-40,1994.

[8] Anderson, Ross., Security Engineering: A Guide to Building Dependable Distributed Systems. New York: John Wiley & Sons.

[9] Anderson, Ross. 2001b. Why Information Security is Hard - An Economic Perspective. Proceedings of the 17th Annual Computer Security Applications Conference,2001

[10] Anderson, Ross, and M. Kuhn., Tamper Resistance - A Cautionary Note. Proceedings of the Second USENIX Workshop on Electronic Commerce: 1-11,1996.

[11] Anderson, Ross, and M. Kuhn., Low Cost Attacks on Tamper-resistant Devices. Proceedings of the Security Protocols, 5th International Workshop: 125-136,1997.

[12] Bernard, H. Russell., Social Research Methods: Qualitative and Quantitative Approaches. Newbury Park, CA: Sage,2000.

[13] Bishop, Matt., Computer Security. New York: Addison-Wesley,2003.

[14] Borisov, N., I. Goldberg, and D. Wagner., Intercepting Mobile Communications: The Insecurity of 802.1. Proceedings of the Seventh Annual International Conference on Mobile Computing and Networking: 180-189,2001.

[15] Brands, Stefan. Electronic Cash. Invited talk, RSA Cryptographers' Colloquium,1996.

[16] Brehl, B., Security of `Cash Cards' Questioned. Toronto Star,. Recommendation X.509: The Directory - Authentication Framework. Data Communications Network Directory, Recommendations X.500-X.521,1997.

[17] Chaum, David., Security without Identification: Transaction Systems to Make Big Brother Obsolete. Communications of the ACM, 28: 1030-1044,1985.

[18] Clarke, Roger., Introduction to Dataveillance and Information Privacy, and Definition of Terms,1999.

[19] Clarke, Roger., Of Trustworthiness and Pets: What Lawyers Haven't Done for e-Business,2001.

[20] Cranor, Lorrie, and Joseph Reagle., The Platform for Privacy Preferences. Communications of the ACM, 42 (2): 48-55,1998.

[21] Cranor, Lorrie F., Web Privacy with P3P. Cambridge: O'Reilly & Associates,2002

[22] Cranor, Lorrie Faith, and Paul Resnick., Protocols for automated negotiations with buyer anonymity and seller reputations. Netnomics, 2: 1-23,2000.

[23] Craver, S., J. McGregor, M. Wu, B. Liu, A. Stubblefield, B. Swartzlander, D. Wallach, D. Dean, and E Felten., Reading between the Lines: Lessons from the SDMI Challenge. Unpublished manuscript, to have been presented at the Fourth International Information Hiding Workshop,2001.

[24] Kambiz Ghazinour and Mehdi Ghayoumi, Dynamic Modeling for Representing Access Control Policies Effect, ICCS, USA, 2015.

[25] Kambiz Ghazinour and Mehdi Ghayoumi, a Dynamic Trust Model Enforcing Security Policies, IPAC, Algeria, 2015.

[26] Kambiz Ghazinour and Mehdi Ghayoumi, An Autonomous Model to Enforce Security Policies Based on User's Behavior, ICIS, USA, 2015.

[27] Treese, G. W., and Stewart, L. C., "Designing Systems For Internet Commerce." New York: Addison-Wesley,1998.

[28] Levy, S., "Crypto: How the Code Rebels Beat the Government-Saving Privacy in the Digital Age." New York: Viking,2001.

[29] Denning, D., "Cryptography and Data Security." New York: Addison-Wesley,1983.

[30] Schneier, B., The Security Patch Treadmill. Crypto-Gram Newsletter, 2001.

[31] Schneier, B,. "Applied Cryptography." New York: John Wiley & Sons,1996.

[32] Dierks, T., and Allen, C. The Transport Layer Security Protocol. Internet RFC 2246,1999.

[33] Rescorla, E., and Schiffman, A., "The Secure HyperText Transfer Protocol." InternetDraft, version 1.1,1995.

[34] RSA Security, "What Are ANSI X9 Standards?" Cryptography FAQ,2003.

[35] Diffie,W., and Hellman, M. New Directions in Cryptography. IEEE Transactions on Information Theory 22(6):644-654,1976.

[36] Rivest, R., Shamir, A., and Adelman, L. A Method for Obtaining Digital Signatures and Public-Key Cryptosystems. Communications of the ACM 21(2):120-126,1978.

[37] Adams, C., and Farrell, S. Internet X.509 Public Key Infrastructure Certificate Management Protocols. Internet RFC 2510,1999.

[38] Davis, D. Non-linear Complexity of Revocation-checking. Post to the Cryptography Mailing List, Nov. 11, 1998.

[39] Myers, M., Ankney, R., Malpani, A., Galperin, S., and Adams, C., X.509 Internet Public Key Infrastructure Online Certificate Status Protocol—OCSP. Internet RFC 2560,1999.

[40] Fisher, S. Privacy By Design. *InfoWorld* **23**(27):20-22,2001.

[41] Harris Poll. Online Privacy: A Growing Threat. *Business Week*,2000.

[42] Culnan, M. J. Protecting Privacy Online: Is Self-Regulation Working? Journal of Public Policy and Marketing 19(1):20-26,2000.

[43] Davies, S.G. , Re-Engineering the Right to Privacy: How Privacy Has Been Transformed from a Right to a Commodity. In "Technology and Privacy: The New Landscape", pp. 143-165. Cambridge, MA: MIT Press, 1997.

[44] Culnan, M. J., and Armstrong, P. K. ,Information Privacy Concerns, Procedural Fairness and Impersonal Trust: An Empirical Investigation. Organization Science 10(1):104-115, 1999.

[45] Smith, H. J., Milberg, S. J., and Burke, S. J. ,Information Privacy: Measuring Individuals' Concerns about Organizational Practices. MIS Quarterly, 167-196, 1996.

[46] Shapiro, C., and Varian, H. R. "Information Rules." Cambridge, MA: Harvard Business School Press, 1999.

[47] H. Abrishami Moghaddam and M. Ghayoumi "Facial Image Feature Extraction Using Support Vector Machines", Proc. VISAPP,Setubal, Portugal, 2006.

[48] Mehdi Ghayoumi, A Review of Multimodal Biometric Systems Fusion Methods and Its Applications ICIS, USA, 2015.

SESSION

CLOUD COMPUTING, INTERNET COMPUTING, AND COMPUTER TOOLS AND APPLICATIONS

Chair(s)

TBA

Personal File Backup in Cloud

J. Perry[1] and D. Yoon[2]
[1,2]CIS Department, University of Michigan, Dearborn, MI, USA

Abstract - A personal file backup in cloud system is designed and implemented using Windows Communication Foundation (WCF) which is part of the .NET Framework. WCF was designed for building distributed systems giving good interoperability with various clients and services.

Keywords: Client, Server, Address, Binding, Contracts (ABCs), *X*ML, WSDL

1   Introduction

Information technology has become an important part in most people's lives. Technology has evolved quite a bit over a short period of time. We have seen the home computer revolution of the 1980s all the way through the current tablet computer and smartwatch craze. People can be quite lost without their gadgets which are becoming more and more interconnected as time goes on. A trend that this evolution has is accessibility to information. For keeping our personal files with us, we have evolved from using floppy discs to USB flash drives to storing the information in the cloud.

One of the benefits of cloud computing is being able to sync and access files remotely [1]. This is a lot more convenient than carrying around a USB flash drive which is easily lost or forgotten. Even if you had one, such a drive might not fit the machine you're using such as the newest Apple MacBook which has a USB-C port and would need an adapter to work with a USB 2.0 or 3.0 drive. A cloud solution simply needs a device and Internet access. Several commercial solutions exist from various companies such as Dropbox, Google Drive, Microsoft OneDrive, Box, Apple iCloud and many more [2].

While syncing files remotely is convenient, it does come with its own concerns. Internet access is very common but is still not always available. It might also be limited such as when using a cell phone as a hotspot. You could go over the data cap really fast if you're not careful. Client applications might not be available for less popular or newer systems like Linux or a tablet. The amount of on-line storage space you get from any of the companies is limited and you may require additional money for a monthly subscription.

Another concern, and one that is a hot topic today, is security [3]. Baber and Chauhan (2011) wrote "One of the key considerations of using public cloud is the security of data that is stored on the public cloud" [4]. The concerns include the security of sending and receiving files to ensure no one intercepts and/or alters the files in transit. It also

includes the security of the files on the host machine making sure no one else has access to them. Many services say they offer encryption but if they hold the key, a rogue employee or other party could potentially have access to the files. You would additionally have to trust the hosting provider of the service as well. Any number of clients can connect to the server and sync with it. This is advantageous for a single person with multiple machines or multiple people wanting to share files.

2   Program Description

This project addresses the need for a backup solution without having to rely on a third-party. It allows a user to backup one or more clients to a server he/she controls and keep each device in sync. This project is designed to allow a user to have a personal file backup server running and waiting for clients to access it. Once the client program is started, it has two options. The first option is to download a fresh copy of previously synced files from the server to the client's sync folder called FileSyncClient, deleting anything that may have been there previously or creating the directory if it doesn't already exist. The second option is to initiate a synchronization process to let the client and server process any changes that may have been made since the last sync. After the sync process is finished, the program continues to watch the client's sync folder for any changes and notifies the server if any are found.

More than one client can be running at any given time. The process each client goes through is the same as just described. Changes from each client are sent to the server with newer changes overwriting older ones if the same file is affected. To minimize data and power usage, the client only retrieves changes from the server if the sync button is pressed which the user can do at will.

2.1   Implementation Overview

This project was written in Microsoft Visual C# 2010 (version 4.0) using Microsoft Visual Studio 2010 Professional (version 10). The server program targets .NET Framework 4 and the client program targets .NET Framework 4 Client Profile. Debugging in OS X of the Windows Forms client program was done on a MacBook Pro in Xamarin Studio 5.9.4, the successor to MonoDevelop, with Mono 4.0.2 installed.

Programming a Web service is made much easier by using a framework. Principe and Yoon (2015) wrote, "Without a framework, a significant part of a programmer's

time is spent on coding standard services such as caching, persistence and security" [5]. It also allows for easier interoperability by taking care of the lower level details allowing the programmer to build on it to make the final program. As mentioned, I chose to use the .NET Framework which "is an application development platform that provides services for building, deploying, and running desktop, web, and phone applications and web services" [6]. It was developed by Microsoft and is common on Windows. It consists of the Framework Class Library and the Common Language Runtime (CLR). The CLR is Microsoft's implementation of the Common Language Infrastructure (CLI) which serves as a virtual machine and executes the instructions of any of several compatible languages such as C#, C++/CLI and Visual Basic [7]. The .NET Framework has a huge library of reliable and reusable code and includes memory management and services that makes application development a lot easier. Microsoft made much of the framework open allowing other implementations of .NET.

Mono is an open source project that provides cross-platform implementations of Microsoft .NET applications. It runs on various operating systems such as Android, Linux, OS X, and others. Mono doesn't fully support all aspects of the .NET framework but does support a large part of it [8]. For instance, while Windows Communications Foundation is supported, I found certain parts of it are not as discussed later in the security section.

For the Web service, the project utilizes Windows Communication Foundation (WCF) which is part of the .NET Framework. WCF was designed for building distributed systems giving good interoperability with various clients and services. Figure 1 illustrates how the client and server interact. The client's proxy stands in for the service, connecting to the service's endpoint and invokes the operations. The settings for the lower level details of things such as the address, binding, and security are specified in the configuration files, Web.config in the case of the server running in IIS and app.config in the client. Servers and clients must agree on the "ABCs" which is a mnemonic for address, binding, and contract. The address describes where the service is located. The binding specifies the network protocols, the encoding method used, whether security is used, and the transport layer. The contract describes each method exposed in the WCF service [9].
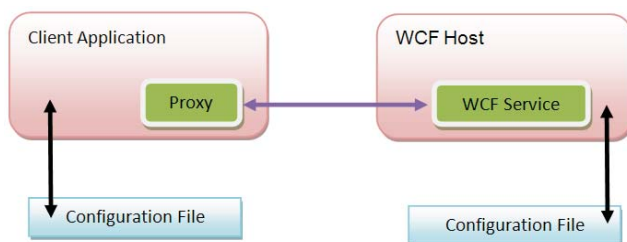

Figure1 A high-level look at a typical WCF application

Messaging is handled by Simple Object Access Protocol (SOAP). It is a standardized way to exchange information in a Web service through a protocol such as HTTP or TCP using Extensible Markup language (XML) which is a set of rules for encoding documents that is both human and machine readable. All data is sent between the client and server using a SOAP envelope. Data is serialized (converted) between XML and .NET Framework objects when it passes through the network. Metadata for the Web service is contained in the Web Services Description Language (WSDL) document which is auto-generated. That document also uses XML and its purpose is to describe the functionality of the Web service. The aforementioned client proxy can be generated from the WSDL document. In short, "WCF implements interoperable SOAP-based Web services, complete with cross-platform security, reliability, transactions, and more" [10].

While TCP could have enhanced the performance, HTTP was used instead to maximize compatibility with clients that may be written in other languages (such as Java) on other platforms. While HTTP performed well in the tests, WCF is versatile enough to allow TCP to be implemented later alongside HTTP if desired.

3   Requirements

Feature	Description
Connect to Server	The client will be able to connect to the server if it's running
Initialize Folder	The folder FileSyncClient will be created if not present
Create File	The user will be able to create a file in the FileSyncClient folder (or a subdirectory within it) and have it uploaded to the server
Create Folder	The user will be able to create a subdirectory within the FileSyncClient folder (or a subdirectory within it) and have the server create it as well
Delete File	The user will be able to delete a file in the FileSyncClient folder (or a subdirectory within it) and have the server delete it as well
Delete Folder	The user will be able to delete a subdirectory within the FileSyncClient folder (or a subdirectory within it) and have the server delete it along with any files and folders contained in it as well
Rename File	The user will be able to rename a file in the FileSyncClient folder (or a subdirectory within it) and have it renamed on the server
Rename Folder	The user will be able to rename a subdirectory within the FileSyncClient folder (or a subdirectory within it) and have the server rename it as well

Modify File	The user will be able to modify a file in the FileSyncClient folder (or a subdirectory within it) and have the modified file uploaded to the server
Watch for Changes	After syncing with the server, the client will continue watching the FileSyncClient folder including any subdirectories within it for changes and notify the server automatically so it can make the same changes
Receive File	The client will be able to receive one or more files from the server and create them locally within the FileSyncClient folder (or a subdirectory within it) and create the subdirectory if necessary
Receive Folder	The client will be able to create a subdirectory within the FileSyncClient folder when notified by the server

Table 1 Requirement for the client application

The client's basic responsibilities are outlined in Table 1. The server has the same abilities of creating, renaming, and deleting files and folders. It's also responsible for comparing the files and folders the client has with what the server itself has and sends instructions back to the client to get the files in sync if they don't all already match by sending or requesting select files. The server stores the synced files in the Data folder. Other housekeeping files are stored in the DataInternal folder.

This project can support any reasonable number of clients connecting to the server simultaneously and the server can be run on different machines by modifying the service address in the client's configuration file and setting the server up on the other machines. File exchange between the server and client happen in a fairly reliable, timely and efficient manner.
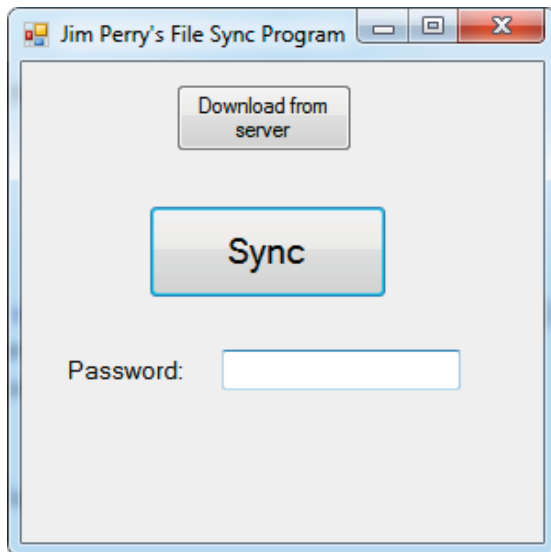

Figure 2 Client user interface

3.1   Description of Client

The client program is written as a Windows Forms application. As mentioned, the client stores synced files in the FileSyncClient folder. That is located in the Environment.SpecialFolder.MyDocuments path of the platform used. In Windows 7, it sets it up in the user's Documents folder. In OS X 10.10 it sets it up in the user's Home folder. The client methods are as follows:

DownloadButton_Click_1()
This is for the "Download from server" button in the client's user interface. Its purpose is to check for a connection to the server, then create the FileSyncClient folder if it's not already present, wipe anything already in it if it does exist, and download all files and folders, if any, from the server. In essence, it starts over with a fresh copy of files. This is useful if the client's files got corrupted or accidentally deleted. It's also useful when setting the program up on a new machine (after the first one) to get it synced with files already existing on the server.
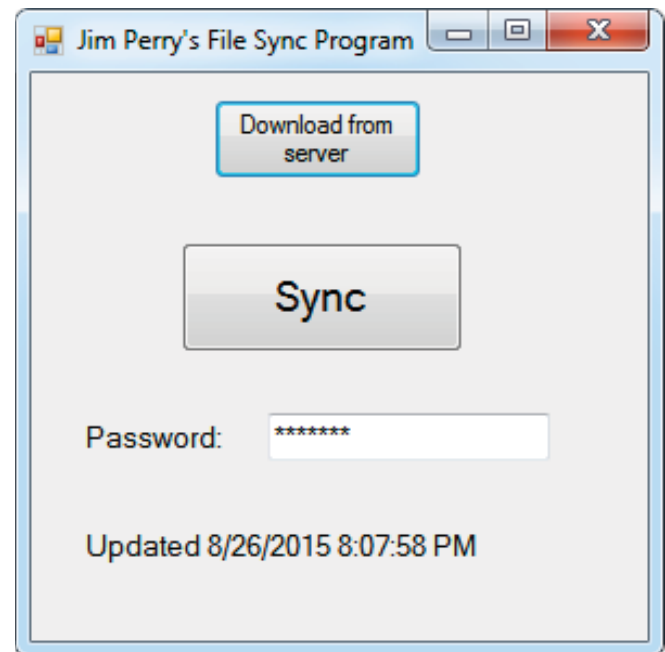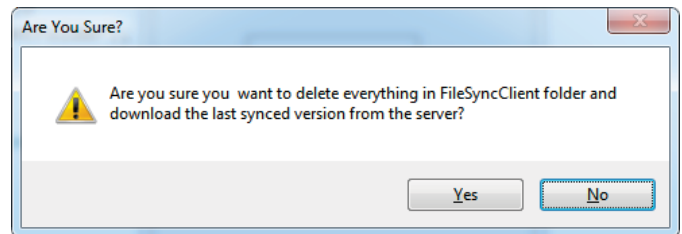

Figure 3 Error Message

syncButton_Click()

This is for the "Sync" button in the client's user interface. It will be the most used button of the two. It disables the "Download from server" button, checks for a connection to the server, creates the FileSyncClient folder if it's not already present, syncs files and folders with the server, then watches the folder and its subfolders for changes. The client program uses FileSystemWatcher to monitor changes in the sync directory. Changes are noted and instructions are sent to the server to bring the changes in sync.

If the server doesn't respond when either button is pressed, the user is notified. The user is also notified if the proper password wasn't given.

Figure 4 Error message

ServerConnection()

This checks to see if the server is online and responding. It also puts "Server not responding" or "Incorrect password" in the message label if needed.

SendNamesAndDates()

This gets a listing of all the files and folders in the client's sync folder and invokes client.CompareNamesAndDates() on the server sending it the list and the machine's name.

GetFileInfo()

This puts the name and modified date of files in a list. It's called by SendNamesAndDates().

WatchSystem()

This continuously monitors the sync folder for changes. It's called by syncButton_Click().

OnChanged()

This processes changes that are monitored, specifically files that are created, deleted, or modified. It's called by WatchSystem().

OnRenamed()

This processes changes that are monitored, specifically files or folders that are renamed. It's called by WatchSystem().

OnError()

This handles errors from WatchSystem().

GiveFileToServer()

This takes the full path name of a file, builds FileBackup.myFile and uploads it to the server calling client.UploadDocument(). It's called by MakeChanges(), ProcessInstructions(), and UploadFilesAndFolders().

iveDirectoryToServer()

This makes a directory on the server or updates it if it already exists by calling client.MakeSubdirectory(). It's called by MakeChanges(), ProcessInstructions(), and UploadFilesAndFolders().

UploadFilesAndFolders()

This takes a directory path and uploads it along with any files and subdirectories. It's called by MakeChanges(), OnChanged() and OnRenamed().

GetSubDirectories()

This gets a list of all the subdirectories of the specified folder and can optionally include the parent directory being brought in. It's called by UploadFilesAndFolders() and SendNamesAndDates().

StripRoot()

This has two overloaded methods which have the purpose of stripping out everything through FileSyncClient in the name.

ProcessInstructions()

This deals with the Get, Give, and Delete commands from the server. It's called by SendNamesAndDates().

InternalDeleteFileOrFolder()

This deletes the file or folder specified including any subdirectories if present. It's called by ProcssInstructions().

MakeDocument()

This is for the client to make a file received from the server. It's called by ProcssInstructions().

MakeSubdirectory()

This is for the client to make a directory received from the server. It's called by ProcssInstructions().

SetTextCallback()

This delegate enables asynchronous calls for setting the text property of a label.

SetMessageText()

This makes a thread-safe call to set messageLabel.Text. It's called by syncButton_Click() and UploadFilesAndFolders().

SetErrorText()

This makes a thread-safe call to set errorLabel.Text. It's called by many methods.

ValidateServerCertificate()
This checks the server's SHA1 hex fingerprint of the self-signed certificate against the known good values. If an SSL certificate from a trusted authority is used, this method would not be needed.

3.2 Description of Server

The server program is written as a WCF service within a class library. It has the files FileBackup.cs and IFileBackup.cs. The interface is located in that second file and is decorated with the [ServiceContract] attribute which turns the interface into a WCF service. The publicly exposed methods (and therefore available to the client) are decorated with the [OperationContract] attribute. Those methods are:

- DownloadDocument()
- UploadDocument()
- ServerConnection()
- MakeSubdirectory()
- DeleteFileorFolder()
- MoveFile()
- CompareNamesAndDates()
- GetAllFilesAndFolders()

A custom datatype is specified using the [DataContract] attribute. This allows it to be serializable. It's a public class called myFile and has six data members decorated with the [DataMember] attribute. It allows all information about a file to be stored as one unit including its name, content, file creation date, file modified date, whether it's a directory or not, and any instructions from the server to the client about the file. The server methods are as follows:

DownloadDocument()
This public method allows the client to download a file from the server. The client only requests a file after the server sends the comparison results.

UploadDocument()
This public method allows the client to send a file to the server.

ServerConnection()
This public method allows the client to confirm the server is running.

MakeSubdirectory()
This public method allows the client to have the server make directories that the client has on its device when changes are detected.

DeleteFileorFolder()
This public method allows the client to have the server delete a file or folder.

InternalDeleteFileorFolder()

This deletes files and recursively deletes folders. It's called by DeleteFileorFolder().

MoveFile()
This public method allows the client to have the server move or rename a file.

CompareNamesAndDates()
This public method allows the server to check to see if it has the files the client has and ensures that it has the same timestamp on the file. This is the method that initiates the sync process.

GetAllFilesAndFolders()
This public method allows the client to begin anew by downloading all synced files from the server.

CompareFiles()
This compares the client and server files adding instructions to let the client know whether to give or get particular files that don't match. It's called by CompareNamesAndDates().

SeeIfDeleted()
This sees if a client file or folder has been deleted on the server, possibly by another client. It uses that information to let the client know to delete it or give the file to the server. It's called by CompareFiles().

ProcessRestOfFiles()
This deals with files the server has but the client doesn't have. They could be new from another client or they could have been deleted by the client currently connected when it wasn't connected (and therefore didn't notify the server). It's called by CompareNamesAndDates().

GetNamesAndDates()
This makes a list of the folders and files on the server along with the modified date. It's called by CompareNamesAndDates().

GetFileInfo()
This puts the name and modified date of files in a list. It's called by GetNamesAndDates().

GetSubDirectories()
This gets a list of all the subdirectories of the specified folder and can optionally include the parent directory being brought in. It's called by UploadFilesAndFolders().

DeletionLog()
This adds deleted files to a log to keep track of them. Only the last 100 files are kept to keep it from getting overly large. It's called by InternalDeleteFileorFolder() and MoveFile().

StripRoot()
This has two overloaded methods which have the purpose of stripping C:\Data\ out of the name.

LastSync()
This updates a file to let the server know when the client last synced. It's called by many methods.

3.3   The DataInternal folder

As mentioned, the server keeps the synced files in the Data folder. It keeps other files in the DataInternal folder. One item in it is a file with the machine name. The server creates it and puts the time the last sync occurred in it. This lets the server know when it last interacted with that particular client (assuming all machines have unique names). It's helpful when determining things like whether it's likely the connected client deleted a particular file that the server has but the client doesn't. The client gives the server its machine name by passing along Environment.MachineName when it syncs.

Another file is "clientInfo.txt" which keeps a log of the date and time each sync occurred along with the username used to gain access. That file is simply informational.

The file "DeletionLog.txt" is also in the folder and as mentioned earlier, it is a listing of the last 100 file and folder deletions. It helps the server determine if a file it does not have has been possibly deleted by another client. If so, it instructs the connected client to delete it as well. If not, it instructs the client to send it the file.

The last file in that folder is "message.txt" which is a log of errors encountered by the server.

3.3.   Taking It Cross-Platform

As mentioned earlier, the program is written in C# using the .NET Framework which has been made cross-platform through implementations like Mono. I regularly use a Windows-based desktop computer as well as an OS X-based laptop so find having the same program being used in both operating systems a very useful feature.

I ran the Mono Migration Analyzer (MoMA) version 2.4 to check the compatibility of the client program with Mono. MoMA helps to identify possible issues with .NET applications when running in Mono [11]. The results of the tool didn't show any problems that wouldn't prevent it from running.

Once Mono is installed in OS X, the client program is run by opening a terminal window, navigating to the folder with the program, and typing mono "FileBackup Client.exe" and waiting a bit for the program to start. It can take over a minute to start the first time it is run on the machine but subsequent runs are much faster.
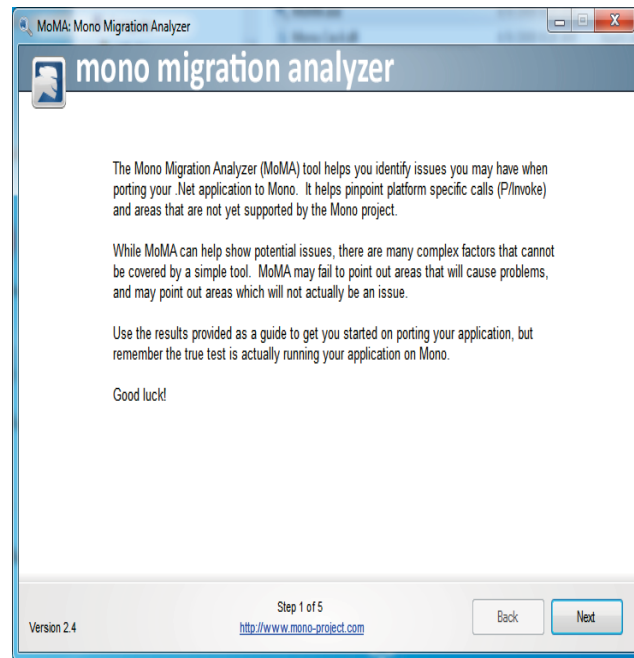

Figure 5 Mono Migration Analyzer

Some debugging was done using Xamarin Studio. When opening the Visual Studio solution in Xamarin Studio on the Mac, I found it necessary to clean and rebuild the solution in order to use the breakpoints to aid in debugging but once I did it worked just fine.

4   Security

As mentioned in the introduction, security is a hot topic today. Chen, Paxson, & Katz (2010) wrote "… security has emerged as arguably the most significant barrier to faster and more widespread adoption of cloud computing" [12]. WCF supports various options of securing the Web service. When first programming and testing on Windows machines, I used the WSHttp binding and Message Transmission Optimization Mechanism (MTOM) for the encoding. WSHttp uses Message security by default and MTOM was chosen because in larger files, it transmits less data than Text message encoding. Unfortunately I found that Mono doesn't support those settings so BasicHttp binding and Text encoding were used instead. Those settings would be more interoperable than the former ones. BasicHttp binding doesn't secure the SOAP message by default but security in this project is still achieved by using Transport security mode [13] which uses Secure Sockets Layer (SSL) over HTTP, more commonly known as HTTPS, to secure the SOAP message. HTTPS provides confidentiality (prevention of eavesdroppers), integrity (prevention of altered contents), and prevention of replay attacks for the SOAP message. The HTTP (non-encrypted) port was disabled in IIS. Transport security does have the advantage of being less computationally complex (and therefore faster) than Message security.

Authentication (ensuring only authorized users have access) is achieved through setting the ClientCredentialType to Basic which lets the client authenticate using a username and password of a Windows user that is on the host machine. I chose to hardcode the username for this project though that can be easily changed for additional security. Anonymous access was disabled in IIS for this project. Since preinstalling the self-signed certificate in each client is not very convenient, the server's X.509 certificate is inspected by the client by comparing the SHA-1 hash fingerprint with the known good values that are hardcoded in the client's program. That won't be necessary if a commercial certificate is used from a trusted authority. The client could simply verify the chain of trust of the certificate. The default HTTPS port number 443 was kept to prevent possible port blocking by hotels and other businesses as they don't normally block common ports but have been known to block others. A check with Fiddler debugging proxy [14] confirmed the communication exchange was being encrypted.

5   Server Hosting

The test server for this Web service is being hosted in Internet Information Services (IIS) 7.5 running in Windows 7 Ultimate. Anonymous authentication was disabled (and others were already disabled) so it would only authenticate using Basic access authentication (with a username and password on the machine). It was also set to require an SSL connection.

The endpoint address for the WCF client is in the app.config file. To make the server easy to find, I put a subdomain I own, pc.littlechoir.org, into the client's app.config file so it could easily find the test computer that the server is hosted on rather than having to use an IP address. The full endpoint address is https://pc.littlechoir.org/FileBackup/FileBackup.svc. I run a program, NameCheap Dynamic DNS Client, on the server to update the DNS servers with the proper IP address of the host computer which takes care of changing IP addresses on my account. The router forwards port 443 to that computer.

Internet Information Services (IIS) 6.0 Resource Kit Tools was downloaded from Microsoft.com to use SelfSSL to create a self-signed certificate with the common name (host name) pc.littlechoir.org to use for the SSL connection. SSLShopper [15] provided nice instructions on how to make and install it in IIS. IIS has the ability to create an SSL certificate but it doesn't allow you to specify the host name when creating it.

The service is compiled into a class library (DLL) file and placed within the IISHost\bin subdirectory of the project. A service file (FileBackup.svc) identifying the service type and the configuration file (Web.config) are placed in the IISHost subdirectory.

The Web.config and app.config files were modified to increase the maxReceivedMessageSize size to 50000000 (measured in bytes) in order to accommodate larger files.
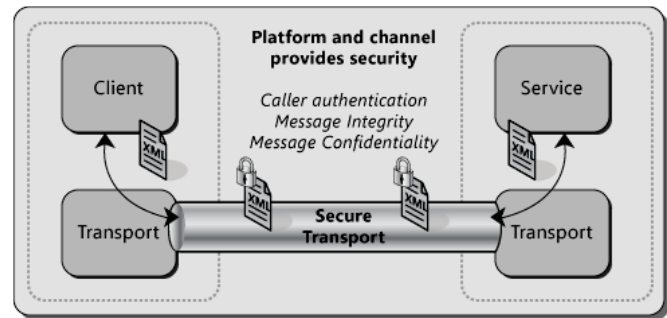

Figure 6 Transport Security

The client program is written as a Windows Forms (WinForms) application. WinForms is part of the .NET Framework and offers an easy way to make an application with a graphical user interface (GUI). Mono makes it possible to run the WinForms program in OS X (as well as other operating systems).

6   Steps in Programming the WCF Service

For anyone new to Windows Communication Foundation services, it would be helpful to include the beginning steps to get one going from scratch. The basic steps were as follows.

Server

In Visual Studio:

1. File -> New -> Project -> Class Library -> (Name it)
2. Delete the Class1.cs file that is auto generated
3. Right-click on the project -> Add -> New Item -> WCF Service -> (Name it)
4. Program away in the code and the interface .cs files

Client

In another instance in Visual Studio:

1. File -> New -> Project -> Windows Forms Application -> (Name it)
2. Right-click on References -> Add Service Reference -> (Put in the address) -> Go -> (It should find the service)
3. (Give it a meaningful namespace) -> OK
4. Design the form and code
5. Update app.config if needed

Preparing the Server Solution for Hosting in *IIS*

In the server solution:

1. Right-click on the solution -> Add -> New Web Site
2. WCF Service (For Visual C#) -> Browse -> (Navigate to the server solution folder) -> Open -> (Name it)
3. Delete IService.cs and Service.cs

4. Right-click on the host project -> Add Reference -> (Make sure the correct service project is selected) -> OK
5. Rename Service.svc to something meaningful if desired -> Open it -> Delete the CodeBehind section
6. In the .svc file, change the Service attribute to the fully qualified name of the service (such as FileBackup.FileBackup)
7. Update the Web.config file with the address, binding, contract, and other items needed

Preparing *IIS*

You may have to turn IIS on in Control Panel -> Programs and Features -> Turn Windows features on or off -> Internet Information Services. There are many checkboxes to choose from and I probably have some checked that aren't strictly necessary for this service. That being said, the ones I have checked are as follows:

Web Management Tools

- IIS Management Console

World Wide Web Services
- Application Development Features
  - .NET Extensibility
  - ASP.NET
  - ISAPI Extensions
  - ISAPI Filters
- Common HTTP Features
  - Default Document
  - Directory Browsing
  - HTTP Errors
  - Static Content
- Health and Diagnostics
  - HTTP Logging
  - Request Monitoring
- Performance Features
  - Static Content Compression
- Security
  - Basic Authentication
  - Request Filtering

1. Launch IIS by typing inetmgr in the run box
2. Expand the root node and sites
3. Right-click on Default Web Site -> Add Application -> Type an Alias
4. Change the Application pool to ASP.NET v4.0
5. Navigate to find the Physical path of the service (the IIS project folder within the server solution)
6. Click OK

7. To see it, highlight the service under the Default Web Site, switch to Content View (at the bottom) -> Right-click on the service -> Browse

Securing the Service in *IIS*

1. Highlight the service -> Make sure Features View is selected -> Open Authentication
2. Disable all authentication methods except Basic Authentication. (If you don't see it, make sure it's selected as a feature in Control Panel)
3. Highlight the service again -> Open SSL Settings
4. Check Require SSL and Accept client certificates
5. Highlight the root node above Default Web Site -> Open Server Certificates
6. On the right side, click Create Self-Signed Certificate. (Alternatively, make one using SelfSSL as I did and import it)
7. Give it a friendly name and click OK
8. Highlight Default Web Site and click Bindings on the right side
9. Click Add -> Select https -> Select the SSL certificate created (or imported) -> OK -> Close
10. Remember that security mode="Transport" and transport clientCredentialType="Basic" must be added to the server's Web.config file. Additionally, serviceMetadata httpGetEnabled="true" needs to be changed to serviceMetadata httpsGetEnabled="true"
11. The client application's service reference will need to be changed to the new https address and the username and password will need to be passed along in the client's code.
12. On the host machine, I also created a new basic (non-administrator) user for this project. You can use the Computer Management console (right-click on Computer and choose Manage) to remove all privileges from the user by deleting the items in the Member Of tab for the user.

7 Conclusion

In this project, C#, Windows Communication Foundation, Internet Information Services, and aspects of utilizing the very powerful .NET Framework have been employed. The ease at which a program can be made cross-platform was exciting to learn as well

A security researcher, Steve Gibson, has the motto "Trust no one" [16]. Having a way to backup files from and to one's own computers helps the user avoid having to trust a third-party service to keep the files safe and secure on servers that could be located anywhere in the mysterious cloud. Whether they are State secrets or the day's weather forecast, they're still worth keeping secret. Even search engines like Google and Yahoo provide SSL protection by default no matter what you're searching for.

Since the user is only limited by the size of the hard drive in the computer, ample storage can be provided for the low cost of electricity for the computer (almost free) whereas

you could spend a lot of money each month using a third-party service. I'm sure this project will be of use to others and I have enjoyed working on it. Thank you.

8   References

[1]   Griffith, E.   2015.   What is Cloud Computing? http://www.pcmag.com/article2/0,2817,2372163,00.asp

[2]   Casserly, M.   2015.   13 best cloud storage services 2015: Dropbox vs Google Drive, OneDrive, iCloud & more. http://www.pcadvisor.co.uk/test-centre/internet/best-cloud-storage-dropbox-google-drive-onedrive-icloud-3506734/

[3]   You, P., Peng, Y., Liu, W., & Xue, S. (2012, June). Security issues and solutions in cloud computing. In Distributed Computing Systems Workshops (ICDCSW), 2012 32nd International Conference on (pp. 573-577). IEEE.

[4]   Babar, M. A., & Chauhan, M. A. (2011, May). A tale of migration to cloud computing for sharing experiences and observations.   In Proceedings of the 2nd international workshop on software engineering for cloud computing (pp. 50-56). ACM.

[5]   Principe, M. and Yoon, D. 2015. A Web Application Using MVC Framework. Int'l Conf. e-Learning, e-Bus, EIS, and e-Gov. pp. 10-15. EEE'15

[6]   .NET Framework 4.   https://msdn.microsoft.com/en-us/library/w0x726c2(v=vs.100).aspx

[7]   .NET Framework. https://en.wikipedia.org/wiki/.NET_Framework

[8]   Mono (software). https://en.wikipedia.org/wiki/Mono_(software)

[9]   Troelsen, Andrew. 2012. Pro C# 5.0 and the .NET 4.5 Framework, Sixth Edition. Apress, New York. pp. 985-1045.

[10]   Chappell, D. 2009. Introducing Windows Communication Foundation in .NET Framework 4. https://msdn.microsoft.com/en-us/library/ee958158.aspx

[11]   MoMA. http://www.mono-project.com/docs/tools+libraries/tools/moma/

[12]   Chen, Y., Paxson, V., & Katz, R. H. (2010). What's new about cloud computing security. University of California, Berkeley Report No. UCB/EECS-2010-5 January, 20(2010), 2010-5.

[13]   Transport Security Overview. https://msdn.microsoft.com/en-us/library/ms729700(v=vs.100).aspx

[14]   Fiddler. http://www.telerik.com/fiddler

[15]   How to Create a Self Signed Certificate in IIS 7. https://www.sslshopper.com/article-how-to-create-a-self-signed-certificate-in-iis-7.html

[16]   Security Now! Transcript of Episode #350: Q&A #142 / Cloud Security. https://www.grc.com/sn/sn-350.htm

The E-Note-Keeping Tool: Thoughtful

T. Simmons[1] and Z. Wang[2]
Department of Computer Science, Virginia Wesleyan College, Norfolk, Virginia, USA
[1]tomasimmons@gmail.com
[2]zwang@vwc.edu

Abstract – *Today's popular note-keeping tools do not offer a simple way for users to easily track the relationship of different ideas. Thoughtful addresses this problem by allowing users to create notes and correlate them, preserving the intuitive relationships that exist between concepts. Thoughtful is divided into a server-side API and a user interface such that neither aspect is dependent on the other, communicating via standardized data without presentation logic. Any application can therefore integrate the API without specifically needing to use the online user interface. Vendors may store data on the server and present information to their own users how they see fit, allowing Thoughtful to be a much more flexible tool than if it were married to its user interface.*

Keywords: Information Systems, Note-Keeping Tool, Server-Side API, REST

1   Introduction

Thoughtful is a relational note-keeping software designed to help users organize and manage ideas. Currently, many applications provide rich text formatting and review tools (such as spell-checking), but they typically lack strong organizational components. Such applications either provide no real means to compartmentalize and abstract information or shoulder the burden of such organization on the user. For instance, the online note-keeping tool Evernote allows users to categorize their thoughts into separate notebooks, and to further organize their thoughts within each notebook as notes, which are detailed text files of arbitrary length on a subject. However, this application's organization system buckles when the volume of data increases; as the number of notebooks and their accumulated notes increases, so increases the effort necessary to retrieve information. This particular shortcoming is repeated across most note-keeping environments; they lack scalability.

Thoughtful aims to address this problem by organizing notes into a highly scalable data structure and providing users an intuitive way to navigate that structure. Users are able to create note pages that are in and of themselves the organizational unit in the Thoughtful system. Each note page is able to be explicitly linked to other note pages by

the user, creating a relationship in the system that is exposed to the user. This allows users to quickly navigate between related pages of notes, organize information in any arbitrary way, and simultaneously abstract information away and access it easily. Notes are indexed to allow rapid searching, helping users find any pages they might have difficulty locating. Furthermore, by allowing users to correlate notes based on their content, the system implicitly mimics the natural thought process of the user, culminating in a web of information that is inherently simple to navigate by virtue of accurately reflecting the user's thoughts.

2   System Design

The Thoughtful system can be logically categorized into two distinct components: the server-side API and the browser-based client that implements it.

The server-side API exports Thoughtful's functionality by interpreting URL strings from client requests as instructions and sending responses back to the client based on those instructions. These instructions are implemented by executing PHP scripts and accessing a MySQL database, the former handling logical execution and the latter storage of information. Every response issued by the server is sent as a standardized plain-text encoding of raw data devoid of presentation logic, which must be interpreted by the client and rendered as desired.

The browser-based client is a single-page application that presents a simple graphical interface for the Thoughtful API, built with HTML, CSS, JavaScript, and the JQuery library. By manipulating the client's interface, users trigger the client to send requests to the API server. Data received in responses from the server are then interpreted by the client, allowing the client to determine how to present the raw information the server has sent to it. New data is rendered on the fly in HTML as necessary. Since the client's primary responsibility is mediating between the user and the API server, we will continue our discussion of the Thoughtful system by exploring the API server at length before considering the inner workings of the client.

2.1   Server Architecture

The Thoughtful API is mostly structured according to RESTful design principles. REST, or Representational State Transfer, is an architecture focused on a system's resources that utilizes stateless data transfers, divides system functionality into mostly distinct logical units ("resources"), explicitly uses HTTP methods in requests, exposes functionality through intuitive URIs, and responds to requests with uniformly encoded data (typically JSON or XML) [1]. Thoughtful operates using a single point of entry for all requests, the "index", where requests are broken down and shepherded to the logical resources available on the server, which respond to the client in turn in a standardized manner via JSON. These design considerations are extremely utilitarian, as they can be easily exploited to make the system very extensible without significant effort.

A "stateless" architecture is one in which all the information necessary to process a request is sent along with the request, requiring the server to store little to no short-term or session-specific data (but note that a stateless server can still store long-term data, such as in a database). The Thoughtful API deviates from this standard slightly by storing session keys tied to each client, utilizing PHP's session handling merely because of the ease of implementation (an aspect of the system that will be removed in the future). In all other matters, however, Thoughtful requests are made by sending all pertinent information with the request rather than by storing state data on the server (such as data indicating what action should be taken on what resources in the server's database by which user). The primary advantage of this design is that there is less demand for system resources, allowing Thoughtful to respond more nimbly to requests.

The Thoughtful API is divided into distinct units, typically referred to as resources in RESTful style (not to be confused with system resources like memory). In Thoughtful's case, these are PHP classes named as nouns (like User or Node). Thoughtful contains the bulk of its functionality in three resources: the User, the Session, and the Node, which we will discussed in more detail in sections 2.2 , 2.3 , and 2.4 . Whenever functionality is accessed, all relevant resource classes are loaded by the server and one or more of their methods are invoked. A specific subset of resources' member functions are exposed in the API; they correspond to HTTP methods that a given resource can respond to. However, other subordinate member functions exist that are not exposed, such as those associated with authentication logic; These are typically there to compartmentalize frequently-used logic that is integral to most requests.

System functionality is accessed by explicit use of HTTP methods and through resource-driven URIs, which combined make the system more intuitive for implementing programmers. The HTTP request methods PUT, GET, POST, and DELETE map one-to-one to the four basic CRUD operations: create, read, update, and delete,

respectively. This marriage of HTTP methods with server actions makes it clear to the implementing programmer what impact a given request will have on data stored on the server (e.g. creating database records versus deleting them). The URIs which expose Thoughtful's API are resource-driven, indicating explicitly which API resource is being accessed with each request. Thoughtful's URIs take the following general form:

baseurl.com/{resource}/{id}?{parameters}.

The resource being accessed on the server is indicated with each request followed by an identifier to access a specific record, if applicable. Any extra parameters pertinent to the request may be listed in the trailing URL-encoded query string. So, if a client sought to read data about a Node resource record with the unique record id 5, the client would send a GET request to

baseurl.com/Node/5 .

Since the HTTP request type indicates the nature of the action being taken while the URI clearly indicates which resource is being manipulated, the API is largely self-documenting, making the system more intuitive to implement.

Finally, following the RESTful paradigm, Thoughtful communicates data to clients in a standard encoding: JSON, or Javascript Object Notation. By not communicating entire web pages with complete markup in response to each request, Thoughtful keeps data-transfer to a minimum. The primary gain of this method, however, is that the client is not forced to present data in any particular way—the server does not prescribe a layout or form of any kind for the information it communicates, as would be the case if it communicated in HTML. Rather, the client, be it the browser-based interface to be discussed in this paper or any arbitrary client requesting data from Thoughtful, is expected to parse the information it receives and apply its own presentation logic to represent that information to the user. Thus, by not marrying data to representation, Thoughtful becomes more flexible and can be employed by any vendor, such as Google or iTunes, as each vendor sees fit. As a whole, by following RESTful design principles, Thoughtful is much more versatile and efficient.

When the server receives a request, that request is handled by the system's single entry point, the index script. This script is responsible for breaking down the request URI into it's constituent parts (the requested logical resource, any identifiers, and any parameters) as well as storing any data from the body of the request. This marks the beginning of the response sequence (See figure 1).

After interpreting the request, the index script then verifies that the client has valid credentials to access the requested resource by invoking functions contained within the Session resource (discussed in section 2.3). Should the client be denied (due to invalid or missing credentials), a warning will then be sent to the client indicating the failure
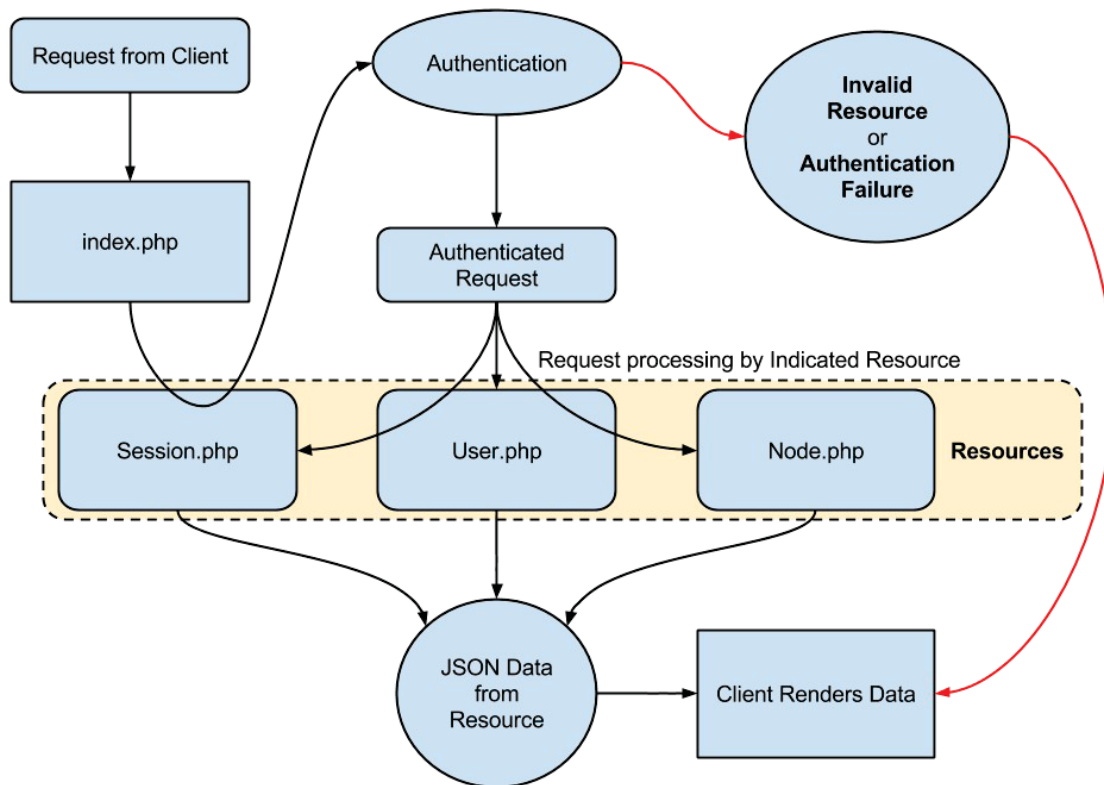
Figure 1: System Diagram. Client requests begin processing at the index script, which authenticates the client (using the Session resource) and triggers the execution of the appropriate resource(s) that then respond with a JSON-encoded message to the client.

of the request. Otherwise, the index script proceeds to shepherd the request to the indicated resource. If the desired resource does not exist, a similar warning will be sent to the client indicating the failure of the request. If instead the resource exists but is unable to handle the indicated HTTP method (for instance, the User resource cannot handle DELETE requests at time of writing), then the index script will likewise dispatch a warning to the user indicating the failure of the request. But if all validation steps are cleared, the PHP class with the same name as the requested resource (Node, User, or Session), will handle the request, executing a member function matching the name of the HTTP method (PUT, POST, GET, or DELETE). The member functions named after HTTP-methods are the only forward-facing members of each class; that is, those functions and only those functions are accessible to the client. However, the request methods may access hidden helper functions owned by each resource, and one resource may call functions of another resource if need be. Once the resource has finished processing the request, a response will be sent to the user.

The response sent to the user is always encoded in JSON, a simple and lightweight data encoding format which is fully documented and explained on its dedicated web page, www.json.org. This response data always contains a similar data structure regardless of the type of request made to the server. Each successful response contains a 'success' index that indicates to the client that the request was handled without error (in the event of an error, however, the

success index will be absent and instead a 'failure' index will contain a textual warning message that may be displayed to the user.) Successful responses may contain a data payload contained under the 'data' index, as well. The data index of the response is not regular between resources in that different resources can issue data with completely different structures. However, requests made to the same resource with the same method always garner data formatted in the same structure. This regular formatting allows the client to implement general functions to handle responses from particular resources, and as previously mentioned, decreases the size of the data payload and allows the client to chose how to represent that requested data.

A a result of these design considerations, adding more functionality to the Thoughtful API is incredibly trivial. The system is designed to automatically find and load class files corresponding to each request, thereby loading only those files absolutely necessary to service a client. Consequently, new resources and therefore functionality can be added to the system simply by adding new class files; no additional configuration is necessary since merely requesting a resource in the URI will trigger the newly-added class to load and process the request. This level of flexibility allows the Thoughtful server to be quickly modified and customized, and moreover preserves an intelligible chain of events for the programmer.

There are three resources in the Thoughtful API that can accept requests and create JSON responses. The first is the user resource, which is responsible for managing user accounts. The second is the session resource, which handles account validation processes like logging in or out. The third resource is the node, which creates, modifies, retrieves, and deletes users' note pages, stored in the Thoughtful database.

2.2   User Resource

The user resource contains the logic to manage User records, currently limited to creating new records within the MySQL database. Each user record has three fields: a numeric primary-key called the id, a unique six-or-more character username, and a password hash (as generated by the PHP password_hash function utilizing the bcrypt algorithm). The password hash is an encrypted form of the user's textual password that can be used to authenticate credentials without explicitly storing the plain-text password. This means that in the event of a system breach, textual passwords associated with usernames will not be easily accessible, protecting users who irresponsibly repeat username/password combinations on other systems. The User resource has only one forward-facing function, the PUT method, used to create new User records. Despite the relative drought of functions performed by the resource, the records thus created are frequently used by the Session resource, discussed next.

2.3   Session Resource

The session resource contains all the functionality for authenticating and terminating sessions. This resource does not save data to the MySQL database; rather, it stores authentication state data using the PHP session variable (thereby deviating somewhat from the RESTful paradigm) and permits or denies other requests to be processed by Thoughtful's resources. When a request is made to the server, the session resource will be implicitly invoked to verify that either the given session has already been authenticated or that the passed-in username and password combination corresponds to a username/password combination stored in the MySQL database. Should a request lack valid credentials or an authenticated session key, the session resource will send an alert to the client indicating that the user is not logged in and terminate further processing of the request. The exception to this rule is when the system is processing requests involved exclusively with authentication or account creation, as neither require credentials to perform.

The session resource will respond to GET, POST, and DELETE requests. GET requests merely inform the client whether or not the user is already logged in (is authenticated). POST requests are used to authenticate a session; clients send their user credentials to the server in the body of the POST request and the session resource

responds by marking the session as authenticated or by rejecting the credentials and notifying the client of failed authentication. Finally, the DELETE request will remove a session key, effectively logging the user out of the system. Subsequent requests to the Thoughtful server will require renewed authentication for all but trivial access.

2.4   Node Resource

The Thoughtful API is primarily concerned with storing and managing information in the form of "notes"; this is where the Node resource comes into play. The node resource manages all of the notes that users store on the system by interacting with two tables in the MySQL database: the nodes table and the links table.

Each nodes table record has a unique id, a content field, a title field, the user id of the node's owner, and a head flag which is used for organizational purposes (typically to represent the "first page" of a notebook) and will be discussed in section 3 . The title and content fields of every record in the nodes table are used to store the bulk o information about the note and are indexed by MySQL to allow keyword searching. The links table is leveraged for organizational purposes, indicating which note pages are related to one another.

Every record in the links table contains only two fields, both ids of node records, labeled "parent key" and "child key". There is no restriction on how many times a particular node id can be used in this table, so the same node can have multiple children or multiple parents as desired, constituting a has-and-belongs-to-many relationship between node records. If the direction of a relationship is significant, the client may expose this; for most purposes, however, the mere existence of a relationship may be all that concerns the client.

The node resource will respond to requests of type PUT, POST, GET, and DELETE. In response to a PUT request, the node resource will insert a new record into the nodes table and can optionally track relationships in the links table, provided that parameters are passed along in the query string of the request. POST requests to the node resource are used to update node records or pertinent relational data within the links table, such as by creating a new linkage between two nodes or deleting a preexisting one. GET requests are used to fetch data about nodes. When a record id is provided in the URI, node data will be retrieved matching the resource id sent in with the request, including any relational information stored in the links table. If no record id is passed in with the request, then the node resource will respond with data based on the search parameters of the request. If no such parameters are provided, then the response will list information about each node with a set head flag (termed "head" nodes). Finally, the DELETE request type will trigger the node resource to either delete a node from the database (and delete any records in the links table associated with it) or unlink the

indicated node from another node (by removing one or more records from the links table, thereby disassociating two nodes from one another), depending on the value of the obligatory "type" parameter sent with the request. In either case, the node resource will traverse the network of nodes to verify that following deletion of the indicated node, there will be no node records left in the database that do not have either direct or indirect association with a head node. If such a disconnected node is found, one of two things may occur: If the request was for unlinkage, the system will respond with an error notifying the client that some nodes would lose access to a head node, requesting that the user rectify the issue by toggling the head status of other nodes in the system. If instead the request was for deletion, the system will simply remove any such marooned nodes entirely.

To further illustrate the node deletion / unlinking process, consider a tree of nodes illustrated in figure Error: Reference source not found. There is one node flagged as a head node, labeled node 1. All other nodes in the database are initially linked (either directly or indirectly) to this node. If the client requests that node 2 be deleted, the node resource will verify that all nodes linked to node 2 are still either directly or indirectly linked to a head node. In this example, the node resource will determine that node 4 would become marooned by this operation, and so the node would then be deleted as part of the operation, as well. If instead the client had requested that node 2 be unlinked from node 1, the node resource would have prevented the operation and issued a warning to the user indicating that nodes 2 and 4 would no longer have a link-path to a head node, requiring user intervention to fix (perhaps by making either one of the indicated nodes a head node).
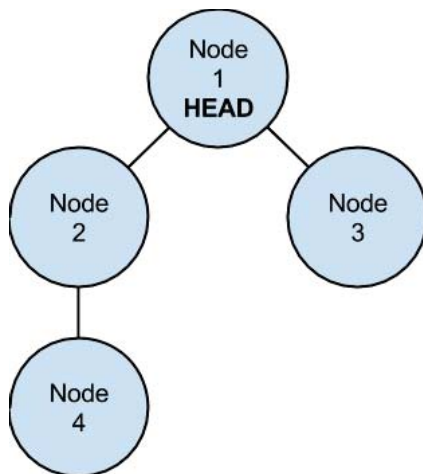

Figure 2: If node 2 is deleted, the system will delete node 4, as well. If node 2 is instead unlinked from node 1, the system will respond with an error indicating that node 4 would become unlinked.

3   User Interface

The browser-based user interface designed alongside the Thoughtful API is a single-page application, meaning that all functional elements of the application are sent to the

user in just one document. The client initially contains all the different "views" (the single-page equivalent of distinct pages in multi-page applications) that the user would need to use the application. These pages contain no user-specific content, however, as this content is added dynamically to the page as the client communicates with the server. Aside from the views themselves, the client also contains all the logic necessary to move the user from view to view and communicate with the server. Since the application contains the logic necessary to render new elements to the document as necessary, it does not request full web pages from the server. Instead, it sends asynchronous JavaScript and XML (AJAX) requests to the API server, receiving JSON-encoded data in response. This response data is parsed by the client and then rendered to the document in various ways depending on context, thereby dynamically updating the content visible to the user.

There are several benefits to this design. Because the layout of the application is communicated exactly once and then dynamically altered by the client itself thereafter, the server is able to abandon the hefty burden of constructing content-rich web pages with PHP before transmitting them to the client, allowing the server to respond more quickly to client requests and decrease physical resource demand. The user experience is consequently also devoid of jarring full-page loads, lending the application a crisp and efficient appearance. Furthermore, the use of JSON to send pure data (as opposed to data married to layout, as would be the case if the server communicated HTML to the client) allows the client to reuse data it has received and present it in any format based on the contextual needs of the client. This allows the client to be more flexible then if the data received from the server were married to a particular layout.

3.1   Interface Layout

The user interface is divided into three primary views: the authentication view, the root view, and the note view. The first handles account creation and authentication, the second serves as the entry point into the user's data, and the third acts as the primary stage for manipulation of user content.

When accessing the Thoughtful browser-based client, the first page presented to the user is the authentication view (figure 3), where users may create an account and sign in to the system. A series of tabs control the visibility of the
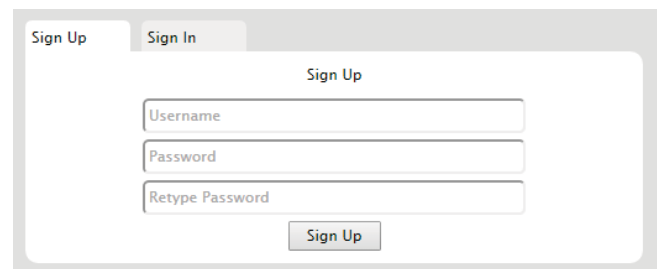

Figure 3: The authentication view. Tabs along the top toggle between account creation and authentication.

sign-up and sign-in forms. If the user fills out either form incorrectly and submits the data, logic embedded in the client will detect the error and prevent the data submission, indicating to the user their mistake. This helps avoid wasting server resources with improperly formatted requests that will inevitably result in error, freeing up the system to respond instead to serviceable requests. If instead either form is filled-out correctly and submitted to the server, the client will switch to the root view.

The root view (figure 4) shows the id and title of every head node owned by the user as well as a preview of the

Figure 4: The root view. Head nodes appear on the left. The space on the right provides preview information about a selected head node.

node's contents. This page acts as the main entry point into the user's data, displaying "covers" to various notebooks. Note, however, that Thoughtful does not restrict these metaphorical notebooks to having only one cover; in this sense, we might think instead of these head nodes as bookmarks in a web of notes. In either case, when any one of the head nodes displayed in the list on the left-hand side of the view is selected, information about the node is presented in the preview pane to the right. New head nodes can be created in the system using the "create" button near the top, and the user can enter the web of data by selecting a node and pressing "view" (or by double-clicking the head node in the left panel). This action ferries the user into the note view.

The note view (figures 5 and 6) allows users to view and edit the title and contents of a note (which we also refer to as a "node"; the controls for the client at writing time are labeled "node" to

reflect the server architecture. We use both terms interchangeably here). The client supports text formatting such as highlighting and font weight, accessible via the "Markup" tab (visible in figure 5). This pane also allows users to insert links to other note pages directly in the textual contents of the note, which allows users to quickly move between related ideas and to organize their information in arbitrary ways as desired. For example, a user could create a new node and place alphabetized links to other note pages in its content, thereby creating an alphabetical index of nodes. But the user could also create a second list (in the same node or in another, or both) to sort a collection of nodes chronologically or by any other criterion, as well. In this way, users are able to organize their information as much or as little as they want.

The ability to save markup and functional elements within the content of a note is achieved by recording groups of text and functional elements in a general JSON data structure, to be stored on the server as node content and rendered by the client in any form desired. This design can be easily extended to incorporate other non-textual elements relatively easily and maintains support for other clients constructed by vendors to incorporate Thoughtful into their own applications.

The "Linking" tab (visible in figure 6) provides users with the tools to create, view, and break the linkages
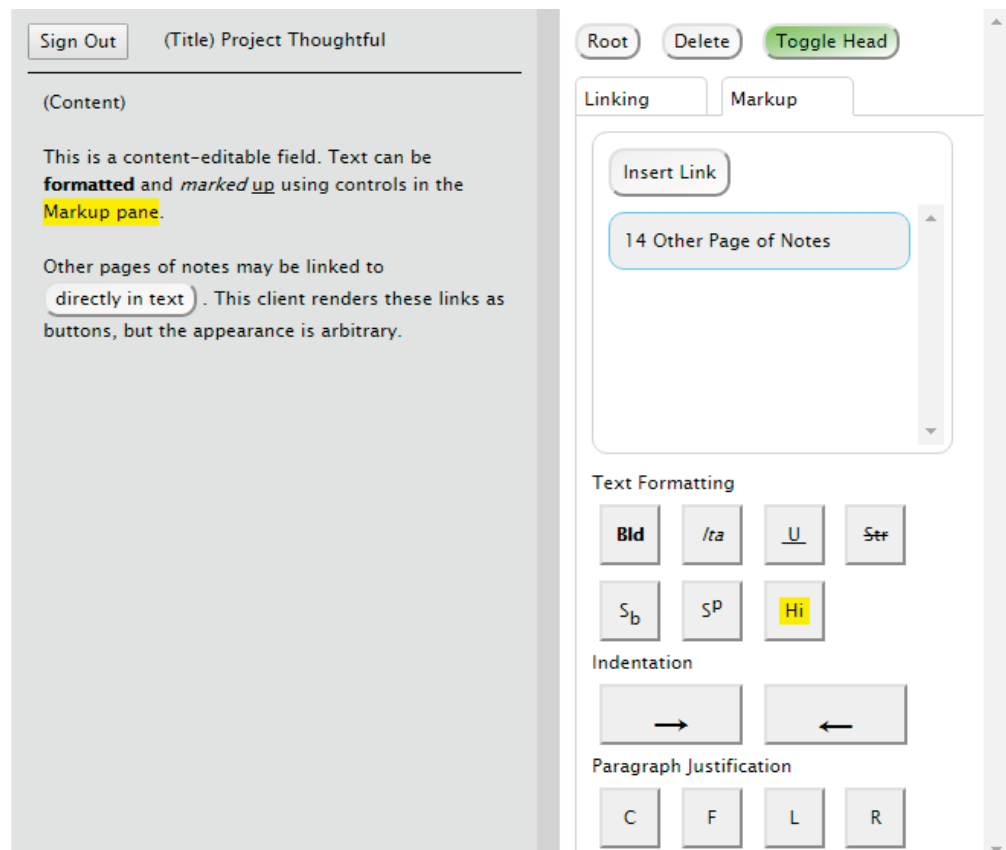

Figure 5: Note view ("Markup" tab active). The note title and contents appear on the left. The markup tab on the right allows users to format text and insert hyperlinks to other ages of notes in the body of the current note.

between nodes that can then be injected into the page via the Markup tab, as discussed. This pane also allow users to instantly create new nodes that are immediately linked to the current node being worked upon, helping to speed up the organizational process. Nodes to be linked can be searched for using the field in the upper-right portion of the panel (the search is based on title and content at time of writing), while nodes that have already been linked to the currently active node are listed at the bottom-right. The client allows users to select these nodes and unlink them from the currently viewed node, as discussed in section 2.4 , and also allows users to select and view these nodes, as well. This latter feature functions similarly to using links injected in the content of a note page, helping users access abstracted or related information easily.

Figure 6: Note view ("Linking" tab active). The linking tab provides users with tools to associate nodes with one another. Associated nodes are listed in this panel for quick reference.

At the top-right of the note view are controls labeled "Root," "Delete," and "Toggle Head". The first control is used to return to the root view discussed previously. The second control is used to permanently delete the currently active node; this triggers the deletion of any nodes that would become marooned from a head node by this process, as discussed in section 2.4 . Finally, the "Toggle Head" control is used to toggle the value of the head flag of the active node between on and off, which determines whether or not the node is considered a head node and will therefore appear in the root view listing. When shaded green, the node is considered a head node in the system; otherwise the toggle is shaded red and the node is not considered a head node. We should note that in order to accommodate users with colorblindness, this use of color to indicate status will ultimately need to be accompanied or replaced by some other indicator in the future, such as a simple "ON" or "OFF" text.

4   Conclusions

The Thoughtful API and browser-based user interface seeks to provide internet users a convenient way to store notes in a relational f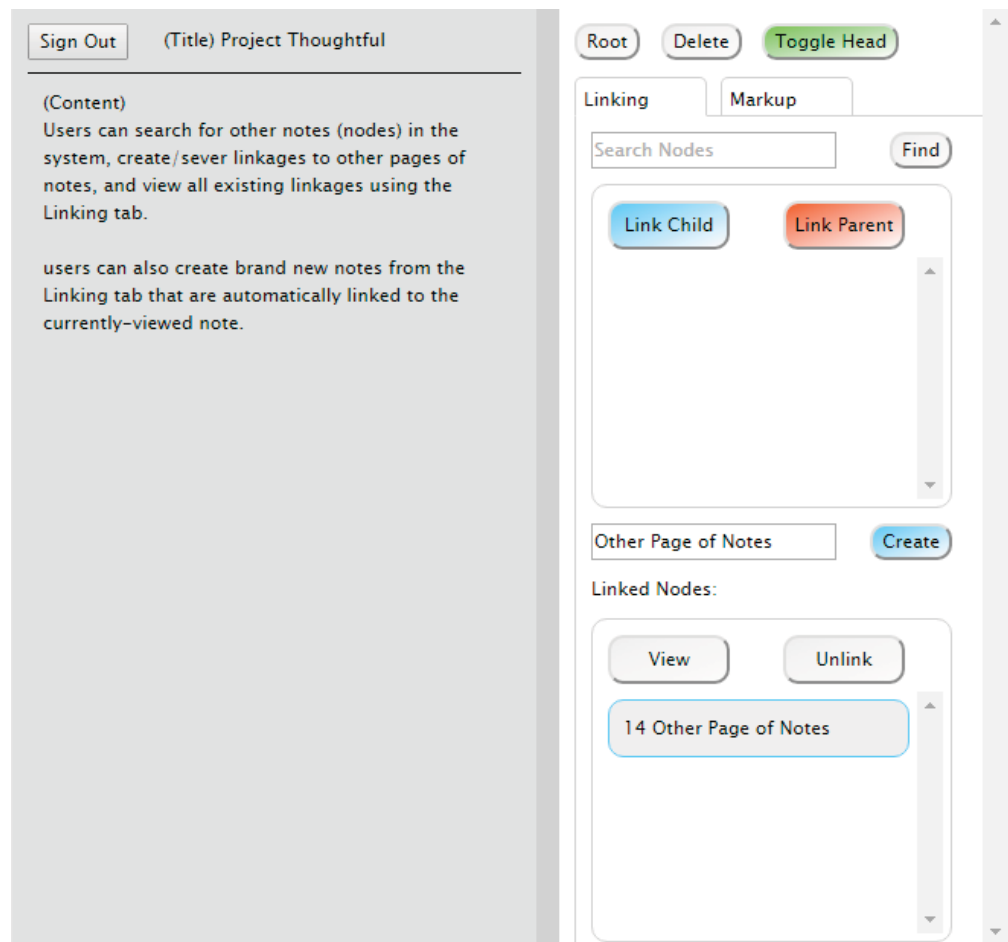ormat. The system takes advantage of relationship tables to store notes while preserving information about how different ideas are related. Furthermore, use of flexible, responsive design principles provides easy access to that data both to general users and vendors interested in incorporating the service. The use of standardized data encoding will ensure that the system is maneuverable and robust enough to be incorporated into existing frameworks while remaining simple to adjust and update without fear of compromising existing functionality.

5   References

[1]   Rodriguez, A. "RESTful Web services: The basics". IBM developerWorks, 2015. Retrieved from http://www.ibm.com/developerworks/library/ws-restful/

SESSION

POSTER PAPERS

Chair(s)

TBA

Interval Type-Two Fuzzy Sets for Defining "Rich" at a Presidential Forum

Ashu M. G. Solo

Maverick Technologies America Inc., Wilmington, Delaware, U.S.A., amgsolo@mavericktechnologies.us

Abstract - *During a presidential forum in the 2008 U.S. presidential campaign, the moderator, Pastor Rick Warren, wanted Senator John McCain and then-Senator Barack Obama to define "rich" with a specific number. Warren wanted to know at what specific income level a person goes from being not rich to rich. The problem with this question is that there is no specific income at which a person makes the leap from being not rich to being rich. This is because "rich" is a fuzzy set, not a crisp set, with different incomes having different degrees of membership in the "rich" fuzzy set. Interval type-two fuzzy logic can be used to properly ask and answer Warren's question about quantitatively defining "rich."*

Keywords: interval type-two fuzzy sets, fuzzy math, fuzzy logic, politics

1   Introduction

During the 2008 U.S. presidential campaign, Pastor Rick Warren moderated the Saddleback Civil Forum on the Presidency [1, 2] with then-Senator Barack Obama, who was the Democratic nominee for president, and Senator John McCain, who was the Republican nominee for president. Warren separately asked McCain and Obama to define *rich* with a specific number. Warren wanted to know at what specific income level a person goes from being not rich to being rich. This was a ridiculous question for a presidential forum and caused everybody to laugh because the term *rich* cannot be defined so precisely as being greater than a single specific annual income. This is because *rich* is a fuzzy set, not a crisp set. Obama and McCain floundered and rambled in trying to answer Warren's question using crisp logic. Warren needed fuzzy logic to properly ask his question. McCain and Obama needed fuzzy logic to properly answer Warren's question.

The author of this research paper described how type-one fuzzy sets can be used for this purpose in [3-5]. Interval type-two fuzzy sets in fuzzy logic have been used for imprecise linguistic terms in many intelligent systems applications, but this research paper proposes the use of interval type-two fuzzy sets [6] for the application of asking and answering queries about quantitatively defining imprecise linguistic terms in natural languages. This research paper describes how interval type-two fuzzy sets can specifically be used in asking and answering queries about defining the imprecise linguistic term *rich.*

A type-two fuzzy set allows the inclusion of uncertainty into the parameters of a membership function. The membership function of a type-two fuzzy set is in itself a fuzzy set. A type-two fuzzy set is three-dimensional where the third dimension indicates the degree of membership of the two-dimensional membership function at each point in its two-dimensional domain. In a type-two fuzzy set, a footprint of uncertainty indicates the upper and lower bounds in the two-dimensional domain of a type-two fuzzy set. A footprint of uncertainty in a type-two fuzzy set is a region bounded by an upper membership function and lower membership function.

An interval type-two fuzzy set is a type-two fuzzy set in which the third dimension is constant in value meaning the degree of membership is constant for the two-dimensional membership function at each point in its two-dimensional domain. Therefore, the third dimension is ignored.

It would be extremely difficult to linguistically describe an imprecise linguistic term with a type-two fuzzy set because there is a third dimension that indicates the degree of membership of the two-dimensional membership function at each point in its two-dimensional domain. It is much less difficult to linguistically describe an imprecise linguistic term with an interval type-two fuzzy set because the third dimension is constant in value and can be ignored. Because it is impractical to attempt to linguistically describe a type-two fuzzy set for an imprecise linguistic term, this research paper only covers the usage of an interval type-two fuzzy set for describing an imprecise linguistic term.

2   Quantitatively defining *rich* with an interval type-two fuzzy set

2.1   *Rich* as an interval type-two fuzzy set

Warren asked McCain and Obama to tell the audience at what specific income level a person goes from being not rich to being rich. There is no specific income level at which an individual goes from being not rich to being rich.

Rich can be arbitrarily defined as an interval type-two fuzzy set with the following parameters: For annual incomes less than an income between $75,000 and $125,000, there is a membership of 0 in the *rich* fuzzy set. As annual income increases from an income between $75,000 and $125,000 to an income between $225,000 and $275,000, the membership in the *rich* fuzzy set increases from 0 to 1 with a constant slope. For annual incomes greater than an income between $225,000 and $275,000, there is a membership of 1 in the *rich*

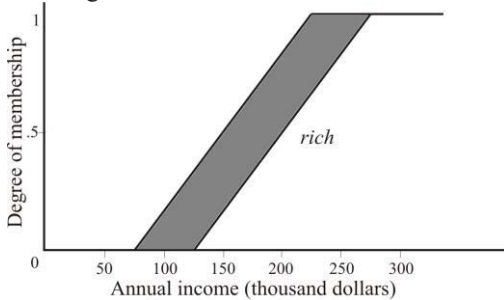fuzzy set. This interval type-two fuzzy set for *rich* is as illustrated in Fig. 1.

Fig. 1. Fuzzy set for *rich*.

2.2 Fuzzy questions for Warren about quantitatively defining *rich* with an interval type-two fuzzy set

In questioning McCain and Obama about the annual income needed for an individual to be rich, Warren first needed to specify in detail the individual's other circumstances affecting his financial well-being. Alternatively, he could have said that the individual's other circumstances were equivalent to those of the average American adult.

Then Warren should have separately asked for a range of incomes below which an individual is definitely not rich, a range of incomes between which an individual is rich to some degree, and a range of incomes above which an individual is definitely rich.

This could be phrased as follows: "In the following queries, assume that all of the circumstances affecting an individual's prosperity are equivalent to those of the average American adult. Give me a range of annual incomes below which an individual is definitely not rich. Give me a range of annual incomes between which an individual is rich to some degree. Give me a range of annual incomes above which an individual is definitely rich." To avoid overwhelming Obama, McCain, and the audience with too many queries at once, Warren could have waited for a response after each query before proceeding to the subsequent query.

2.3 Fuzzy answers for Obama and McCain in quantitatively defining *rich* with an interval type-two fuzzy set

Obama and McCain" first needed to make clear that the definition of *rich* varies considerably depending on many factors affecting an individual's financial well-being other than annual income. They should have stated their assumptions regarding the other factors or asked Warren for more details. Then they could have given their perception of what annual income is needed to be rich for the average American by providing a range of incomes below which an individual is definitely not rich, providing a range of incomes between which an individual is rich to some degree, and providing a range of incomes above which an individual is

definitely rich. This is how one would define *rich* with an interval type-two fuzzy set.

This could be articulated as follows: "There are many different factors other than annual income that affect an individual's prosperity. If we make the assumption that these other factors are equivalent to those of the average American adult, then in my perception, an individual with an annual income less than an income between \$75,000 and \$125,000 per year is definitely not rich. As an individual's annual income rises from an income between \$75,000 and \$125,000 per year to an income between \$225,000 and \$275,000 per year, he is rich to some degree and his degree of being rich steadily increases. An individual with an annual income greater than an income between \$225,000 and \$275,000 per year is definitely rich."

3 Conclusion

It's easier to define an imprecise linguistic term with a type-one fuzzy set than with an interval type-two fuzzy set, but an interval type-two fuzzy set allows for the inclusion of uncertainty about the bounds of the membership function. If one wants to include uncertainty about the bounds of the membership function in a quantitative definition of an imprecise linguistic term, then an interval type-two fuzzy set should be used.

An understanding of the basic principles of type-two fuzzy logic can be extremely useful in asking proper questions and giving proper answers about quantitatively defining imprecise linguistic terms. Interval type-two fuzzy logic can be extremely useful in politics, public policy, and law, which are full of uncertainties and imprecision. This is described in much greater detail in [7].

4 References

[1]   Saddleback Civil Forum on the Presidency, Saddleback Church, Lake Forest, Calif., Aug. 16, 2008, URL:

http://www.saddlebackcivilforum.com/thepresidency/

[2]   Saddleback Civil Forum on the Presidency, CNN, Aug. 16, 2008, URL: http://transcripts.cnn.com/TRANSCRIPTS/0808/17/se.01.html

[3]   A. M. G. Solo, "Fuzzy Sets for Defining 'Rich' at a Presidential Forum," Proceedings of the 2012 International Conference on Information Society (i-Society 2012), pp. 484-485.

[4]   A. M. G. Solo, M. M. Gupta, N. Homma, and Z.-G. Hou, "Type-One Fuzzy Logic for Quantitatively Defining Imprecise Linguistic Terms in Politics and Public Policy," in Political Campaigning in the Information Age, A. M. G. Solo, Ed. Hershey, Penn.: IGI Global, 2014, pp. 239-255.

[5]   A. M. G. Solo, M. M. Gupta, N. Homma, and Z.-G. Hou, "Obama, McCain, and Warren Needed Fuzzy Logic to Define 'Rich' by Income," Proceedings of the 2009 International Conference on e-Learning, e-Business, Enterprise Information Systems, and e-Government (EEE'09), pp. 265-270.

[6]   J. M. Mendel, R. I. John, and F. Liu, "Interval Type-2 Fuzzy Logic Systems Made Simple," IEEE Transactions on Fuzzy Systems, vol. 14, pp. 808-821, 2006.

[7]   A. M. G. Solo, "Interval Type-Two Fuzzy Logic for Quantitatively Defining Imprecise Linguistic Terms in Politics and Public Policy," in Political Campaigning in the Information Age, A. M. G. Solo, Ed. Hershey, Penn.: IGI Global, 2014, pp. 256-264.

SESSION

LATE BREAKING PAPERS

Chair(s)

TBA

Computers as Tutors:
Tools for Next Steps in Education

Clarence Lehman[1] **and Todd Lehman**

[1]University of Minnesota, 123 Snyder Hall, 1475 Gortner Avenue, Saint Paul, MN 55108, USA

*"Education is simply the soul of a society as it passes
from one generation to another."*
—G. K. Chesterton

Abstract—*The way we commonly educate today—one instructor with many students—advanced civilization and changed the world. But it is not the best way. Private one-on-one tutors, speaking individually with students, drawing pictures, asking and answering questions, can be superior to standard classroom teaching as well as to canned educational videos. However, it has not feasible to educate an entire population with private tutors in this way—not until now. Synthesized computer voices have reached a stage where, with simple clues for emphasis and cadence, they can reasonably compete with human voices. Moreover, computer capacity and speed have reached a stage where graphics and animation can be displayed and coordinated seamlessly with synthesized voice. Questions by the computer tutor can be put to the student and alternative branches in a lesson on any topic can be followed. Here we describe a software tool that allows educators to create and edit such computer-as-tutor lessons for any audience. A source script specifies the entire lesson with visual displays, spoken words, and coordinated timing and cadence. A built-in "compiler" converts the source script to an intermediate form and a corresponding "assembler" converts to synthesized voice and visuals. These allow the source script to be edited as a text document and then processed to update the lesson in any way. The goal is to achieve a "wiki" capability, where multiple authors in remote places at different times can contribute and improve individual lessons. The tools use standard components—TEX [1] for typesetting and graphics, STAGE2 [2] for pattern matching, and JavaScript [3] for presenting—though any components that meet the interface requirements could be substituted. We make these tools available under public license for comment, criticism, use, and improvement as we begin to apply them in educational settings. We have found such lessons relatively easy to develop and have begun rigorous tests to calibrate their effectiveness against other methods of teaching.*

Keywords: automated learning, tutoring software, synthesized voice, audio-visual scripts.
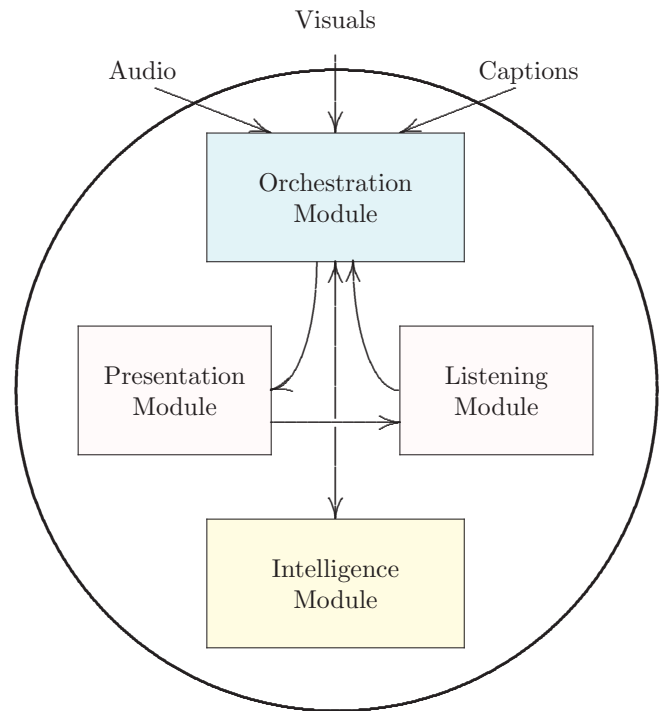

Figure 1. Tutoring software. *An orchestration module coordinates the flow of information. Presentation and listening modules handle output and input, interacting with the student. An intelligence module decides the path through the lesson, based on simple branches or upon subtleties. For input to the software, the audio can be natural voice or synthesized. The visuals are a series of connected images synchronized with the audio, and the captions are optional.*

1. Background

When it was only for a favored and fortunate few, education could afford custom one-to-one tutoring. The best tutors would sit side-by-side in explanation, continuously assessing the student's understanding and subtly tailoring the presentation so that learning was efficient, but also exciting and filled with joy. However, though it was efficient for the student, it was not efficient for the educational system, nor for society. Private tutoring could not be sustained as needs and opportunities for mass education expanded.

Accordingly, instructors have labored to develop all the methods of modern education—with textbooks, lectures, discussions, evaluations, and now short canned videos—that allow a single educator to reach many students simultaneously. Alas it is not the same. Good lecturers take care to pause for questions, and in active-learning classrooms to move from table to table for interactions, but with one-to-many communications, presentations simply cannot be adapted perfectly to the individual needs of every student. For difficult topics, learning remains difficult.

Therefore we were surprised to realize that seemingly impersonal digital technologies have left us poised to recover some of the personal benefits of private tutoring. By branching within digital media, we can harness student feedback through touchscreen, keyboard, voice recognition, or other input. Coupling that with a small amount of artificial intelligence in the software controlling the lesson, we can create a rich instructional network to present difficult topics that become customized to the individual student.

We have worked to enable short branching lessons, available online as part of coursework, that explain topics in one-to-one manner—branching according to students' interactions, always remaining agreeable, always encouraging, always presenting the next step for the student to consider, based on minute-by-minute responses the student provides to questions posed in the video.

In our initial explorations we were struck by two things: first, how very frequently and naturally the dialog flipped back and forth between tutor and student, mimicking real one-to-one communication, and second, how quickly and naturally it developed into deeper aspects of a subject for students already familiar with the basics. We have started to develop these ideas for students to use and evaluate.

We have new prototype software to create editable interactive lessons that guide students one-on-one in response to their backgrounds and needs. It has "wiki" properties, by which we mean that many people beyond the original author can incrementally edit, improve, and perfect it. This could be through a global website, but that is not the essential part.

1.1 Historical connections

The idea of using machines for teaching arose with machines themselves. Cunniff reviews the history [4], with patents for learning machines reportedly appearing late in the 19th century. An early teaching machine in the 1920s offered information to students in a window and offered multiple-choice questions whose answers corresponded to one of four keys on the machine. When the correct key was pressed, the machine would advance to the next set of information and the next question in order. Even such a simple machine was groundbreaking in its day—having machines teach people was a new step for civilization.
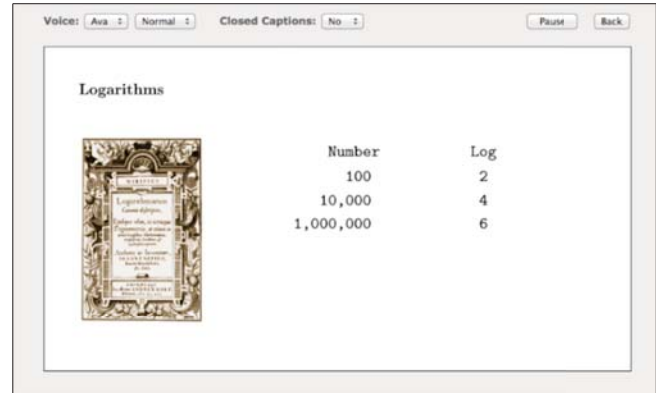

Figure 2. *Visuals are presented in a window with controls for navigation included. Progress during the session is recorded so that it may be interrupted and resumed later.*

A remarkable advance by the 1970s was the "System 80," an electromechanical machine that combined human voice pre-recorded on random-access phonograph records synchronized with random access photographic frames. The machine would conditionally branch around within the lesson, presenting customized learning based on the student's answers. One of us (TL) used those machines in grade school near the end of their era and remembers fellow students eagerly awaiting their time on the machines. The Chicago Daily Herald headlined the system as a "teacher who never shouts at pupils." [5] The system supported complex branching structures to adapt to individual needs, but because of the early technology large efforts were needed to create lessons.

As mainframes and mini-computers with distributed terminals advanced, a new generation of machine tutors developed, exemplified by systems such as PLATO. [6], [7] The PLATO system directly supported text, graphics, and animation, but since it arose before good synthesized voice was possible, the voice feature of the System 80 was largely lost. It had its own scripting language for creating lessons. [8] PLATO was in use for over three decades, ceasing active use only in the first decade of the 20th century.

The computer tutoring system we describe here is more modest in scope than the largest systems of the previous generation, though it incorporates synthesized voice, which adds a dimension to its scope. Also, following Moore's Law since the 1970s, with computational capacity doubling every year or two, it can take advantage of computers roughly a billion times more capable ($2^{45/1.5} \approx 10^9$).

1.2 Real-world experience

As part of developing the software we developed four prototype lessons on logarithms and their application to biodiversity measures using the Shannon information index. We first tested the lessons with a group of approximately 20 students from across our university, comparing synthesized voices with a cheerful human voice. Many preferred

the human voice, but found the synthesized voice entirely acceptable.

We later formally tested the computerized lessons against standard teaching methods in a replicated experiment with approximately 120 students and 3 experienced instructors. Students learning from the computer tutor learned statistically as well as those from the human instructors. Results of that experiment are being prepared for publication in the educational literature.

2. A sample lesson

2.1 Synthesized voice and visuals

To get a feeling for how this works, look at the following representation of voice and visuals. The synthesized computer voices that the student hears are in italics, and the corresponding visuals are non-italic.

The lesson starts with a synthesized voice explaining, *"Logarithms are 'calculating numbers' developed by John Napier. Think about a number and its logarithm, abbreviated 'log'."* Synchronized with the voice, the student sees the corresponding words, as follows.

```
     Number                 Log
```

Now the voice says, *"The easiest way to start understanding them is to think of powers of ten, which are numbers starting with one and followed by zeros. So for example, the logarithm of one hundred is two."* At that point a new line becomes visible on the display:

```
     Number                 Log
      100                     2
```

The synthesized voice continues, *"The logarithm of ten thousand is four,"* and another line appears:

```
     Number                 Log
      100                     2
    10,000                    4
```

This continues, *"The logarithm of a million is six,"* synchronous with the next visual line:

```
     Number                 Log
      100                     2
    10,000                    4
  1,000,000                   6
```

At this point, just a minute or so into the lesson, it is time to make sure the lesson so far is clear. So the synthesized voice says, *"That's the idea. So let me ask you this. What is the logarithm of one thousand?"*

A set of choices for the value of the logarithm of 1,000 appears, and the student picks one with a selection device or, with suitable hardware, merely speaks. The computer tutor might offer, for example, the choices 100, 0, 3, 4, and −1. If the student picks the correct answer, 3, the computer tutor says, *"Yes, that's right. Let's continue,"* and then it proceeds with the lesson. But if the student picks some other

answer, the computer tutor responds, *"Oh, not quite, let me explain that more carefully,"* and then begins a more detailed exposition.

What can make this comfortable for students is that their computer tutor will always be polite, never become impatient, and never give up. We also feel it is important that the computer tutor does not disclose data to the student's human instructor telling how many times the student has tried a pathway, or how long it has taken the student to complete the lesson. The computer tutor may keep track of those details to alter and adapt the presentation, and may offer them anonymously summarized, but so that students will feel comfortable, those details should be private information between the computer and the student. What matters is how well the lesson was learned, not how easy or hard it was to get through. Computers should act as accommodating servants, not masters.

2.2 Structure of the tutoring software

The tutoring software described in Figure 1 carries out the operations outlined in the preceding section. It is conceptualized in four parts that read three kinds of data, audio, visuals, and captions. First, the orchestration module formats a visual image, selects the corresponding audio sequence, and presents them to the student through the presentation module. At the minimum the presentation module has access to a graphics display and audio speakers, plus some selection device, and that is all we have implemented thus far. Optional captions are available for students who learn better with all visual cues, or who have difficulty hearing auditory signals.

For a series of steps that are purely presentational, control oscillates between the orchestration and presentation modules. Before long, however, the system reaches a branching point, where the student will respond to a question presented by the computer tutor. Then the listening module accepts input from the student and presents it to the orchestration module, which chooses the future direction based on preassigned pathways or on more elaborate decisions. Pattern-matching software incorporating what we call the intelligence module will be part of more elaborate decisions—an area for future development and experimentation.

The display screen (Figure 2) has controls to adjust the speaking rate, choose alternative synthesized voices, switch captions on and off, and to pause and go back.

The intelligence module is designed to use the publicly available pattern-matching language STAGE2. [2] Formatting for the presentation module is by the open-source typesetting system TEX [1]. The orchestration module uses standard JavaScript. [3] Our developments amount to under 10,000 lines of code total.

```
  Logarithms +
  \n\n\n\n

~~~~
<Logarithms> are "calculating numbers"~ developed
by John {Nape year}{Napier}.
  \Image(borderless) BookNapier.jpg 1.82 x 2.75 []
  \ImageLeft
  \vskip 0.05in \hskip 0.6in John Napier + \T\

You <see> the cover of his 17th century <book> on
the left.

~~~~
Think about a <number>

  =
  =      Number            \T\

and its logarithm, abbreviated "log".
  =      Number            Log

The easiest way to start understanding <<them>>
is to think of powers of ten,~~ which are
<numbers>~ with a <single> 1~~ followed by
<zeros>.~~

So >>for<< example, the logarithm of 100
  =
  =        100             \T\

~~ is two.
  =        100              2

Ten thousand,
  =
  =      10,000            \T\

the logarithm of ten thousand~~ is four.
  =      10,000             4

A million,
  =
  = 1,000,000             \T\

the logarithm of a million~~ is six.
  = 1,000,000              6

<<That's>> >>the<< idea.~~
So let me ask you <this>.~~
  =
  =       1,000            ?
  =
<What>~ is the logarithm of~~ one thousand?
  =
  \sl\blue{What is the logarithm of 1000?}
  =
  =(100) (0) (3) (4) (-1)
  /
```

Figure 3. *The tutorial script is a moderately simple language for specifying the audio and visual parts combined.*

3. Writing the lessons

3.1 The script

Our starting point for authoring lessons is a tutoring script in text-based scripting language (Figure 3). Once written, the script is compiled and assembled into a lesson. A tutoring script is conceptually analogous to a UNIX shell script—a general form that underlies other higher level UNIX processing.

Designers who know how to apply typesetting commands and graphics languages can create tutoring scripts directly with a text editor. That is how the lessons we have made so far have been created, and how we will continue creating lessons in the near future. Over longer times, we expect to design higher-level interfaces that will let a broader set of designers create lessons. Alternatively, we would be perfectly happy if other groups would develop such interfaces.

3.2 Structure of the script

The script has audio and visual specifications interspersed in the order they occur moment by moment (Figure 3). Audio specifications start in column 1 and visuals are indented two spaces. For example, the top two lines in Figure 3 are indented two spaces, so they specify visual material. The first line causes the word "Logarithm" to be placed in the upper left of the screen, and the plus sign ('+') to its right makes it larger and bolder. That word can be seen at the upper left of the screen area in Figure 2. Two plus signs would make it larger still. The next line in Figure 3 ('\n\n\n\n') merely specifies four lines of white space below the word "Logarithm."

Next is a string of tildes. It starts in column 1 and therefore is part of the audio. Tildes simply cause the synthesized voice to pause—the more tildes, the longer the pause. If there are n consecutive tildes, the silent pause will last for a time proportional to $F(n)$, where F represents the Fibonacci sequence $(1, 2, 3, 5, 8, 13, 21, \ldots)$, an exponential scaling that has worked well. The duration of the pause is important to a realistic and comfortable sound in the synthesized voice.

A graphical image typically grows in stages with each new set of lines, as illustrated in the script of Figure 3. That growth can be modified with the special marker "\T\", shown in several places in the script. That marker means "temporary," and causes the line with the marker to be overwritten when the next line arrives. For example, the line that reads "= Number \T\" will appear on the screen as

$$\text{Number}$$

When the subsequent line that reads "= Number Log" arrives, it will replace that previous line with the new one and the screen will show

$$\text{Number} \qquad\qquad \text{Log}$$

In other words, the word Log will appear to pop onto the screen, since the word Number is already there. This marker is just to make some common operations in the building of images easier.

3.3 Cadence and captions

Synthesized computer voices have become quite understandable, and their ubiquity in cell phones, global positioning systems, elevators, traffic lights, and elsewhere have made them familiar and acceptable. Still,

they can be improved by adding context that the synthesis software has no way of discerning. For example, next is the audio sentence, "`<Logarithms>` are `'calculating numbers'` developed by John `{Nape year}{Napier}`." The angle brackets (< >) around "Logarithms" stretch the word out slightly by slowing its timing, for emphasis. It turns out that people emphasize words not as much by saying them louder, but by saying them subtly slower. One set of angle brackets slows down the word, for ordinary emphasis. Two nested pairs (<< >>) slows it further, and additional nested pairs further still. (Though too many pairs will give the synthesized voice an inebriated sound, usually undesirable for a tutor.) In contrast, inwardly facing angle brackets (> <) will speed up the word. With practice one learns how and where to adjust the cadence.

Another encoding in that sentence is the form `{Nape year}{Napier}`. Consecutive pairs of braces (`{ }{ }`) are pronunciation aids. The synthesized voice will pronounce it more naturally as '*Nape year*' but will spell it correctly as 'Napier' in the closed captions. This is also handy with mathematics, where the form `{the square root of x}{$\sqrt x$}` will say 'the square root of x' but display '$\sqrt{x}$' in the closed captions.

3.4 Images

Photographs or other pre-formed images are included as JPEG, PNG, and so forth. An example is a picture of the cover of Napier's book, specified in Figure 3 and depicted in Figure 2. The specification is two lines:
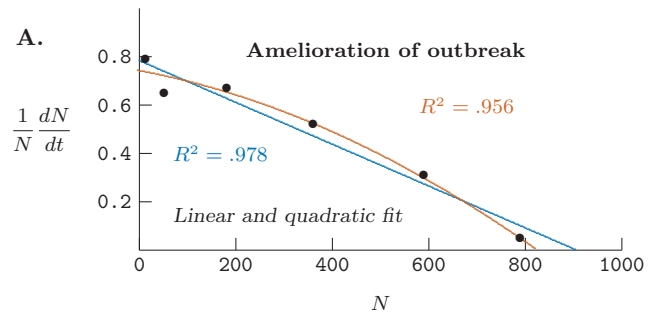
```
\Image(borderless) BookNapier.jpg 1.82 x 2.75 []
\ImageLeft
```

The first of the two lines introduces an image and says that it should not have an additional border, which would otherwise be a thin black box around it. Next to that on the line is the name of the image file. Subdirectories or complete file paths can be part of this name as needed. Next to that is the size of the image on the screen in inches, with the width first and the height second, separated by the marker 'x'. Finally, any comment describing the image can be placed within brackets at the far right of the line.

The next line tells whether the image should appear to the left of any subsequent text or to the right. Here it is to the left, as it appears in Figure 2. Images can also be centered, with text above and below them.

In this case all the text that follows will be placed to the right of the figure, until the ending marker arrives. The ending marker is simply a slash standing alone on the line, '/', indented to column 2 to indicate it is part of the image and not the voice.

These basic imaging features work for the almost all situations and present a uniform, uncluttered appearance to

A.

B.

```
This <outbreak>~ >spread to affect< almost <800>
victims.

  \beginpicture
  \setcoordinatesystem units <0.003 in, 1.5 in>
  \setplotarea x from 0 to 1000, y from 0 to 1

  \axis left label {$\displaystyle
    {1\over N}{dN\over dt}$}
    ticks in numbered from 0.2 to 0.8 by 0.2 /

  \axis bottom label {$N$}
    ticks in numbered from 0 to 1000 by 200 /

  \put{\bf Amelioration of outbreak} [rb] at 800 .8
  \put{\sl Linear and quadratic fit} [lb] at  70 .1
  \put{\red {$R^2=.956$ }} [r] at 800 .6
  \put{\blue{$R^2=.978$ }} [l] at  70 .4

  \blue{\plot 0 0.784 907.1277 0 / }%
  \setquadratic
  \red{\plot 0 0.741 410 0.481565 827.77 0 / }%

  \multiput {$\bullet$} at
    12 .79 51 .65 181 .67 360 .52 589 .31 789 .05 /
  \endpicture
```

Figure 4. *This is graphical material in a script, since it is indented two spaces. The code in Part B is* PICTEX, *which is a readable graphics language that produces the picture in Part A.*

keep visuals simple. Where a more elaborate placement of images is necessary, images can be included and placed in any configuration in graphs, described next.

3.5 Graphs

More complex than pre-formed images are custom charts and graphs. Any graphics language that works with TEX could be used, but the package PICTEX [9] has worked well for us to produce high quality graphs relatively easily. One merely writes the graphics commands indented two spaces in the script and the graphics appears, exemplified by the excerpt in Figure 4.

That excerpt starts with a sentence for voice synthesis, introducing the graphics. Then the graphics are defined in textual format. The details are not necessary here but are covered in the reference material for this particular graphics language. [9] Briefly, the image is bracketed with `beginpicture` and `endpicture` statements. Between

those statements are commands to define the units for the coordinate system, to specify the size of the plot area, the structure and labeling of the axes, and the points and curves to be plotted in specified colors. Each element of the graph in Figure 4A can be seen specified in the language statements in Figure 4B.

Successive parts of a graph can be coded with an option to produce stepwise graphical animations. With the forward and back buttons on the screen, the student can move around to review individual steps in the animation.

The graphics language is compiled along with the rest of the script to produce voice and images.

3.6 Branching

The central feature that allows the computer to act as tutor is branching. We use the term as it is used in computer programs and have four kinds of branch instructions:

1. A simple unconditional branch (goto) that jumps to a new place in the script with no implicit provision for return.
2. An unconditional subroutine call, which jumps to a new place in the script and later returns to the point immediately following the instruction.
3. A conditional branch that jumps to a new place in the script with no provision for return, but jumps conditionally based on a response from the operator, or on internal conditions that can be tested in the system.
4. A conditional subroutine call, combining the properties of 2 and 3 above.

There is also a simple pause instruction that stops the lesson at a particular place until the student clicks a continuation button. This is intended to allow the student time to study the screen and ponder more difficult concepts.

The above set of branching instructions has been sufficient for us to develop the prototype lessons we have used and have tested, but at least one more would be desirable. For example, the "come from" instruction discussed later would simplify the design of lessons.

3.7 Interaction

Students cannot alter the order of the parts of the lesson unless that is specifically preprogrammed into the lesson, but there are provisions for interactions that will not interfere with orderly presentation of the materials. There is a PAUSE button and a corresponding RESUME button that allow students to slow down the lesson, giving ample time to think, or even take a break and return later. The RESUME button backs up a few seconds before the previous PAUSE, to provide a degree of conceptual continuity.

The orchestration module maintains "breadcrumb trails" of all states and pathways taken through the lesson, a feature which supports a BACK button and a corresponding FORWARD button. These buttons allow students to revisit recent parts of the lesson and even choose new paths when proceeding forward again. The pathways are maintained by
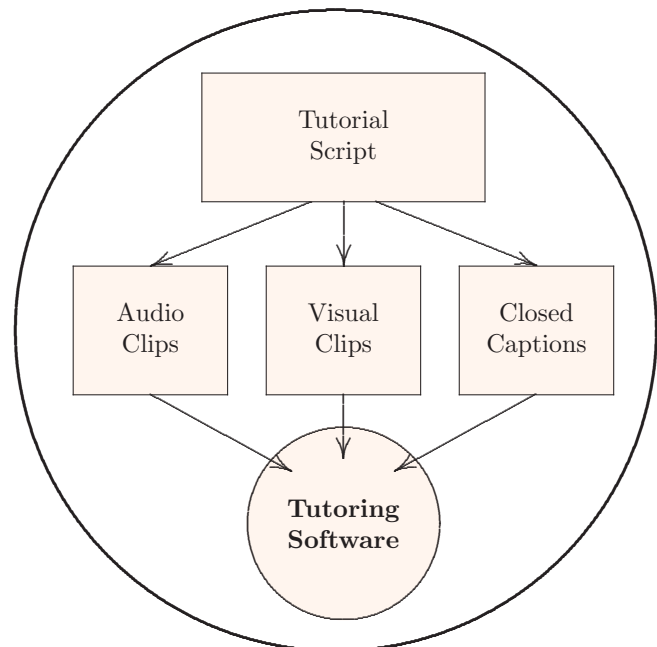

Figure 5. *Structure of the scripting software. The scripting software parses the script and synthesizes graphics and spoken voice. The synthesized voice can be replaced by narrated human voice if desired once a lesson is perfected.*

the web browser in persistent storage, ensuring that the latest path can be restored if the web browser is closed for any reason. Thus students can simply return later and continue where they left off.

In addition, as mentioned earlier, students can change voice and speaking rates to suit needs or personal preference.

4. From script to lesson

4.1 Compiler

Scripts such as those shown in Figures 3 and 4 are converted to an intermediate form by software we call a compiler, and the intermediate form is then translated by software we call an assembler into a final form that can be handled in web browsers. We use the terms compiler and assembler in analogy with software that compiles ordinary programming languages into object forms for the computer.

The compiler is largely built of STAGE2 modules to convert the script for the lesson into a collection of intermediate files, including the following:

1. A text file describing the structure of the lesson, with branches and return points hierarchically arranged and corresponding with the components of the other files.
2. A text file with phrases for voice synthesis, in order. This includes the left member of equivalent voice–visual pairs described earlier.
3. A PDF file with each caption for inclusion in the lesson, in one-to-one correspondence with the other files. This

includes the right member of equivalent voice–visual pairs.

4. A PDF file of all of the visual images, including each successive subimage that will be presented individually, synchronized with corresponding individual voice phrases.

Lesson authors may view each of these intermediate files separately or in groups to assess the correctness of the processing and the appearance of individual images. However, these intermediate files have no value to students until they are assembled into an "object format."

4.2 Assembler

The set of intermediate files produced by the compiler feed into the assembler, which produces an object format known to standard web browsers. It assembles the separate intermediate files described above into the following.

1. A master file in the structured data format JSON (JavaScript Object Notation), that coordinates all of the object material produced by the assembler.
2. A collection of portable net graphics image files, PNGs, created from the compiler's PDF file of images. We also tested converting the compiler's PDF file of images into scalable vector graphics, SVG, an image format of unlimited resolution that will support interactivity and animation. However, those images were considerably larger and the resolution of the PNG files was sufficient, so we followed the simpler path first.
3. A collection of synthesized voice files in standardized formats such as 'm4a' (MPEG-4 audio files), and also 'ogg' (Ogg Vorbis) files. Synthesied audio files in various voices, accents, and speeds are assembled to afford the best experience for the student, though with future advances in voice synthesis, these files will be able to synthesized in realtime.

A future feature would be a pathway to allow pass-through of arbitrary HTML, so that videos, interactive sliders on graphs, and other interactive forms could be part of the lessons. That is possible today but was considered beyond the scope of this initial project.

4.3 Runtime environment

The runtime environment consists of JavaScript object code that runs in a web page to interpret the assembled data. It is structured to run as if it were interpreting ordinary machine code, with a program counter, address register, and instruction set for branch, call, and return instructions. It also interprets instructions to prompt the user, play audio clips, and display slides. It is essentially a small virtual machine.

We have implemented and tested STAGE2 in JavaScript, and in future development some parts of the virtual machine will reside there, especially the decision-making parts.

5. Future paths

This project has developed basic ideas and demonstrated one way of converting them into reality. Undoubtedly a lifetime of work lies ahead to realize all implications in concert with advancing technology, and with knowledge emerging in new science-of-learning foundations. [10] A few steps for the near future are clear now. For one thing, we have been doing these with the classical compile–assemble–test protocol. An incremental "test as you go" is readily within reach today—only a matter of design and programming effort. When creating and testing a lesson with that new form, the lesson designer would merely back up in the lesson to a place before changes needed, edit and recompile the script, and continue with the modified lesson from there. This is available now in some systems and in our experience is an extremely valuable feature for software development.

5.1 Higher-level interface

An obvious limitation is that the highest level available to our lesson authors is the scripting language. We feel this was the right way to start, because first of all it is straightforward, and furthermore because it creates a unified common format that future methods of designing lessons can map into.

A future interface with multiple windows will be useful. Images and text from around the computer's screen would be dragged and dropped into windows of the interface to build lessons. The "test as you go" feature should be an interval part of this. Also highlighting and choosing cadences for speech from menus with a selection device rather than through syntactical elements in the text string will be preferred by some. Immediate feedback from the synthesized voice would make the process even easier.

With these and other future possibilities, everyone with background making slides for presentations should be candidates for making lessons with computers as tutors.

5.2 Internationalization

Presently we render the voices into various styles and accents and allow the student tool choose among them. But because the voices all correspond precisely to textual scripts, we could also allow the student to translate them automatically to a preferred language, using one of several moderately good language translators that are now available. Of course the results sometimes will be puzzling, but this possibility for translation is much more difficult with lessons that start with human voices.

A variant would be to allow only the captions to be translated, so that the student would listen in one language and see the captions as subtitles in their preferred language. That could have advantages for students learning a new language at the same time as they are learning the concepts of the lesson.

5.3 The intelligence module

Beyond the above, the intelligence module may have future possibilities whose limits are not presently knowable. Refinements here can support further adaptive learning developments [11] and other learning frameworks by evaluating responses and dynamically modifying the learning process.

Much research has targeted artificial intelligence applications for computer tutors. We expect to proceed with some relatively simple approaches. As mentioned earlier, we have implemented the publicly available pattern matching system STAGE2 in JavaScript, based on its easy portability and our past experience with it. The system can fairly easily realize certain pseudo-intelligent kinds of interactions, such as those exhibited by Eliza [12] and its derivatives. Its most definitive feature is using best-fit character string patterns as part of a programming language, providing a kind of polymorphism that goes beyond what is ordinarily available in object oriented languages.

The first thing we expect is to supplement the present branch, call, and return instructions that the runtime environment interprets with a new kind of instruction that is the opposite of an old-fashioned "go to" instruction. We envision something more like a "come from" instruction. When the lesson must branch from a main pathway to handle something that the student does not seem to have understood, it can be difficult in the main branch to determine precisely where to go. Instead the main branch will simply put out a call for help, including a description of what seems to be missing and present in the student's understanding. A set of all subroutines capable of helping will be evaluated as a standard part of the pattern matching process, and the subroutine judged most capable by the pattern matching process will take control and start interacting with the student. When that process is completed, the subroutine will return control to the previous location, without that location having been aware of what happened.

With each progressive development in the intelligence module, we expect that the orchestration module, which presently runs instruction streams, will become more and more merely a liaison between the student and the intelligence module.

6. Conclusions

This is a simple idea with far-reaching potential, within academia and across culture. The idea has been around for a long time, but what is different now is that computer technology has passed a threshold where voices can be synthesized expeditiously to provide "wiki" capabilities to allow lessons the flexibility of expanding and adapting through time.

That flexibility arises because lessons are not tied to their original authors with this approach, nor to the original voice narrators, and do not demand takes and retakes to match volume, tempo, and temperament. Feedback on changes is rapid, with no need to send revised scripts to a production facility to obtain the final lessons. Thus the synthetic words and voice can be repeatedly fine-tuned, a process that is cumbersome with a voice narrator. The fluidity with which lessons can be adapted creates possibilities that were not there before.

One can never be certain, but if events develop as envisioned here, information of the future will be presented not just as reference material in books and in vast online encyclopedias, but also as vast collections of one-to-one interactive modules for the benefit of students learning materials for the first time.

7. Acknowledgements

8. Contributions

CL developed the compiler portion of the software and TL developed the assembler and runtime environment. Both authors contributed to the manuscript.

References

[1] D. E. Knuth, "The T_EXbook," *Addison–Wesley, Upper Saddle River, NJ*, p. 483 pp, 1984.

[2] W. M. Waite, "The mobile programming system: Stage2," *Communications of the ACM*, vol. 13, pp. 415–421, 1970.

[3] D. Flanagan, "Javascript: The definitive guide, edition 5," *O'Reilly Media*, 2006.

[4] D. T. Cunniff, "An investigation into the affect of the borg–warner system 80 machine on the reading program of selected primary students," *Walden University ScholarWorks, Dissertations and Doctoral Studies*, p. 127 pp, 1972.

[5] K. Boyce, "System 80: Teacher who never shouts at pupils," *The Daily Herald, Chicago, Illinois,Thursday, April 5, p. 6*, 1973.

[6] S. G. Smith and B. A. Sherwood, "Educational uses of the PLATO computer system," *Science*, vol. 192, pp. 344–3552., 1976.

[7] C. Staff, "PLATO user's guide," *Control Data Corporation*, 1981.

[8] B. Sherwood, "The TUTOR language," *Computer-Based Education Research Laboratory, University of Illinois at Urbana*, 1974.

[9] M. J. Wichura, "The pictex manual," *T_EX Users Group, T_EXniques Publication Number 6*, p. 85 pp, 1986.

[10] S.-S. Lim, *npj Science of Learning*, vol. 1, p. 16009, 2016.

[11] A. Paramythis and S. Loidl-Reisinger, "Adaptive learning environments and e-learning standards," *2nd European Conference on E-Learning, ECEL*, 2003.

[12] J. Weizenbaum, "ELIZA—a computer program for the study of natural language communication between man and machine," *Communications of the ACM*, vol. 9, pp. 36–35, 1966.

Information Systems and Online Education:
Cloud computing for E Learning in Higher Education

Qasim Alajmi[1,2] Ali Safa Sadiq[1*]

[*1]Faculty of computer systems & Software Engineering
University Malaysia Pahang(UMP)
alisafasadiq@ump.edu.my
Kuantan, Gambang, Pahang(Malaysia)
[2]Department of Computer Science & MIS
Oman College of Management and Technology(OCMT) Barka, Oman
Qasim.alajmi@omancollege.edu.om

Abstract— *E-Learning is one of the significant services in 21st century that all educational institutions across the world should deal with caution. The learners usually look for knowledge either via the traditional-instructional materials or through online gate known as (E learning). the application of e-learning mechanism depends on the level of educational institutions as primary-schools would not be encouraged enough to online services due to lack of enough-experiences, but higher education institutions can adapt such service and force the students to utilize of it through many ways. Information system provides lots of benefits to educational institution through e-learning. However, the application of information system is high in commercial field. Nowadays, the education has changed in many ways and most of the countries have got rid of the traditional-education of their shoulder to the private sector (services provider), so the educational institutions started adapting the information systems to produce emergence technology. This paper highlights the E-Learning services based on cloud computing, the level of awareness among the Higher education institutions about information systems and discuses e-learning system in the present day scenario. Further the paper attempts to unearth the challenges facing educational institutions in the implementation of LMS. Finally, the paper presents some cloud computing deployment models and services which can help the higher education institutions in improving their existing E-learning service.*

Keywords*:* E-Learning, Online Education, Cloud computing, LMS, IaaS.

1. INTRODUCTION

Just like business organizations are transforming by adopting online services, higher education institutions are also seeking a more effective way of implementing their IT services in order to achieve their educational goals easily and and achieve cost-effectively.
As President Nelson Mandela said "…the Internet and education are the two great equalizers in life, leveling the playing field for people, companies, and countries worldwide". They want to adapt by being able to respond rapidly to reach maximum number of learners (customer) in short period of time to implement a business-critical application [1].The higher education institutions need to realize the full potential of their data systems in order to inform the strategic decisions of the future. Accordingly, there is no better way to achieve these unique needs than to adopt the online services.

According to [2] the availability of online teaching and earning study material has augmented the convention of e-learning methodology worldwide. Also, we can utilize of the cloud computing technology for implementing the E services such as online educations. Arias [3] defines cloud computing as a computing paradigm where a large pool of systems are linked either in private or public networks, to offer dynamically scalable infrastructure for major purposes such as application, data and file storage. Similarly, cloud computing is a method of providing a set of shared computing resources including computing storage, networking, deployment platforms and business processes. It provides developers and IT departments with an opportunity to focus on what is critical in order to avoid undifferentiated work such as capacity planning and maintenance. It has become popular following different models and deployment strategies that have been developed to meet specific needs of various users.

2. LEARNING MANAGEMENT SYSTEM

Adopting any LMS (Learning Management System) application would require a decision from the organization whether to hosted internally or cloudily. Application hosting required list of support services to maintain the LMS, such as storage, servers, maintenance and software, this is not recommended by the writer. Alternatively, the type of cloud computing to deploy differs depending on the requirements also. [4] Said: "The primary benefit of cloud computing is cost-effectiveness on demand resource availability and scalability might become an alternate solution for such scenarios. The educational institutions, including schools, colleges and universities, desirous of facilitating e-learning courses and computing resources online to its stakeholders, may adopt the cloud computing service-based solutions which

can provide spot solutions."

The LMS in higher education institutions can be managed by either of the following deployment models, with each having its specific features that support the needs of services offered and the users involved with the clouds:

Public Cloud-This cloud infrastructure can be accessed by the public on a commercial basis through a cloud service provider (CSP). As such, the consumers are able to develop and deploy services with less financial outplay. The financial factor is attractive for higher education institutions as other deployment options are associated with higher capital expenditure requirements.

Private Cloud-This cloud infrastructure is maintained as well as operated for a specific organisation. These operations could be in-house or under the management of a third party still within the promises.

Community Cloud-This cloud infrastructure is shared among various organisations that have common interests. If the higher education institutions were to adopt this type of cloud computing, they would be able to limit their capital expenditure costs in establishing the service as the costs are shared among the institutions. Most probably, satellite campuses have the best chance of using cloud computing infrastructure.

Hybrid Cloud-The hybrid cloud infrastructure hosts a number of clouds of every type. However, these clouds allow data and applications to be moved from one cloud to the other through their interfaces. It can combine the public and private clouds that support the need to retain some data within an organisation.

3.   CLOUD COMPUTING DEPLOYMENT MODELS

A. SaaS (Software as a Service):
SaaS is the most common model of cloud-computing model. It is software that is deployed over the internet in the 21st century. With SaaS, the providers license an application to their consumers as a service that is offered through a subscription in a "pay-as-you-go" model. It can also be offered absolutely free when there is a chance to generate revenue from other streams such as user list sales. With SaaS, the education institutions will not need to think of whether the service is maintained or even how the infrastructure is managed. Rather, the focus will be on how the software will be used. Consumers can access the various applications under SaaS through applications such as Google Docs, Gmail or through other devices such as iPads, laptops and smart phones. Unlike other software used before, the SaaS model does not need a license or an upgrade for it to work. Other advantages of this model include its configurability and multitenant efficiency [5].

With respect to its common features, SaaS is managed from a central location and the software is delivered in a "one to many" model. It requires web access to commercial software, and the users are not required to handle any of the software upgrades and patches. One of its major characteristics is that it allows for the integration between the different pieces of software since it is boosted by Application Programming Interfaces (APIs). Cloud computing, specifically SaaS, has evolved over the past few years as a popular technological method in different institutions. Having said that, the higher education institutions that are considering the move to adopt Cloud computing should decide which of the applications to move to. Some of the recommended candidates to be moved to SaaS include the tax software used on monthly basis. Other applications that have a significant need for mobile access should be moved alongside those applications that interlink the organization and the outside world such as the email newsletter software. However, there are specific situations that SaaS should not be used for software delivery such as applications that require fast processing of real time data or where regulation does not allow the data to be handled externally.

Oman could currently be approaching SaaS with caution. Many of the higher education institutions in Oman rely on applications that have been built on legacy mainframe, ERP platforms, or other home-grown apps. These applications are often difficult to maintain and upgrade which is a venture that takes a toll on their budgets especially now that education institutions are trying to cut down costs. SaaS takes care of these technical and budget issues that have for long nudged the higher education institutions to move closer to the inevitable transition. Some of the universities who have shared their experience of having implemented SaaS have cited significant gains in efficiency, scalability and availability. SaaS can be accommodated by the higher education institutions with ease as it can host various applications, ranging from the horizontally significant tools such as customer relationship management (CRM) to the more vertically useful tools for specific tasks such as classroom scheduling and medical bills management. Furthermore, SaaS has already been proven to be popular across many industries including in higher education since the early 1990s. It has played a significant role in U.S. universities and colleges where students have been able to share ideas, and education infrastructure, resulting in reduction of the various institutions' overhead expenditures. Some of the SaaS providers that could be helpful to the higher education institutions include the Zoho, Salesforce.com and the Google Apps.

B. PaaS (Platform as a Service):
PaaS is defined as a computing platform that enables the consumers to create web applications easily thereby foregoing the complex challenges involved in purchasing and maintaining the software and infrastructure within it. With

PaaS, the cloud service providers provide, operate and maintain the system software and the computing resources. The consumer's role is to manage and run the application software provided by the CSP. Besides giving the customers the chance to access ready to use applications, PaaS gives them the opportunity to design, develop and test the applications directly on the cloud. However, the consumers have to gain access to the platforms by making a purchase to enable them to deploy their software and applications in the cloud computing platform. PaaS has an added advantage as it supports collaborative work between team members, making it suitable for multiple developers working on a common development project. PaaS is similar to IaaS in various ways, but it is unique due to its added value services. It is different from IaaS as it offers a collaborative platform for software development as well as a platform that allows software creation using proprietary data from an application. The major goal of the PaaS providers is to create an abstracted process that accommodates the deployment of high-quality applications that can be implemented either in public or private cloud models.

Despite its added advantages, the PaaS should not be used in cases where the applications require to be extremely portable with respect to where it is hosted. It is also not suitable where the proprietary approach would impact the development process or act as a hindrance to future moves to other providers.

C. IaaS (Infrastructure as a Service):

The IaaS contains the building blocks for cloud computing in IT. Just like the SaaS, IaaS is also developing at a fast rate to offer organizations an edge in terms of higher flexibility and management control over the IT resources. The IaaS delivers the Cloud Computing infrastructure such as servers, network and the operating systems as on-demand services. It is the most straightforward platform of the three models as it delivers computing resources in the form of virtualized operating systems, hardware, software and storage services. It can be obtained either as a public or private infrastructure and/or both. The public cloud infrastructure is basically what consists of the shared resources that are provided on a self-service basis to the users over the internet. As for the private cloud infrastructure is concerned, virtualization is practiced more in the form of the Cloud Computing features. According to [6] some hosting providers are now offering a combination of traditional hosting along with public and private cloud networks. According to [7], the consumer has the main responsibility of running and maintaining the operating system as well as the software applications on the virtual recourses.

IaaS acts as a practical solution for institutions and organizations that want access to resources through an on-demand basis. It is also used to augment the data center services. Through this function, the providers are able to increase capacity on demand, replace the worn out hardware

with cloud-based services and offer a continuous access to sophisticated services. Just like the major aim of any service model in business is to enable the specific organization to access an on-going support as the business changes, IaaS allows the organizations to experiment with modern innovative software approaches with minimal budget alterations. Some of the core characteristics that describe IaaS allow for multiple users per a single piece of hardware. The IaaS allows for dynamic scaling as the resources are distributed as a service. It makes sense in several situations that are also closely linked to its major benefits. Some of the most appropriate situations that deserve to be enhanced by the IaaS include where there are variations in demand of the infrastructure. It is also appropriate for companies that have insufficient capital to invest in hardware [8]. Some of the higher education institutions were inspired by this feature to adopt cloud computing. Even more appropriate is if the organization is growing rapidly in such a way that scaling the hardware would pose a huge challenge. IaaS is also suitable where an institution has an increasing pressure to limit its capital expenditure and try to compensate that with a more efficient operating expenditure [9]. Evidently, the higher education institutions need to compete while being able to minimize their costs and capital expenditure. Therefore, the best option is cloud computing. It appears to be a good inspiration to adopt cloud computing for the higher education institutions, but it is not recommended where its limitations could be a hindrance. Such situations include situations where regulatory standards make data outsourcing more difficult. It is also not applicable where a higher level of performance is expected, or the current infrastructure still has the ability to meet the stipulated needs efficiently. One of the most famous public infrastructures in IaaS includes the Amazon's Elastic Computing Cloud.

4. IMPORTANT FEATURES/BENEFITS THAT CLOUD COMPUTING COULD OFFER TO EDUCATION INSTITUTIONS:

- ❖ Increased access to the limited IT expertise
- ❖ Decreasing capital expenditure and total costs of information technology in higher education institutions
- ❖ Enables the sourcing of either cycles or storage powered by renewable energy
- ❖ Scales IT services as well as resources
- ❖ Promotes additional IT standardisation
- ❖ Facilitates the direct match of IT costs, demand and funds
- ❖ Increases interoperability within previously disjoint technologies between institutions
- ❖ Free up more resources to support the core mission of the higher education institutions
- ❖ Enables universities to take advantage of the economies of scale they previously could not have achieved

5. CHALLENGES AND SECURITY ISSUES FACED WHEN IMPLEMENTING THE CLOUD COMPUTING SERVICE

The challenges around implementing the cloud computing service within the higher education institutions in Oman relate to trust confidence and surety. Building an IT institution's confidence in a system requires a combination of consistency in performance, service guarantees, transparency and plans for contingencies [10]. In most instances, cloud services may not have the track-assured record on which one can build the needed trust to shift the existing services without a proven compelling benefit. These service attributes, unfortunately, come with time and experience. On top of these challenges, most IT organisations within the higher education institutions are usually not highly skilled in assessing and managing risk as well as service performance in 3rd parties. Other challenges may include poor and/or non-existent service level agreements, market immaturity and management issues [11].

Some cloud-computing requirements are similar across all sectors. However, The Learning Management System (LMS) such as TalentLMS.com in higher education institutions face particularly challenging circumstances in several areas. Specifically, higher institutions in Oman may face the challenge of finding the right balance between private and public cloud. They must determine the right balance after considering all the security and legal issues and then pursuing change management strategies so that all the stakeholders can comprehend why the institution favours one application over another. Secondly, data privacy implications tend to be the major concern for higher education IT organisations. In the past decade, security has assumed an added dimension of complexity due to the development of bring-your-own-device programs in many education institutions [12]. As such, the Oman education institutions could find themselves being overwhelmed by the huge number of devices all requiring some form of on-college protection.

According to [13], the magnitude of the involved risks is amplified by the burden of public trust associated with institutions that conduct research on human objects. What's more, the institutional culture acts as a real barrier to incorporating any of the above cloud computing models. Numerous research reports indicate that IT security and regulatory compliance also play a huge role in hindering the adoption of the cloud computing services being offered [14]. IT experts in higher education institutions identify potential security breaches as the biggest barrier to adopting cloud computing models. There is a need to address the privacy issue that makes the above concerns real as they can be resolved through architecture. Unless the higher education institutions in Oman commit to study these issues, they may not be motivated to adopt the cloud computing services. Therefore, if the higher education institutions in Oman choose to adopt the cloud computing services, they could be faced with the following common risks associated with all cloud computing services in all industries:

❖ Lack of consumer isolation with the use of secure, scalable and multitenant services.
❖ Security which is not adequately focused during application.
❖ Failure to optimally exploit cost-saving initiatives such as disaster recovery during the cloud computing process.
❖ Insufficient virtualization within the computing resources.

Whichever cloud computing strategy adopted by the Oman higher education institutions, it should always remain focused on firmly positioning education as the institutions' priority. In higher education institutions, the major objective of cloud computing does not have to be geared towards reducing the headcount in IT. Instead, the major objective is to give technology an opportunity to support the higher education institutions by providing education to the students.

6. FEATURES/BENEFITS OF E LEARNING TO EDUCATION INSTITUTIONS FORM LEARNER POINT OF VIEW:

There are significant advantages of having E Learning approach for the organizations in general, and for the education purpose in particular. This study has brought out the following features/benefits of e-learning approach in higher education institutions:

❖ Time and location independence: The learner can access to the uploaded material at any time, from anywhere. This will help the learners who don't have time to follow fixed schedule to attend the classes physically.

❖ Cost cutting: The learner does not have to spend some money for traveling form one place to another to attend the class in particular college or university. This will save traveling cost and time.

❖ Self-paced: The learner will have the options to choose the courses and materials from varies options which they are interested in and meeting their need for that period of time.

❖ Faster learning curve: The learners will skip the knowledge that they are aware about, they will be seeking to new knowledge and information as they will select the content where they would need more training.

❖ Easy management: The LMS requires less updating efforts and time, because you will need to update the content on the server only, irrespective of its being hosted or clouded.

7. CONCLUSION

Innovative higher education institutions seek to understand how and where to deploy the cloud computing models

efficiently and securely to improve the E learning system in a manner that decision makers can play the right role. Their choices promise to transform the role of technology in their institutions. The higher education institutions need to keep up with various competing demands, such as delivering web-based services to students at a rapidly accelerating pace without any proportionate increase in budget for upgrading software, hardware and improved personnel. They also need to compete against the rest of the global higher institutions, the majority of which are adamant in differentiating themselves in the market with respect to the services they offer to their learners. Therefore, to support the transition, the higher education institutions must develop the most suitable cloud-computing strategy that addresses the problems and needs unique to every institution. The strategy has to have a risk-assessment framework in order to lead the practitioners through a risk-analysis of both premises and cloud-based delivery alternatives. Adopting cloud-computing services in higher education institutions has to be conducted cautiously as the unique models have different usage of resources. Since it is a relatively new adoption in many countries, the higher education institutions that wish to transition have to maintain contact with the organizations that establish the industry standards in order to ensure that there is a uniform and smooth transition. The three explained deployment models have to be selected carefully by the institutions to match their need of services.

8.   REFERENCES

[1]   Katz, R. N., & Educause (Association). (2008). *The tower and the cloud: Higher education in the age of cloud computing*. Boulder, New York: McGraw-Hill.

[2]   Kaewkiriya T, Utakrit N and Tsuji H (2011), "*Experimental Evaluation of Distributed e-Learning Management System*", IEEE TENCON, pp. 1044-1048.

[3]   Arias,T.(2011). The cloud computing applications handbook: Everything you need to know about cloud computing applications.S.L: Emereo Pty Limited.

[4]   Narayan A, 2014, 'Performance-Centric Cloud-Based e-Learning', *The IUP Journal of Information Technology*, Vol. 1, No. 2, 2014, pp. 1-9.

[5]   Chao, L. (2012). Cloud computing for teaching and learning: Strategies for design and implementation. Hershey, PA: Information Science Reference.

[6]   Terplan, K. (2011). *Cloud computing*. Mitp/bhv, Heidelberg, Neckar: mitp/bh.

[7]   Sosinsky, B. A. (2011). *Cloud computing bible*. Indianapolis, IN: Wiley.

[8]   Korzeniowski, P. (2011). *Profiles of the use of cloud computing in higher education*. New York: Primary Research Group.

[9]   Mahmood, Z. (2011). Continued rise of the cloud: Advances and trends in cloud computing. Springer.

[10]   McDonald, K. T. (2010). Above the clouds: Managing risk in the world of cloud computing. Ely: IT Governance Pub.

[11]   Leymann, F. (2011). *Cloud computing*. München: Oldenbourg.

[12]   Catlett, C. (2013). *Cloud computing and big data*. Amsterdam: IOS Press.

[13]   Rittinghouse, J. W., & Ransome, J. F. (2010). *Cloud computing: Implementation, management, and security*. Boca Raton: CRC Press.

[14]   May, J. (2011). *Cloud computing*. Atlanta: 3rdness Press.

An Adaptive Brain Computer Interface Collaborative m-Learning System

AbdelGhani Karkar

Department of Computer Science and Engineering

Qatar University

Doha, Qatar

a.karkar@qu.edu.qa

Abstract—**Brain-Computer Interface can read brain signals and transform them into readable information. It can be used in the education field to enhance learning capabilities. For instance, an instructor can use such device to track interest, stress level, and engagement of his students to adapt his teaching approach. We propose in this paper a mobile learning system that can automatically adapt its content to keep students engaged while the instructor is explaining the material. The main aim of our system is to enhance those children learning capabilities, engagements, thinking, and memorization skills.**

Keywords— Mobile Learning; Brain Computer Interface; Automatic Content Adaptation; Virtual Reality; Education.

I. INTRODUCTION

Nowadays mobile devices opened a new horizon for learning. As most people own handheld private portable smart devices, this has become the main means of connectivity and communication between people. Using smart devices for learning is beneficial and more attractive as learners can access educational resources at any time. Different eLearning systems provide diverse options for classroom environment. However, they do not consider all effective needs to adapt learning materials.

In the other hand, brains are saturated with neurons. Neurons work at every time an individual thinks, feels, moves, or remembers. The work can be carried by slight electrical signals that move from neuron to another. A brain-computer interface (BCI) is a device can read brain signals of an individual, and transform them into readable information. It can be employed with computer devices, such as computers, smart devices, prosthesis, and others.

While mobile devices can be employed in schoolroom, and BCI devices can support ad-hoc connectivity to read brain signals, an m-learning classroom environment would be practically organized with low costs. In this study, we propose an m-learning system that uses BCI device to adapt its content automatically to keep the reader engaged to access learning materials.

The following section II contains more information about previous studies. Section III presents the m-learning system with its functionalities. Section IV gives details on the system implementation. Section V describes experiments and evaluation for the system. Finally, section VI concludes the paper.

II. BACKGROUNDS

Diverse BCI based solutions have been proposed to perform automatic adaptation of content according to the engagement level of the user [1-3]. Marchesi and Ricco [1] introduced an e-learning system that operates with BCI to straighten the educational experience. The adaptation is based on the reactions of the user and preferences. The proposed system showed performance improvement through neurofeedback loops and computerized adaptive testing (CAT) [4]. Lóska [2] proposed an attempt to develop an automatic based quantitative measurement of satisfaction using BCI to monitor the mental states of users. The study showed that the attention variable is a reliable one to measure satisfaction. Ghiani et al. [3] proposed an adaptive user interface framework based on physiological measurements. The general objective of the proposed framework is to provide as a tool content developers of Web applications, such as operator of online learning management systems. Thus, using the proposed approach, a teacher can make his educational contents and identify how to automatically adapt content based on students' behavior to enhance learning process.

Huang et al. [5] proposed an mental signals-augmented reading system called "FOCUS". It monitors the engagement level of children in real time, and provides contextual BCI training sessions to improve the accuracy of detecting the engagement level. An experiment has been conducted to analyze the validity of the system. Results presented that the proposed system can increase engagement significantly. Yan et al. [6] developed a system to track in real time the engagement level of audience using BCI device. The system triggers the adaptive cues relying on the engagement level received from the BCI device. The system showed that it can detect the level of the engagement and perform dynamic adaptation to retain the engagement level of the user.

Abdelrahman et al. [7] proposed a BCI based concept and preliminary study to detect the engagement level of museum visitors. Detecting the engagement in the museum can be used implicitly to organize and adapt the museum to satisfy the tastes of its visitors.

Coelli et al. [8] conducted a study to assess the association between mental engagement level and endured attention in nine hale adults carrying out a Conners continuous performance test (CPT) [9]. Assessment results confirmed the relation between engagement, afforded attention, and vigilance. Andujar et al. [10] depict a proof-of-concepts examines how users can conserve information though incrementing reading engagement physiologically. McCullagh et al. [11] employed BCI devices to assess the readiness of the technology for teaching and learning application. Authors proposed a hybrid BCI methodology the can be utilized to collect mental signal data during immersive control task. The alterations in the in the signals give thematic measures concerning user engagement with tasks.

As many systems have been proposed to perform dynamic adaptation by reading brain signals. BCI technology is not considered as part of a mobile educational system that can surround the environment with reading mental signals to automatically adapt the content.

III.   The Proposed System

Our proposed system can generate illustrative images through textual sentences. The system can adapt the generation of illustrations according to the engagement level of the user. The adaptation is based on facial expression and on brain signals. The mobile device can connect a multimedia server to fetch required objects. The instructor can manually define his own content and attach illustrative pictures that can be automatically adapted. The automatic adaptation of illustrations would become further time efficient according to the process of machine learning.

In order to create our multimedia storage, we have fetched diverse educational resources and collected required pictures that can be loaded in two modes: 1) normal view: the user can use this mode to see the image on the mobile device; and 2) 360° panoramic view: this mode enables the user to see the image of any angle of a physical space. Thus, the students can visualize graphical depiction of words linked to their characteristics (e.g., brown doggy, white rabbit, etc.) and their behaviors (e.g., eat, play, etc.). For instance, for the sentence 'the brown doggy is running', the student can see illustrative image that depicts the sentence. The device of the instructor is the primary device that can control student devices. It can operate with headset mounted device (HMD), such as Cardboard box [12], to extend the perspective with fully immersive virtual reality (VR) mode.

The system is composed from different components as following: 1) Natural language processing: this component processes the sentence entered by the user and determines the required illustrations; 2) Scene generation: it fetches the required illustrations from the multimedia storage; 3) Knowledge base: this component defines terms semantically and their relationships; 4) Communication: it provides the ability of exchanging messages between end-to-end devices.

A.   Applied Methodology

We have used the IEEE 1074-2006 standard criterion to develop our system. It is a standard for evolving software project life cycle procedure [13]. We have designed the client-server architecture for the system, defined the required services, and devised the user interface. Consequently, we put a structure to build our educational frame. We put a prototype to define required settings to automatically load images and to know possible characteristics. For instance, *What are the possible colors of a rabbit? How to automatically color objects?* Eventually, we have designed a databased schema enables storing data about any type to benefit from semantic interlinking.

B.   EEG Data

Electroencephalography (EEG) is a method to monitor brain electrical activities. Electromyography (EMG) is a technique to evaluate and monitor electrical activities resulted by skeletal muscles. EPOC Plus (EPOC+) device [14] has been employed to read both EEG and EMG header data which include gyro (GYRO), accelerometer (ACC), MAG-Netoencephalography (MAG), and facial expressions. These data can provide information such as engagement, observation, excitement, and so.

C.   Message Structure

The message is serialized in JSON [15] format. It is composed of three sections: 1) *message ID*: is a globally unique identifier (GUID) to identify the message; 2) *header*: used to identify the type of the message (e.g., heartbeat, broadcast, etc.); and 3) *content*: contains the serialized content as a result from the server, or as update request from the instructor device.

IV. System and Mobile Application Implementation

A.   Modules

The system consists of five modules as shown in Figure 1: 1) The *BCI Data Processing* module provides the functionality of analyzing facial expressions and brain signals according to trained data sets. 2) The *Adaptation* module adapts the content according to the engagement level of the children (e.g., change the 2D image into 360° panoramic one, etc.). 3) The communication module provides the logic of

sending and receiving messages in live mode. 4) The Presentation module provides the services to control the application and enter required sentences. Finally, 5) the *Knowledge Base* module supplies services of loading educational materials.
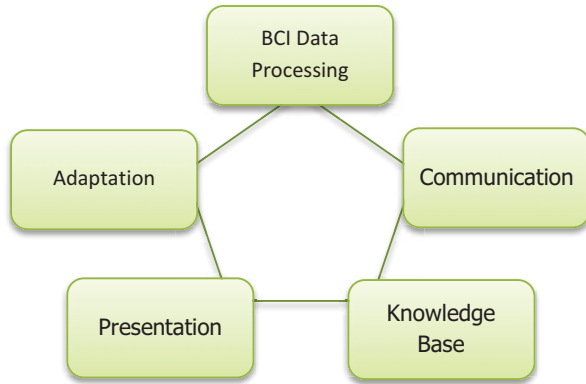

Fig. 1. System modules.

B. System Architecture

The architecture of the system is composed of two parts: 1) a messaging server that executes messages according to their priority. And 2) a client application that uses the API of the server to exchange messages in real time. The main benefits of this architecture are: 1) to separate the logic of processing information from the presentation; 2) to provide a secure reliable connection; 3) to reserve the reusability and efficiency of packages; and 4) to reserve messaging techniques and track system failures remotely. Figure 2 shows the architecture of the proposed system.

Fig. 2. The proposed architecture.

The Client mobile application is a hybrid application created with Unity 3D game engine [16]. It can be released to operate on different kind of smart devices (e.g., iPhone, Android, etc.). The client application establishes a socket connection with the server to exchange required information.

C. EPOC+ Communication

EOPC+ has been used in order to read EEG data and facial expressions. EPOC+ can be used with devices that support Bluetooth Smart (LE). Android 6.0 (API 23) has been employed to access Bluetooth LE package. Figure 3 shows a code block done in C Sharp programming language [17] to train cognitive actions (mental commands).

```
01    // called once every frame
02    void Update () {
03      // train the neutral state
04      if (Input.GetKeyUp(KeyCode.N))
05        EmoCognitiv.StartTrainingCognitiv(
06          EdkDll.EE_CognitivAction_t.COG_NEUTRAL);
07
08      // train the lift state
09      if (Input.GetKeyUp(KeyCode.L))
10        EmoCognitiv.StartTrainingCognitiv(
11          EdkDll.EE_CognitivAction_t.COG_LIFT);
12
13      // train the push state
14      if (Input.GetKeyUp(KeyCode.P))
15        EmoCognitiv.StartTrainingCognitiv(
16          EdkDll.EE_CognitivAction_t.COG_PUSH);
17
18      // train the pull state
19      if (Input.GetKeyUp(KeyCode.B))
20        EmoCognitiv.StartTrainingCognitiv(
21          EdkDll.EE_CognitivAction_t.COG_PULL);
22
23    }
```

Fig. 3. Code block to train cognitive actions

The variation of brain data happens every time an individual thinks. Figure 4 shows an example of the different performance metrics changing on level Y and time X. It shows also two colored periods: 1) grey period: it is the normal period prior showing an attractive illustration; and 2) red period: it is the attractive period when a random attractive illustration has been displayed. The engagement level increased significantly when the user saw the attractive image.
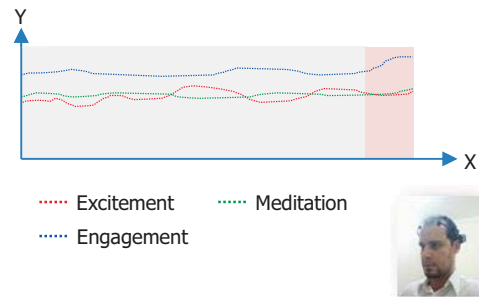

Fig. 4. Performance metrics.

D. Knowledge Base

We have designed a light database schema to store data about all types of objects. Hence, all information about objects are extracted from a database created with MySQL [18]. The database contains educational

explanations, information about objects (e.g., nature, insects, etc.), relations, and illustrations. The relation between objects can be recursive where an object can be linked to another one through a named link relation. For instance, one possible relation between canary bird and pine forest is lives in. Hence, it is possible to get all related information about pine forest and other related information. Figure 5 shows the schema of the developed database. The table *ETypes* can be accessed to determine the type of the object (e.g., word, sentence, explanation, etc.). The table *Objects* stores required information about the objects. Thus, objects can have hierarchical relations connected through the attribute ParentID. The table *Relations* defines the connection between two objects. Objects can have sequential relations. For example, the second stage of the *fish* lifecycle is *Larval*. The table *Links* can be used to determine the link type between objects (e.g., the link between *fish egg* and *fry* is *next stage*). It can be also used to show a sequence of objects' connections (e.g., the next stage of *fish egg* is *fry*, and the next stage of *fry* is *adult*). Eventually, the table *Illustrations* stores the images that can be used to illustrate objects.
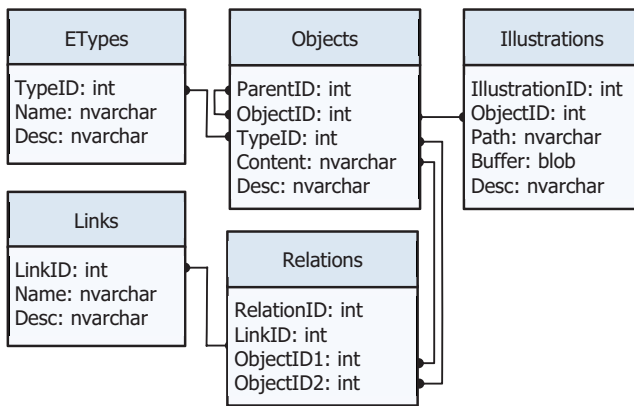

Fig. 5. The database schema.

D. Messages Types

There are four different types of messages: 1) *heartbeat*: a periodic message sent initially from the client to the server device. If the server did not receive the heartbeat message within a specific interval it will mark the client device as disconnected. 2) *broadcast*: the message that contains information that should be distributed to all users that are working together, 3) *getcontent*: a request message sent to the server to get the new content, 4) *content*: the message that contains the buffer of the message, 5) *processsignals*: a request message sent to the server to process BCI data. The request has a flag identifies if data samples are compressed or not, and 5) getlast: is a request message sent to the server to get latest content. It is often used when the client device joins the network late or if it lost the connection.

E. System Operation

When the server starts, it loads its components and opens a TCP connection to receive the users' requests. After launching the client application, it attempts to connect the server, which verifies whether the authentication is valid and establish the connection with the end user.

Upon a successful connection attempt, the user will be able to enter or load existing stories and process them. When the instructor choses a new request, a query message will be created and distributed to all student devices. When the server receives the request, it parses the message and checks the header of the message to identify which function will be executed. After processing the query, the server puts the result in a structure serialized in JSON format. According to the type of the request (i.e., get or broadcast), the server returns the result to the device or broadcast it to other ones.

In order to make the phase of processing messages hidden from the user, messages are being processed in different threads. Thus, the user will take the advantage to continue his work normally in the class without waiting. In the other hand, while the server is processing the requests, it displays all the required information that the administrator may use in order to perform analysis or report certain malfunctions happened. Furthermore, the server application can be configured to send emails depending on the priority of the error, to keep the administrator aware of the server performance. Figure 6 shows client-server sequence diagram to present the different communication phases.
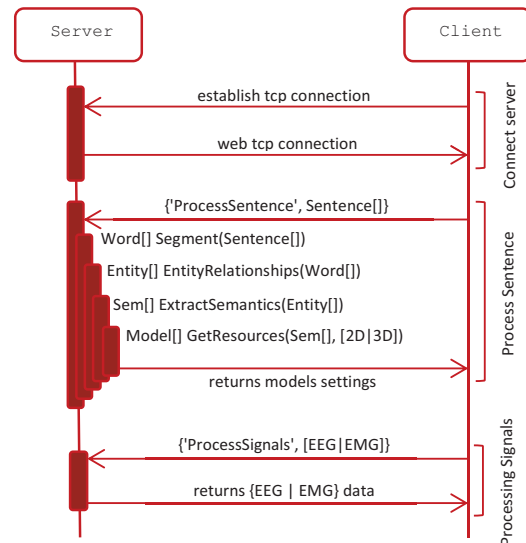

Fig. 6. Sequence diagram.

While the application is running, it stores in a log file: when the application started, when it is closed, the GUID of all received messages, and the receipt time of each. The log file is used to validate the receipt of messages and to compare the consumed time used prior receiving them.

When the client finishes processing the broadcast message, it loads the content, retrieves the required pictures, and displays them. Finally, Figure 7 shows different adapted multimedia scenes on two different mobile devices.

Fig. 7. Adapted environment on different mobile devices.

V. EXPERIMENTS AND EVALUATION

The implementation of the system still incomplete, we have done a preliminary assessment for twenty five users who age between 3 to 19 years old. The assessment consists from: (1) the preferred drawing type (i.e., cartoon or realistic 3D model), and (2) the animation rate.

A. Drawing Type

In this section, the evaluation of drawing type has been maintained. The scene is set to automatically change to assess the attraction of the user. The user has been asked which type he liked the most. Figure 8 illustrates the preferences of users using questionnaire.
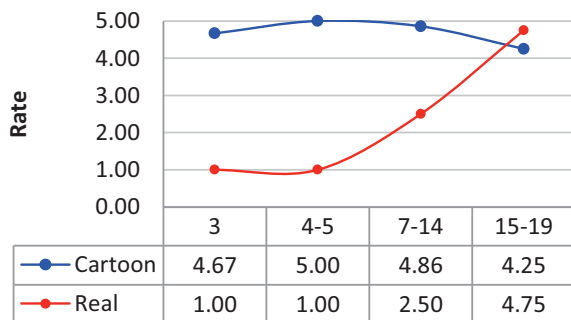

	3	4-5	7-14	15-19
Cartoon	4.67	5.00	4.86	4.25
Real	1.00	1.00	2.50	4.75

Fig. 8. Preffered drawing type of different ages using questionnair.

Discussion: based on the results above, users between 1 and 14 years old preferred to see cartoon scenes. While users age above 14 years old preferred to see realistic illustrations. As the implementation is incomplete, the results of questionnaire will be compared with the obtained results of the BCI device. Therefore, in order to keep users who are between 1 and 14 years old engaged, it will be appropriate to show more cartoon illustrations with few real ones. In the other hand, to keep users who are between 15 and 19 years old engaged, it will be adequate to focus more on realistic illustrations with few cartoon ones.

B. Animation Rate

In this section, users have been asked to rate how much they prefer to see animation while seeing illustrations. The rate can be in an interval from 0 (do not want animation) to 5 (i.e., want animation). Figure 9 shows the animation rate.
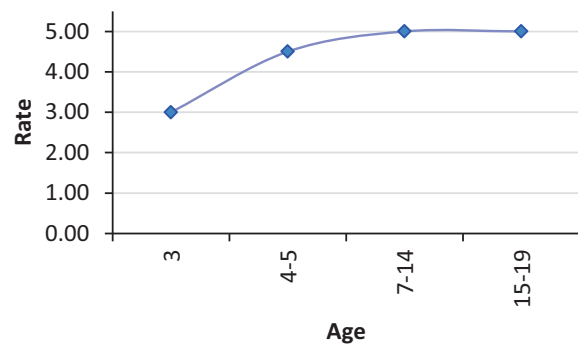

Fig. 9. Rate for animated images.

Discussion: based on the results above, most users preferred to see animation while watching illustrations. It might be hard and time-consuming to animate illustrations, generating 2D/3D scenes with predefined animation paths and automatic rigging can be considered another research. In the other hand, to keep users engaged, it is possible to display 3D models with the ability of rotating the object in different perspectives.

VI. CONCLUSIONS

This study proposes a collaborative m-Learning system that illustrates the content of sentences. The mobile application tracks the brain state of the user to determine his engagement level, interest, and focus. The system becomes more practical when it exerts to automatically adapt the content to keep the student engaged while the instructor is giving the material. The system can be used to teach children in an attractive and non-traditional ways. The main aim of the system is to enhance children engagements, learning capabilities, understanding, communications, and memorization skills while reducing the administrative and teaching overhead through automating the adaptation procedures and learning process.

REFERENCES

[1] M. Marchesi and B. Riccò, "BRAVO: a brain virtual operator for education exploiting brain-computer interfaces," in *CHI'13 Extended Abstracts on Human Factors in Computing Systems*, 2013, pp. 3091-3094.

[2] Á. Lóska, "BCI and virtual collaboration," in *Cognitive Infocommunications (CogInfoCom), 2012 IEEE 3rd International Conference on*, 2012, pp. 89-94.

[3] G. Ghiani, M. Manca, and F. Paternò, "Dynamic user interface adaptation driven by physiological parameters to support learning," in *Proceedings of the 7th ACM SIGCHI Symposium on Engineering Interactive Computing Systems*, 2015, pp. 158-163.

[4] D. O. Segall, "Computerized adaptive testing," *Encyclopedia of social measurement,* vol. 1, pp. 429-438, 2005.

[5] J. Huang, C. Yu, Y. Wang, Y. Zhao, S. Liu, C. Mo*, et al.*, "FOCUS: enhancing children's engagement in reading by using contextual BCI training sessions," in *Proceedings of the 32nd annual ACM conference on Human factors in computing systems*, 2014, pp. 1905-1908.

[6] S. Yan, G. Ding, H. Li, N. Sun, Y. Wu, Z. Guan*, et al.*, "Enhancing Audience Engagement in Performing Arts Through an Adaptive Virtual Environment with a Brain-Computer Interface," in *Proceedings of the 21st International Conference on Intelligent User Interfaces*, 2016, pp. 306-316.

[7] Y. Abdelrahman, M. Hassib, M. G. Marquez, M. Funk, and A. Schmidt, "Implicit Engagement Detection for Interactive Museums Using Brain-Computer Interfaces," in *Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct*, 2015, pp. 838-845.

[8] S. Coelli, R. Sclocco, R. Barbieri, G. Reni, C. Zucca, and A. M. Bianchi, "EEG-based index for engagement level monitoring during sustained attention," in *2015 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, 2015, pp. 1512-1515.

[9] C. K. Conners, M. Staff, V. Connelly, S. Campbell, M. MacLean, and J. Barnes, "Conners' continuous performance Test II (CPT II v. 5)," *Multi-Health Syst Inc,* vol. 29, pp. 175-96, 2000.

[10] M. Andujar and J. E. Gilbert, "Let's learn!: enhancing user's engagement levels through passive brain-computer interfaces," in *CHI'13 Extended Abstracts on Human Factors in Computing Systems*, 2013, pp. 703-708.

[11] P. McCULLAGH, G. LIGHTBODY, L. Galway, C. BRENNAN, and D. TRAINOR, "Assessment of Task Engagement using Brain Computer Interface Technology," in *Workshop Proceedings of the 11th International Conference on Intelligent Environments*, 2015, p. 244.

[12] J. Vandecasteele, F. Dieke, and C. Vandekerkhove, "Cardboard box," ed: Google Patents, 2007.

[13] D. J. Schultz, "IEEE standard for developing software life cycle processes," *IEEE Std,* pp. 1074-1997, 1997.

[14] (2015, May). *Emotiv EPOC+*. Available: https://emotiv.com

[15] D. Crockford, "The application/json media type for javascript object notation (json)," 2006.

[16] R. H. Creighton, *Unity 3D game development by example: A seat-of-your-pants manual for building fun, groovy little games quickly*: Packt Publishing Ltd, 2010.

[17] A. Hejlsberg, S. Wiltamuth, and P. Golde, *The C# programming language*: Adobe Press, 2006.

[18] A. MySQL, "MySQL: the world's most popular open source database," ed, 2005.

Evolution of ICT industry landscape and its impact on higher education competencies

Abdelaziz Bouras[1]**, Alanood A. Zainal**[1] **and Mahmoud S. Abdulwahad**[2]

[1]Department of Computer Science and Engineering, Qatar University, Doha, Qatar
[2]Technology Innovation & Engineering Education unit (TIEE), Qatar University, Doha, Qatar

initial_of_firstname.lastname@qu.edu.qa

*Corresponding Author: abdelaziz.bouras@qu.edu.*qa

Qatar University, College of Engineering
Po. Box 2713 – Doha, Qatar

Abstract- Higher education sector is one of the main suppliers of work force to the working industry and economy. The dependability of the industry on higher education adds pressure in how academic programs are constructed, constantly trying to meet the ever changing industry requirements for competencies. This paper reports on the Information and Communication Technology (ICT) growing needs in Qatar and analyses the relevant functions, descriptions and components related to competency models and education skills.

Keywords: ICT Skills, Knowledge, Competency models, Education.

1. Introduction

Understanding what the industry requires andwhat opportunities are available for certain majors could also potentially be a good source for career guidance to students. In Qatar, like many other countries, the development of educational curricula need to keep pace with the growing complexity of the industry, technology and economy. Moreover, research outcomes of educational institutions, typically presented to the scientific community need to be directly accessible to the industry. This will help the industry stakeholders to comprehend and to adapt to the technological advances in a direct way. As illustrated by the Knowledge Triangle concept in Figure (1) proposed by Westkämper et al [1], knowledge is supplied by both universities and research institutes and then implemented in the industry. The need for integrating the cornerstones of the knowledge triangle into a single framework to support

education has given rise to a number of learning paradigms and mechanisms.

On the other spectrum, industry employers may not be fully aware of the new learning outcomes that are generated by programs to fit the new jobs they aspire to offer. They may not be also aware of new programs emerging and how can interdisciplinary programs fit into different types of jobs at the same time. Understanding the employee's education may be a key to identify what training programs are required in their first few years of employment. The analysis could potentially save the company money by avoiding training programs that generate competencies which the employee already possesses.
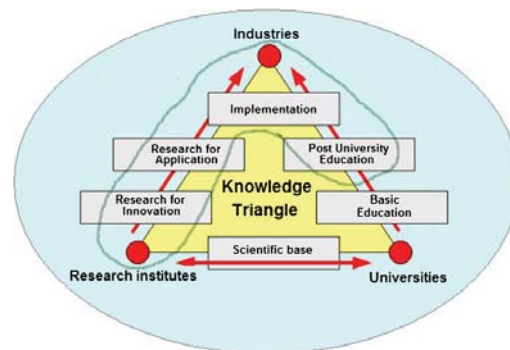

Figure 1. The Knowledge Triangle

This work is linked to a collaborative research project, titled PROSKIMA (PROfessional education development and SKIlls Management) - NPRP 7-1883-5-289- and awarded by QNRF [2]. The paper aims to study existing competency reference models and

refine is specific to Qatar's context.

2. Competency reference models

Competency models have gained popularity in the last decade for their use in developing human resource strategies. Reference models are promoted by consultants and technology providers with the promise of enhancing effectiveness in the organizations using them in their HR functions. They are mainly used by organizations that seek the competency approach in their HR practices [3]. A reference model could be in its simplest form, a standardized list of competencies that the organization desire their employees to acquire. Reference models would typically describe competencies in a high level and then cascade down to sub skills and competencies to further detail the use of the model. The model must contain a clear definition for every competency and must have a standard that enables measuring and assessing the competency for each assessed individual.

2.1 Competencies within the ICT industry

Since the 1990's, a need has emerged to define skills and competencies demanded and supplied by the industry due to their importance in job placements [4]. Many national initiatives have been lead in order to formalize the definitions of competency and skills in the industry. Examples include O*NET [5] in the United States, "AMS-Qualifikationsklassifikation" in Austria, "Kompetenzenkatalog" in Germany and "ROME" in France [4]. These approaches have been classified to define competencies and skills as three main approaches. The first approach is used by psychologists, it specifies that skills and competencies are measured by comparing portfolios in a quantifiable way. This method is highly standardized, basic and does not cover identifications of competencies in depth. The second approach relies on building individual portfolios by collecting documents such as reports and certificates. On the contrary of the first method, this method is highly individual, non-standardized and could be used by any individual regardless of his qualification. The third method is simply using a comprehensive list of competency and skills to describe profiles of individuals, this is considered to be a standardized method that could apply universally to all individuals.

2.2 Competencies generated from academic programs

In higher education institutions, academic programs are developed mainly using two approaches. The approaches seem to relate to applying science and work place requirements. In developing curricula, the first approach uses applied sciences as an input, in the contrary the second approach uses work place skill requirements as an input to develop programs. The first approach bases the curriculum around teaching the basic and core knowledge in the relevant science discipline, where it is believed that learned knowledge would help students in acquiring the basic skills needed in their workplace after they graduate. The second approach starts with analyzing the required job skills needed to perform a task and later a curriculum is developed to generate the correct competencies looking for a job in that specific field. The second approach of curricula design would require an assessment of the current local and global trends in technology and demand of competencies to perform the different sets of jobs. The outcome of the assessment should lead to designing a competency framework, where programs in different disciplines could refer to when designing their curricula.

Higher education institutes use different methods to model competencies in order to be able to start developing the curriculum method of their academic programs. One of the most well-known methods is DACUM (Designing A CUrriculuM) [6]. The DACUM model was born in Canada and then disseminated at the international level [7]. It consists of a top-down analysis: a profession, a function or a family of occupations or functions. First, the subject of analysis is determined, then the different responsibilities or the constituent tasks of these occupations or functions are defined, in turn they are broken down into tasks, subtasks, actions, each with an analysis of the knowledge, skills, standards, resources to be mobilized. The originality of this method is that it relies only on small groups of professional experts who comes from the same professional domain. The experts are considered to be well positioned to describe their own work. Moreover, the analysis is not exclusively made by experts themselves, it also includes some representatives of trade unions, employers, academics, policy makers, etc. This is necessary because the outcome is not only a technical analysis, but also an agreement between different social partners: companies, schools (or universities), states, and representatives from trade unions [8].

Hence, the principle of using the DACUM method relies on the knowledge of experts who perform the daily task of the job, which the assessors are interested to analyze. Educators get to interact one to one in a workshops to help them understand the competency requirements and find the answer to "what needs to be taught?" when developing a new academic program. One of the main reasons this method is effective is because it has been identified that there is a gap between what education programs offer and between the skills that are actually needed by employers [6].

Another model is the European e-Competence Framework (e-CF), which was established as a tool to support mutual understanding and provide transparency of language through the articulation of competences required and deployed by ICT professionals [9]. A framework has been developed, maintained and supported in practical implementation by a large number of European ICT and HR experts in the context of ICT. The Information Security Management part for instance, related to cybersecurity is very informative. It ensures that security risks are analyzed and managed at all levels with respect to enterprise data and information strategy.

The Information Technology Competency Model [10] is also another contribution that uses a pyramidal representation of layers to represent the information. The arrangement of the tiers in such shape implies that competencies at the top are at a higher level of skill. Other models exist but the summarized models in this section are among the closest ones to our needs. They are rather generic and do not clearly tackle the complexity of the specific nature of some particularities in the graduate ICT degree levels and their dynamic issues such as Cyber security problems. For the specific issues, complementary field expertise is necessary (interview of experts).

3. ICT demand of skills in Qatar

To support its 2030 vision, the state of Qatar has established a Supreme Council --in 2004 through an Amiri decree [11]-- than a Ministry of Information and Communications Technology (ictQATAR) which currently merged with the Ministry of Transport to form the new MOTC Ministry of Transport and Telecommunications). Realizing the major role ICT is playing currently, one of MOTC's main aims was to ensure that all Qatari society acquires the skills and knowledge to use ICT in their daily life and uses ICT effectively and safely. The Digital Society Program they offer

focuses on enhancing digital inclusion, digital literacy, developing ICT skills and Digital Impact and Emerging Technologies [20]. To support their objective in developing ICT skills in the Qatari society, TumuhaTEC initiative have been launched [12]. The initiative aims to promote innovative ICT jobs to the youth in Qatar and making ICT related jobs as desirable career choice. TumuhaTEC's role is to raise awareness about the new career opportunities in ICT and enhance their youth skills through internship and training programs. This is achieved by connecting with major ICT employers in the country and major education institutions in Qatar. Qatar's vision and the role of MOTC proved that the proposed enhanced reference model will help supporting the initiatives to bridge the gap between the industry and education programs, which emphasizes on the significant problem studied in this thesis and on how critical is finding an efficient solution to bridge the gap. The MOTC has a specific ICT Observatory[1] and regularly updates its "ICT landscape" report measures of the development of the ICT sector in Qatar. In 2015 for instance, the government of Qatar contracted with AMRB, a market research firm in the MENA region, to conduct a large-scale study of 1,093 business establishments spread across industry sectors. They varied in size, ownership, and geographical location. Between March 2015 and May 2015, face-to-face interviews were conducted with senior employees—including ICT managers and owners—at these establishments. During that same time period, based on extensive research by AMRB that identified close to 550 ICT enterprises in Qatar. Figure (2) highlights that 58% of the ICT enterprises in Qatar have a presence only in Qatar, and Figure (3) shows that approximately 70% of the companies surveyed are involved in ICT hardware trading and 56% in ICT software development.

In terms of the importance of the ICT industry to the government's vision, Qatar is ranked 3rd worldwide out of 143 countries in the Networked Readiness Index 2015, second among GCC countries[2].

---

[1] https://ictobservatory.gov.qa/

[2] World Economic Forum Insight Report, The Global IT Report 2015: ICTs for Inclusive Growth, http://www3.weforum.org/ docs/WEF_Global_IT_Report_2015.pdf.
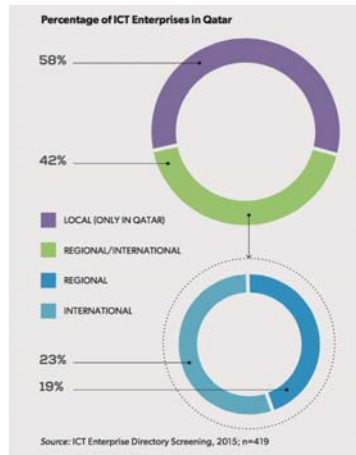
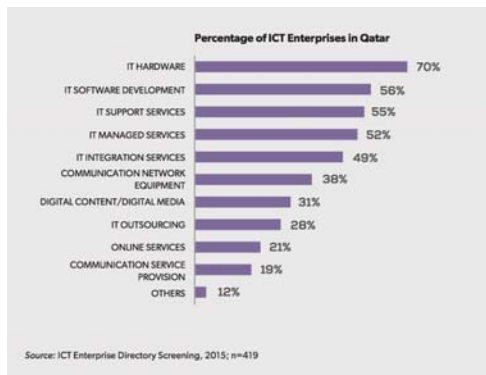*Figure 2*. ICT enterprises in Qatar: Geographical location

Figure 3. ICT enterprises in Qatar: Offered products and services

Figure (4) highlights the current industry growth by segment and Figure (5) the main key drivers for the growth of the ICT industry in Qatar.
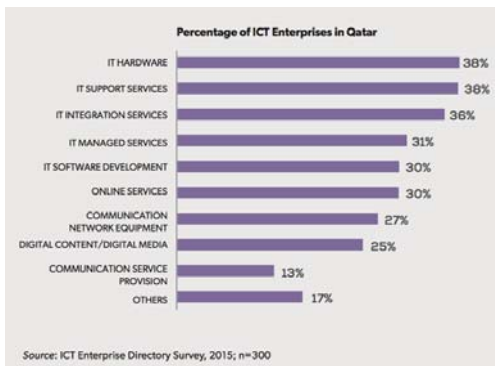

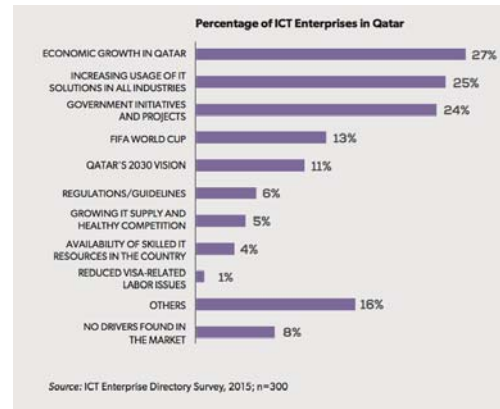*Figure 4*. Qatar's ICT Industry growth, by segment

Figure 5. Qatar's ICT Key drivers for industry growth

Among the conclusions of the "Qatar ICT Landscape" 2015 we can cite:

- There is **a continued progress in the ICT sector in Qatar** as well as the transformation of businesses that are critical to the growth and diversification of Qatar's economy. In 2014, the total revenue generated by the surveyed ICT providers in Qatar is estimated to be close to QAR 9 billion. The revenue of the ICT industry has seen a cumulative annual growth rate of about 15.4% during the 2012–2014 period.

- Following the worldwide trend, **the ICT industry is helping to fuel growth and diversification in Qatar's economy**. While the ICT industry in Qatar is still import dependent, all leading ICT products and services are currently available in Qatar, mainly through resellers and service providers.

- **The number of ICT professionals in Qatar is growing.** An estimated 35,500 ICT professionals work in Qatar, representing 3% of the total number of people employed in Qatar's business establishments. The wholesale and retail trade, construction, and information and communications sectors have the highest numbers of ICT professionals.

- **R&D expenditures of ICT enterprises are low, inhibiting innovation**. 10% of the ICT enterprises reported that they have invested in R&D activities in 2014.

- **ICT penetration and usage have grown** among business establishments over previous years.

- **ICT is benefiting and helping to transform businesses in Qatar**. 83% of business establishments believe that their businesses have benefited from ICT.

- **The security of networks and data**

continues to pose risks for business establishments. Overall, only 15% of the business establishments in Qatar reported the presence of a documented and internally published ICT security policy.

- **The government is viewed as a key driver in the continued growth of the ICT industry in Qatar.** Nearly 40% of the ICT enterprises reported that government initiatives, the FIFA World Cup, and the Qatar National Vision 2030 also play a critical role in driving the ICT market.

Education institutions hold the major responsibility of supplying the labor market with the structured qualifications according to the current industry needs. The nature of the qualification needed in the industry is dynamic, it changes with the innovation and the striving need of companies to gain a competitive advantage [13]. This imposes a great challenge to educators when formalizing program outcomes and implementing them. Such factors seem to contribute to the fail of catching up with the current needs of the industry by education institutions. The existing MOTC/ictQatar Chair Professor position between the Ministry of Transport and Telecommunication (MOTC) and Qatar University contributes to a better understanding between the universities and the industry in Qatar. Roundtables and panels have been organized by the MOTC/ictQatar Chairship in several conferences, such as IEEE AICCSA 2014[3] and IFIP PLM15[4] to:

- **Promote synergy** between the academia stakeholders and industry;
- **Understand the evolving needs** of the ICT industry for training and education
- **Jointly define the content**, the pedagogic approach and the delivery mechanisms for future curricula,
- Better integration research and innovation with education and training activity

With the existence of an assessment mean that can dynamically identifies the gap between the supply and demand of competencies needed, education programs will be able to shorten the gap that is currently being formed with the traditional means of identifying the current industry need of competencies.

4. Competencies modeling

---

[3] IEEE AICCSA is an ICT international conference dealing with theory and applications
[4] IFIP PLM is an international conference related to the application of ICT in industrial Engineering fields.

Meeting the required job related competencies would require a candidate to display that he/she possess all required job competencies for a specific job position. O*NET classifies competencies into three sub competencies: Knowledge, Skills and Abilities. Each competency category represents a set of competencies listed for all possible competencies belonging to each category. If we assume that Competency is set C, Knowledge is set K, Skill is set S and Ability is set A, then the following is true:

$$C = K \cup S \cup A$$

O*NET lists each occupation with a set of competencies required to qualify applying to that occupation. If we assume that the competencies required for job A is C1, then the following is true:

$$C1 = K1 \cup S1 \cup A1$$

Where,

$$C1 \subseteq C$$
$$K1 \subseteq K$$
$$S1 \subseteq S$$
$$A1 \subseteq A$$

A student is required to complete a Study plan which is a set of courses that qualify a student to complete the degree requirements to attain the degree. Each course in the Study Plan contains a set of learning outcomes. We assume that each learning outcome generates a competency that a student acquires after completing a course. If we assume that SP is a set of all study plans offered by a university, CO is a set of all courses offered by a program and LO is the set of all learning outcomes offered by each course, then the following is true:

Each element in LO is equal to Some element(s) in C

To build an employee profile we will assume that every student will carry the competencies gained from learning outcomes as a set of competencies when he/she becomes an employee. We assume that the gap analysis is performed when the competencies in an employee's profile is compared to the competencies required for a specific job. Performing the gap analysis will result in one of these three conditions:

- Fit: where an employee has exactly all the competencies required for the job.
- Not Qualified: where an employee does not have all the competencies required for the job.
- Over Qualified: where an employee has more than the competencies required for

the job. If we assume that the Employee Ahmed has gained C2 set of competencies and he is applying for Job A. In order for Ahmed to be considered as "Fit" for Job A, the following condition must be fulfilled:

$$C2 = C1$$

In order for Ahmed to be considered as "Not Qualified" for Job A, the following condition must be fulfilled:

$$C2 \subseteq C1$$

In order for Ahmed to be considered as "Over Qualified" for Job A, the following condition must be fulfilled:

$$C1 \subseteq C2$$

To build a competency model, the following logical steps should be performed in order to reach the gap analysis required:

Step1. Identify the employee
Step2. Identify study plan from employee
Step3. Identify courses from the study plan
Step4. Identify learning outcomes from the courses
Step5. Match between competencies and learning outcomes
Step6. Identify if the employee is "Fit" to a specific Job
Step7. Identify the gap of competencies required to achieve being "Fit" to specific Job

Building a competency model is an important issue but this should be based on accurate and updated information defining ICT job descriptions. The next section deals with the

5. Description and data collection

A data analysis based on the DACUM methodology and on experts' feedback has been conducted. The main information constituting a first reference model base is the one related to all the descriptors for any selected ICT occupation (that could be completed later by a rating of how important each descriptor is to the occupation). For any general ICT occupation, these descriptors should include (but not limited to):

- Occupation, title, and definition
- Tasks - specific work activities that can be unique for each occupation.
- Tools and Technology - provides information, tools, and software that people may use.

- Knowledge - organized sets of principles and facts that apply to a wide range of situations.
- Skills - developed capacities that facilitate learning and the performance of activities that occur across jobs.
- Abilities - enduring attributes of an individual that influence performance.
- Work Activities - kinds of tasks that may be performed across multiple occupations.
- Work Context - physical and social factors that influence the nature of work.
- Education - summary data on the level of education required for this occupation.
- Credentials - relevant training programs, certifications, licenses, and registered apprenticeships for this occupation.
- Interests - person's preferences for work environments and outcomes.
- Work Values - global aspects of work that are important to a person's satisfaction.
- Additional Information - Selected sources are listed to provide additional information on related jobs, specialties, and/or industries.

While such descriptors attempt to cover a wide range of ICT industry competencies, their instantiation is not intended to be a definitive list of all ICT knowledge, skills, and abilities. A continuous update is to be conducted and specific issues should be incorporated depending on the local context. While fundamental knowledge (use of computer, communication devices, and related applications to input, retrieve, and communicate information…) is the pillar for any ICT occupation, additional specific skills are needed for Cybersecurity related occupations for example, such as:

- Understand the importance of privacy and potential abuses of private information
- Be able to stay safe in an online, networked environment
- Demonstrate ability to find and select the information, appropriate tools, and processing techniques needed for a task
- Understand the importance of updating and using the most recent security systems, to protect against online threats
- Recognize and respond appropriately to suspicious vulnerabilities and threats
- Recognize methods of network access security
- Explain the importance of user authentication and recognize examples
- Protect and manage personally identifiable information
- Understand virtualization concepts, features, benefits, and considerations

- Understand and use privacy and security settings on social networking applications to share only appropriate personal information
- Review the privacy policy and understand what data (location, access to social networks) an application can access prior to downloading and installing
- Understand the risk of connecting to an unsecured or unprotected network
- Understand metrics used to characterize data and different kinds of data
- Understand the main characteristics of clouds and clouds services from a business perspective
- Understand importance of very large, unstructured data sets that have to be managed and queried in new ways to find meaning and value ("Big Data").
- Understand the use of basic encryption, etc

More globally, specific ICT occupations need to master the standards, issues, and applications used to protect the confidentiality, integrity and availability of information and information systems. This leads to handle the following work functions such as:

- Risk Management
- Security and Information Assurance
- Security Operations
- Business Resiliency
- Incident Management
- Secure Information System Development

The underlying base for these functions could be defined as technical content areas, as :

- Program Management
- Data Accessibility
- Data Integrity
- Data Protection
- Development
- Operations
- Legal, Regulations, Investigations and Compliance
- Security Classification
- Networking and Communications
- Physical Security
- Threats
- Forensics

To limit the study, we currently focus on the identification of the specific knowledge, skills, and abilities needed in the Qatari context for graduate curricula. The intention is to clearly represent in the final model, both the generic information on occupational competencies of a graduate curricula in computing, that can be extracted from O*NET OnLine, and the specific needs, such as for Cybersecurity.

A feedback has been given within several NPRP7 ProSKIMA project meetings conducted with experts from several companies and organizations in Qatar (Thales, Qapco, Airbus, MOTC ministry, North Atlantic college, etc), and will be pursued with the ICT services of several other local companies such as Qatar Petroleum, Dolphin Energy, Total, Ashghal and Astad. This will help enhancing the model components and better understand the local context's needs. Additionally, a first brainstorming workshop, held in November 2015 in Doha, was an important step as it helped to confront the first proposal and ideas with the academic and industry experts of the workshop (from Qatar, France, Canada and Switzerland). This feedback is intended to be completed by a benchmarking with other existing industry integrated curricula, mainly from US and Australia (through a planned field study in summer/autumn 2016).

6. Conclusion

An interdisciplinary and collaborative approach is necessary to evolve an academic curriculum in the field of computing sciences, towards a stronger professionalization perspective. More collaboration between academics and professionals is the base to let the students perform successfully in their fields and provide to them the willingness to learn and apply new knowledge and skills.
This paper has described the most important functions, descriptions and components related to competency models. Its specific adaptation to the Qatari local context is the focus of the next steps of the work.

Acknowledgement

7. References

[1] Westkämper, E. (2008). The potential of regional manufacturing networks in Europe. St. Etienne: Presentation at Manufuture Conference.

[2] Bouras, A., Veillard, L., Tralongo, S., Lenir, M. (2014). Cooperative education development: Towards ICT reference models, in ICL 2014 International Conference on Interactive Collaborative Learning, pp. 855–861

[3] Markus, L., Thomas, H. C., & Allpress, K.

(2005). Confounded by competencies? An evaluation of the evolution and use of competency models. New Zealand Journal of Psychology, 34(2), 117.

[4] Markowitsch, J., & Plaimauer, C. (2009). Descriptors for competence: towards an international standard classification for skills and competences.Journal of European Industrial Training, 33(8/9), 817-837.

[5] National Center for O*NET Development. (2015). O*NET OnLine. Retrieved May 29 from http://www.onetonline.org/.

[6] Norton, R. E. (1997). DACUM Handbook. Leadership Training Series No. 67.

[7] Rauner, F. (2008). Qualification and curriculum research. Handbook of technical and vocational education and training research. Dordrecht: Springer, 364-371.

[8] Veillard, L. (2012). Transfer of learning as a specific case of transition between learning contexts in a French work-integrated learning programme. Vocations and Learning, 5(3), 251-276.

[9] ECF (2014). European e-Competence Framework 3.0. A common European Framework for ICT Professionals in all industry sectors. CWA 16234:2014 Part 1. © CEN.

[10] Hawthorne, E. K., Campbell, R. D., Tang, C., Tucker, C. S., & Nichols, J. (2014). Information Technology Competency Model of Core Learning Outcomes and Assessment for Associate-Degree Curriculum.

[11] Almeezanqa. (2016). Decree 36/2004 for the creation of ictQATAR Supreme Council, http://www.almeezan.qa/LawPage.aspx?id=570 (accessed on 8 June, 2016).

[12] TumuhaTEC. (2014). Ministry of Transport and   Communications, http://www.ictqatar.qa/en/tumuhatec (accessed on 8 June, 2016).

[13] Szabó, I., & Neusch, G. (2015). Dynamic Skill Gap Analysis Using Ontology Matching. In Electronic Government and the Information Systems Perspective (pp. 231-242). Springer International Publishing.