eLmL 2015

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Forward

The seventh edition of the International Conference on Mobile, Hybrid, and On-line Learning (eLmL 2015), held in Lisbon, Portugal, February 22 - 27, 2015, focused on the latest trends in e-learning and also on the latest IT technology alternatives that are poised to become mainstream strategies in the near future and will influence the e-learning environment.

eLearning refers to on-line learning delivered over the World Wide Web via the public Internet or the private, corporate intranet. The goal of the eLmL 2015 conference was to provide an overview of technologies, approaches, and trends that are happening right now. The constraints of e-learning are diminishing and options are increasing as the Web becomes increasingly easy to use and the technology becomes better and less expensive.

eLmL 2015 provided a forum where researchers were able to present recent research results and new research problems and directions related to them. The topics covered aspects related to tools and platforms, on-line learning, mobile learning, and hybrid learning.

We take this opportunity to thank all the members of the eLmL 2015 Technical Program Committee as well as the numerous reviewers. The creation of such a broad and high-quality conference program would not have been possible without their involvement. We also kindly thank all the authors who dedicated much of their time and efforts to contribute to the eLmL 2015. We truly believe that, thanks to all these efforts, the final conference program consists of top quality contributions.

This event could also not have been a reality without the support of many individuals, organizations, and sponsors. We are grateful to the members of the eLmL 2015 organizing committee for their help in handling the logistics and for their work to make this professional meeting a success.

We hope that eLmL 2015 was a successful international forum for the exchange of ideas and results between academia and industry and for the promotion of progress in eLearning research.

We also hope that Lisbon provided a pleasant environment during the conference and everyone saved some time for exploring this beautiful city.

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Mobile Computing Program Curriculum —Design and Implementation

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***Abstract*—Mobile computing is revolutionizing the way computers are used. By looking at all of the entities in mobile computing (mobile users, mobile contents, and mobile devices), it forces us to consider a new curriculum design and teaching strategy to teach computing courses to students. Our unique mobile computing curriculum design focuses on given students an in-depth knowledge of comprehensive mobile computing development techniques. This is achieved by not only integrating mobile concepts into a few specific undergraduate traditional computing courses but across the curriculum [13]. This paper presents a new curriculum design that reflects nowadays existing mobile computing technologies. Some of the courses are lab intensive where students experiment with various mobile devices to develop and deploy applications. Also, the paper reports the teaching strategies, feedback, and challenges.**

Keywords- Mobile Computing Curriculum; Computer Science; Teaching Mobile Computing; Portable Devices; Mobile Development;

I. INTRODUCTION

Internationally, mobile computing is on the cutting edge of business software. Accessing information ”anywhere” and ”anytime” has been a driving force for the increasing growth in web and internet technologies, wireless communications, and mobile computing devices. According to Brahima Sanou, Director of the ITU[4]’s Telecommunication Development Bureau, Near-ubiquitous mobile penetration makes mobile computing devices the ideal platform for service delivery in developing countries [1]. This is due to the widespread use of mobile computing devices. Many universities in the world started offering a few mobile computing courses [3][21]. This enables computing schools’ graduates to be familiar with mobile computing concepts that are essential within the rapidly changing environment of mobile computing, so that students can pursue a related career or further relevant academic study [13].

Mobile computing is interdisciplinary in nature and the name originated from two words mobile and computing [4] [7][8]. The word mobile refers to mobility of users, contents, and devices, while the word computing is any goal-oriented activities demanding algorithmic processes. Moreover, the area of mobile computing is the merger of computing and communication with the aim of providing seamless and ubiquitous computing environment for mobile users. This “mobile shift” in computing poses fundamental challenges for virtually every curriculum designer, and calls into question most established assumptions about how to implement a curriculum to provide a broad based educational experience of mobile computing to students that reflects todays existing computing technologies rather than improving traditional computing courses in the fields of computer science and computer engineering [5][6]. This paper is the author’s attempt to design a new curriculum and teaching strategies of mobile computing program with new mindset that reflects newly emerged theories, techniques and paradigms relevant to mobile computing.

Therefore, the paper is organized as follows: Section 2 gives an overview of the current state of the art and summarizes the paper. Section 3 present previously published papers on mobile computing curriculum and survey of selected universities offering some courses on mobile computing. Section 4 introduces the program framework that contains our goal and philosophy of the program and descriptions of the courses and topics covered. Section 5 presents the teaching strategy for the new curriculum. Section 6 describes several challenges in designing the curriculum and teaching strategy of our program. Section 7 presents the results and feedback. Section 8 concludes the paper and gives possible future work.

II. STATE OF THE ART

Recent years have shown that computing is moving towards an increasingly mobile computing environment with wireless laptops, smart phones, handheld computers and even wireless printers and digital cameras. All of these devices need to be programmed to interact correctly, increasing the demand for these programming and design skills. This demand prompted many universities in the world to introduce mobile computing courses to their undergraduate computer science and computer engineering students. By scanning the literature, we can see that mobile computing courses are only taught as introductory CS and CE courses. For example,

- **In computer science curricula**, the courses introduce the student to mobile software development. The courses focus on building mobile native and web applications [2].
- **In computer engineering curricula**, the courses focus on introduction of mobile and wireless networks.

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However, increasing number of universities has started new mobile computing undergraduate programs leading to bachelor degrees in computer science and engineering with specialization in mobile computing.

- **In computer science curricula**, the programs emphasize on topics which require specialized knowledge from only one particular aspect of mobile software development. For example, interface design issues, multimedia, or graphics design for mobile devices [20].
- **In computer engineering curricula**, the programs focus on mobile communications systems or embedded systems within the context of mobile devices.

In the above universities, the approaches of mobile computing courses taught in the CS and CE curricula are either introductory or intensively focused on one particular area of mobile computing. Our approach differs from existing mobile computing curricula by avoiding too much specialized knowledge from one particular area of mobile computing. The goal of our suggested mobile computing curriculum is to provide students with various courses of computing such as software development, cloud computing, security, multimedia, wireless communication, database, virtual communities, operating systems, human-computer interaction, and game graphics design within the context of heterogeneous mobile devices.

III. BACKGROUND

The ACM/IEEE Computer Science Curriculum 2013[17] lists Mobile Computing as an elective course under the "Platform-Based Development (PBD)" Body of Knowledge and as an core 1 tier 2 topic under several" Knowledge Areas such as "Human-Computer Interaction (HCI)", "Networking and Communication (NC)", and "Social Issues and Professional Practice (SP)". Also, the ACM/IEEE Computer Engineering Curriculum 2004[18] lists Embedded Systems as a Body of Knowledge and also lists Wireless and Mobile Computing under "Computer Networks" Body of Knowledge. The ACM/IEEE Curriculum concluded that it is important for both computer engineering and computer science undergraduate students to be familiar to the concepts of Mobile Computing.

Recently, many papers have been published related to teaching and curriculum of mobile computing. Those papers are as follows:

- Instructors sharing their own teaching strategy of mobile computing class [11][13][14].
- Instructors sharing their mobile computing concepts into the course's topics [12][15][16][20].

A study conducted on selected universities offering a study of mobile computing course(s)**.** From the survey, it can be seen that universities are using five models to integrate mobile computing into their computer science and engineering curricula [19]:

1. Offering undergraduate courses on mobile computing.
2. Offering graduate courses on mobile computing.
3. Integrating mobile computing concepts into their traditional courses.
4. Combining model 1, 2, and 3.
5. Offering mobile computing as an area of research to their graduate students.

Model 1 is used by several universities such as Stanford University, University of Maryland, and Zhejiang University. The majority of universities that have graduate programs are using model 2. Some universities are using Model 3 and integrating mobile computing concepts as topics in their existing courses, as seen by the University of Guelph. The University of Bridgeport, Carnegie Melon University, and Massachusetts Institute of Technology are employing Model 5. Furthermore, an increasingly number of universities such as Middlesex University, Carleton University, Oxford Brooks University, Webster University, and Newcastle University started using a more aggressive approach by offer mobile computing program leading to BSc degree specializing in mobile computing.

In a relevant issue, mobile devices have become attractive learning devices for education. Almost every university student uses a mobile device for both personal and academic reasons [22].

Mobile learning (m-learning) is more flexible, interactive, involving more contact, communication, and collaboration with people than e-learning. Given this environment, we believe that the value of using mobile technologies to support teaching and learning lies in integrating mobile technologies with the current e-learning environments in which the university has made major investments. A project is started to capitalize on these enormous array of mobile devices to promote communication, collaboration and learning. This project is aimed to investigate the development of the Mobile Assistant and Registrar System (MARS) using Cloud Services for the Faculty of Information Technology at the University of Tripoli. The MARS project started with an idea crossed the mind of the author. MARS attempts to alleviate the hassles that students face when registering courses using the existing simple on-line registration system. MARS provides several assistance and course registration services to students, staff, and faculty members through mobile devices.

The project development phases are divided into several smaller projects. A Student task is to choose a MARS project and implemented on a semester or a year long project as part of his/her Mini Project or Senior Project. This collaboration with students and faculty members can help the Faculty of Information Technology enhance classroom activities and learning, as well as administrative functions by integrating mobile technologies with its e-learning environments.

IV. PROGRAM FRAMEWORK

Our suggested mobile computing program curriculum focuses on building an in-depth knowledge of advanced mobile computing and development techniques. Because basic mainstream computing skills and knowledge are still required by academia and industry, our curriculum is divided into two components. The two components are defined as follows:

TABLE I. SHOWS COURSES OF THE CC.

Introduction of Computing	Introduction to Programming	Operating System	Foundations of Database
Data Structure & Algorithms	Computer Organization	Computer Networks	Problem Solving Techniques
Basics of Information Security	Software Engineering	Internet Development	Discrete Mathematics
Object Oriented Programming	System Analysis		

- **Computing Component (CC).** It contains courses drawn from computing-related disciplines such as mathematics, statistics, physics, and computing. In the area of computing, students are required to take some traditional courses in area of computer science and computer engineering. The CC courses are listed in TABLE I.
- **Mobile Computing Component (MCC).** All mobile computing-related courses are placed in this component. The MCC courses are listed in TABLE II and TABLE III.

With both CC and MCC are defined. Why is it necessary to split the curriculum into two components, namely, CC and MCC? The answer to that is in the very real differences between the two. MCC is, to an extent, CC, but CC is not necessarily MCC. What this means is CC is not just a single discipline but it is a family of disciplines and therefore meets the definition of CC. In addition, CC may or may not incorporate mobile devices in its educational content and as such may or may not meet the definition of MCC. In many ways, CC acts as a pillar to MCC. The courses in MCC have one or more prerequisite courses from CC designed to ensure adequate preparation for courses in a sequence. This strategy allow students to gain broad knowledge of computing-related disciplines covered in CC, and then gain advance knowledge of mobile computing-related discipline covered in MCC. For example, foundation of database course in CC is a prerequisite to mobile database course in MCC, and operating system course in CC is a prerequisite to mobile operating system course in MCC, and so on.

TABLE II. THIRD YEAR COURSES IN MCC.

Course Number	Course Name	Course Content
ITMC 311 L | P	**Mobile Applications**	C#, Objective-C, and Java Mobile Applications programming foundation.
ITMC 312 L | P	**Personal Area Networks**	Concepts, Architecture, Design, Performance Evaluation, Protocols, and Applications.
ITMC 313 L | P	**Mobile Operating Systems**	Using Architectures of (Android, iOS, Windows).
ITMC 321 L | P	**Mobile Interaction Design**	User Behavior, Interacting with Information, and Theoretical Models of Movement and Perception.
ITMC 322 L | P	**Heterogeneous and Mobile Databases**	Extensively discusses Multi-Database Systems (MDBS) and Mobile Data Access Systems (MDAS)
ITMC 323 L | P	**Principle of Wireless and Mobile Networks**	Introduction to Mobile and Wireless Networks.
ITMC 324 L | P	**Application Development with Java ME**	J2ME using the following Models: Web Applications using Mobile Client Frameworks, and Native Applications using appropriate SDKs.

The advantages of our suggested mobile computing program curriculum can be summarized as follows.

- Allows students to gain fundamental knowledge and skills of computing-related disciplines by taking courses in CC. Then, students enhance and apply their transferable knowledge and skills in courses taken in MCC.
- Varieties of text books available that teach the fundamentals of computing such as programming, database, networking, and computer architectures. This variety of text books might not be available in the area of mobile computing, while those acquired knowledge will be useful in leaning the courses in the MCC.
- It simplifies teaching.

In this curriculum, MCC contains elective courses in which students can select five courses. These courses may emphasize on topics relevant to mobile computing area. Examples of elective courses are the following courses:

- ARM Microprocessor
- Programming Paradigms

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- Mobile Commerce
- Topics in Compilers Construction
- Mobile 3D Graphics
- Parallel and Distributed Computing
- Mobile Game Developments
- Topics in Mobile Computing
- Faculty Free Elective

As an interdisciplinary curriculum, non-technical schools and institutions across the university can contribute to the curriculum by creating specialized elective components (SECs). For example, the School of Arts and Media may integrate a SEC (Media Design) in this curriculum by choosing five specialized electives courses from its school. As a result, students will have a unique opportunity to take selected classes from other programs as part of their degree.

V. Teaching Strategy

The teaching strategy for the new curriculum is enable student to gain theoretical and practical skills of the entities in mobile computing (mobile contents, mobile communications, and mobile devices), and not only how to design, develop, and then test mobile applications on various mobile devices. As shown in TABLE II and TABLE III, some courses are tagged with two letters "L" or/and "P". The letter "L" indicates that the course requires supervised lab. While, the Letter "P" indicates that the course require mini project. The project can be a group project. Except for ITMC 324 course, programming languages and mobile platforms used in this curriculum is not glued into a particular language or device. This will give student an opportunity to learn application development running various environments such as Android, Windows, and iOS. To elaborate further on course content and teaching strategy, some selected courses in MCC are discussed below:

ITMC 311 Mobile Applications:

Prerequisite courses: Object oriented programming course, problem solving course, and data structure and algorithms course. Since a student entering this course has a basic knowledge of programming in a particular language, object-oriented concepts, and problem solving skills, this course covers the principles of mobile analysis, design, and development concepts using various languages such as C#, Java, and Objective-C running on iOS, Android, and Windows. This way a student is focused on mobile application development at the same time exposed to various languages and platforms. At the end of this course, student has experienced mobile developments using different tools, languages, and platforms.

ITMC 324 Application Development with Java ME

Prerequisite courses: Mobile applications course. This course covers advance mobile applications development using J2ME mobile application programming for mobile

TABLE III. FORTH YEAR COURSES IN MCC.

Course Number		Course Name	Course Content
ITMC 411		**Security in Mobile Computing**	Mobile computing. security and privacy from the prospective of (mobile interaction, mobile application, wireless communication)
L	P		
ITMC 413		**Social Networking**	Architectural Principles for Heterogeneous Social Networking Platforms, Social Concepts, Agent-Based Computing, and Information Exchanged between Community Members.
L	P		
ITMC 421		**Fundamentals Ubiquitous Computing**	The visions of Ubiquitous Computing and some of its applications, such as Location, and Context Awareness in Ubiquitous Computing.
	P		
ITMC 422		**Cloud Computing and Mobile Applications**	Cloud Computing Services and Infrastructures (Virtualization, plus Developments of Mobile Apps that interacts with the Cloud.
L	P		
ITMC 423		**Mobile Multimedia**	The Creation, Delivery and Analysis of Multimedia Content in Systems with Mobile Devices
L	P		

platforms using the following models: Web applications using mobile client frameworks, and native applications using appropriate SDKs.

ITMC 411 Security in Mobile Computing

Prerequisite courses: Mobile applications course, principle of wireless and mobile networks course, and mobile interaction design course. Topics covered are select from multidisciplinary: Mobile interaction (Principles of usability, security, and privacy; Methodologies for evaluating usable security; security and usability analysis Phishing and Risk; Knowledge-based authentication; Biometric and alternative authentication; Security and privacy; Usable security software design principles; Human-in-the-loop design framework; Security indicators and warnings; Usable security for security administrators). Mobile application (Mobile Platforms, mobile services). mobile communication systems (Mobile cellular telephony. Wireless internet; Mobile ad hoc; Sensor networks).

ITMC 422 Cloud Computing and Mobile Applications

Prerequisite courses: Heterogeneous and mobile databases course, and social networking course. Topics covered: Cloud computing services and infrastructures; development tools; fundamental tradeoffs and algorithms and applications. iOS, Windows, and Android programming to develop mobile applications with backend storage, and computing components running on the cloud; Accessing cloud services with mobile devices; Extending mobile applications with cloud processing and resources; Extending cloud services with the collective power of mobile devices; Partitioning of service functions between mobile devices and clouds; Data management for mobile cloud.

Next, a discussion of assignments, exams, labs, mini projects, and senior projects is presented.

Assignments

Due diverse areas of MCC courses, the assignment deadlines should be flexible. The instructor needs to remember that some of the students will have to learn some extra material on their own in order to do the assignment.

Exams

Initially, students are expected to do two midterm exams plus final exams. Due to emphasize of hands-on experience, instructor can have one midterm exam instead of two. Marks are split evenly between exams and assignments on one hand and projects and labs on the other hand.

Labs

A mobile computing education requires hands-on experience because you can't give in-depth explanations of many abstract mobile development concepts without practical hardware and software demonstrations. We use two types of labs (supervised and unsupervised) to enhance students' learning. As it stands today, all faculty members owns at least one laptop and mobile devices are now necessary tools in students' daily life. These mobile devices create mobile lab since a classroom can be easily converted into a lab. Also, students are encouraged to use their mobile phones.

Mini Projects

In addition to the assignments, students are required to be organized into teams, of at most two students, to work on semester long projects. Based on the particular course, projects are either hands-on intensive programming or/and survey type projects. The objective is that the students should choose a topic relevant to the course, study it on their own, (with help from the instructors) and will learn about in much more depth that they don't get from the class lectures. Students are required to provide periodic reports of their progress in addition to their final reports and presentations at the end of a semester. Furthermore, some of the term project topics can be chosen by students as their senior projects.

Senior projects

Senior-project students will soon be entering the workforce. Hence, it is important that graduates have full grasp of various aspects of mobile computing, as well as the ability to design and implement mobile systems and services. Senior-projects are a semester long and can be extended to second semester. The senior project must encompass the process of concept creation and development, testing, and debugging of the mobile application. Students will be applying collaborative skills to synthesize ideas and technical skills to create the "app" and conclude the senior project with a presentation of final application design and implementation. As mentioned earlier, senior project can be a continuation of mini project. A maximum of two students can work as team on senior project.

VI. CHALLENGES

The challenges can be view from the following perspectives:

Books perspective: Although, there are several books available that covering various aspects of mobile computing. For instance, textbook for mobile application developments focus only on one particular language and device. In our curriculum, the course "ITMC 311 Mobile Applications" covers the principles of mobile analysis, design and development using various languages such as C#, Java, and Objective-C running on iOS, Android, and Windows. Asking students to buy several books for one course in the MCC is a daunting task. Also, we could not find suitable text book that cover one aspect such as mobile operating system, mobile database, and mobile security that is not a collection of papers published in journals and conference proceedings.

Topics perspective: Mobile computing is a multidisciplinary topic and students are expected to be exposed to various areas. Hence, it becomes important to avoid dealing with topics or emphasizing on topics which requires too much specialized knowledge from one particular area. In our curriculum the course "ITMC 411 Security in Mobile Computing" covers the principles of mobile computing security from three angles, namely, mobile interaction, mobile application, and mobile communication systems. Also, new mobile technologies will continue to emerge, as a result, MCC's courses must adapt to changes and innovations occurred in its area.

Instructors perspective: The instructor should take into account the constant innovation nature of mobile computing for a particular course and adapt the course material and topics accordingly. This implies that the instructor should be ready to add and/or delete some of the initially planned course topics during the semester. This requires the instructor to integrate any emerging trends of mobile computing technology into corresponding course.

VII. RESULTS FEEDBACK

The university curriculum committee originally approved the mobile computing program in the Spring of

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2013/2014. The new course "ITMC 311 Mobile Applications" was offered for the first time in fall of 2014/2015 in the software engineering program and internet technology program. The mobile computing program commences to start in Spring 2014/2015 academic year.

Yearly, the faculty hosts the Technology Days event. This event gives staff, faculty, and students an opportunity to learn about technologies on campus and participate in discussions of the current state and future innovations in the Faculty of Information Technology. The mobile computing curriculum was presented and a student questionnaire was conducted in the last day of the event. The students' responses we received were positive. Many students expressed enthusiasm to a great extent to enroll in the new program. Majority of the students stated the importance of gaining practical skills and broad knowledge in mobile computing area in their future career and academic endeavors.

At the end of the new course "ITMC 311 Mobile Applications", we asked students to complete evaluation surveys. Ninety percent of the students completed the survey. The following statements represent selected statements of the likert scale survey.

Statement. 1 The instructor presented content in an organized manner.

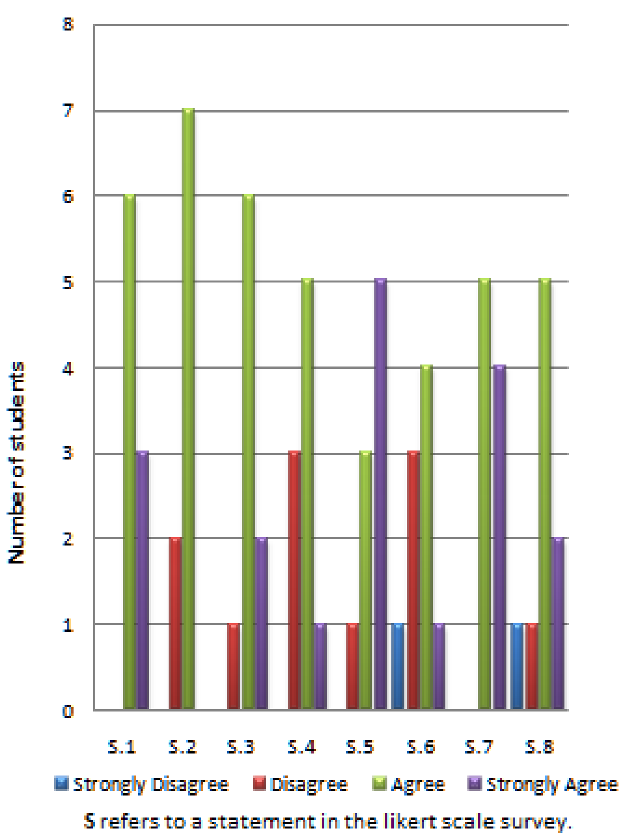

Figure 1. Students Results.

Statement. 2 The instructor presented content in an organized manner.

Statement. 3 The instructor helped me identify resources I needed to carry out the project.

Statement. 4 The course was appropriate for the stated level of the class.

Statement. 5 Course was difficult than what I thought.

Statement. 6 Mobile development was more educational than desktop development.

Statement. 7 I recommend my fellow students to take the course.

Statement. 8 The course encouraged me to develop mobile app in my senior project.

Statement. 9 I prefer to take more courses in mobile application development.

The overall response from students was positive. Figure 1 presents the students' response to the likert scale survey. In the open-ended questions students' responses were positive on how would you rate the overall effectiveness of the instructor's teaching? On the question of what did you like best about this course, most students expressed development of mobile apps on their smart phones. On the question of what did you dislike about this course? The response was marks should be better distributed to reflect the time spent to develop mobile applications. They suggested marks for labs should be higher than written exams. On the question of what was the most challenging aspect in this course, most expressed lack of previous practical programming skills.

VIII. CONCLUSION

We have presented our experience in designing and teaching strategy of an undergraduate level program leading to bachelor of information technology in mobile computing. Our unique mobile computing program covers various aspects of mobility in the area of computing. The curriculum is divided into CC and MCC. In the CC, students required to take courses in diverse set of areas such as mathematics, statistics, physics, and computing. In the MCC, students are required to take several courses in mobile computing area. The constant innovation effecting mobile computing area makes the curriculum in the MCC dynamic. This allows adaptation of innovation occurring in the mobile computing area to be easily adapted into our curriculum.

For future work, we will continue to integrate more area of mobile concepts across our program's curriculum as new technology in mobile computing emerges and changes in mobile paradigm arise.

ACKNOWLEDGMENT

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An Empirical Study on the Ludic and Narrative Components in Mobile Game-Based Learning

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Abstract— **The paper presents the results of an empirical study conducted on a mobile game-based learning kit, composed by 30 serious games, developed in the framework of an European project on mobile learning for corporate training, titled "InTouch". The study analyzes the role of the interest of the goal, the fun of the gameplay, and the realism of the game narration in determining the willingness to play again, as expressed by a sample of 54 users. In the light of the debate between ludic and narrative approach to games, the study can be interpreted as an empirical evidence of the simultaneous, and yet independent, important role of both the ludic and narrative component of a serious game. The fun of the gameplay showed to a have a very important role in predicting the willingness to play again, with a robust direct effect, and significantly contributing to the indirect effect of the interest of the goal. The realism of the game narration exhibited a lower, even though significant, level of influence on the willingness to play again, contributing only in a direct form, and with a smaller amount compared to the level of fun. The interest of the goal has a significant direct influence on the willingness to play again, that can be enhanced by the fun of the gameplay, while it did not show to be significantly modified by the realism of the game narration.**

Keywords - Mobile Game-Based Learning; Corporate Training; Serious Games; Ludology; Narratology.

I. INTRODUCTION

Mobile game-based learning (mGBL) is an educational trend that is gaining more and more in popularity. Its main advantages are considered mobility and portability, flexibility, accessibility, and informality [1]. Thanks to mGBL, didactic contents are made available anytime and anywhere, and learning is linked to activities in the outside world environment [2][3]. Serious games for mobile devices can teach soft skills that support self-efficacy, self-directed learning and reflection upon performance [4][5].

In 2012, at the end of a two-year European Project, a kit of 30 pedagogical serious games for smartphones and tablets was developed and tested with a sample of Small and medium-sized enterprises' (SME) employees from the seven countries participating the project (Italy, England, Sweden, Switzerland, Austria, Lithuania, Bulgaria).

The analysis of the kit of serious games for mobile devices is here referred to a subject of debate about games, concerning the relationship between narrative and game design, namely between ludology and narratology [6].

In short, the narratological position considers games as novel forms of narrative that must therefore be studied using theories of narrative. Ludologists, on the other hand, state that games are essentially formal, contrary to narratives that are basically interpretative [7]. Games according to narratologists are closely related to narrative and stories: even thought basically made of rules, they mainly tell stories, contain narrative elements, and show narrative structural sequences [8]. Ludologists think that the study of games should concern the analysis of the abstract and formal systems they describe, that is game structure, rules, interactivity and gameplay. These are the elements that give immersion and the feel of real experience of a game and are more important than optional narrative elements [9].

Other hybrid approaches emerged trying to conciliate and comprehend both points of view. Ryan proposed to incorporate narratology inside ludology, since it deals with the construction of stories that is similar to the game mechanics [10]. Aarseth, although considered a radical ludologist, stated that games and narrative significantly overlap [11]. Lindley unified in a heuristic triangular space ludology, narratology, and simulation, describing the relationships between gameplay and narrative as a competition determining ludic interaction on one side, and narrative patterns perception on the other side [12]. Jenkins proposed a middle-ground position, talking about games as "spaces" with narrative possibility enriching gameplay [13].

The present study aims at giving an empirical contribution to the debate among ludologists and narratologists, referring to it as an interpreting key for the causal relationships among the interest for the goal and the willingness to play again, as mediated by the fun of the gameplay, and the realism of the game narration. Even if ludology and narratology are complex and multidimensional concepts, in fact, the fun of the gameplay and the realism of the game narration can be considered, at least partially, two components of these constructs, and their causal role within a serious game can shed light on the juxtaposition between ludology and narratology.

Points of interest of the present study can be considered: (1) the fact that it adds empirical data and analysis to a field that has been mainly developed on theoretical basis, (2) the focus on serious games for mobile devices that represent an expanding sector [14]. In particular, the considered mobile serious games are very short in duration (few minutes to complete each game) and are playable through a touchscreen interface using only one finger. That is to say, they are games the users can play in short casual bursts of time, anywhere and at any time, at work or at home, or even on the way to/from work/home [15]. It has been considered relevant to transfer the ludology/narratology debate, usually referred to more structured games, to this kind of games.

This paper will give a description of the project whose main objectives were the development and testing of the serious games kit (Section 2). Scope and hypothesis of the present study will then be illustrated (Section 3). Methods and results of the empirical analysis will be reported, illustrating the statistical work that has been done and what it produced (Sections 4 and 5). The paper will end with a conclusion and future work section, explaining how the results of the present study can be interpreted in the light of the ludology/narratology debate, the limits of the present study, and how a further deepening of these issues can be addressed.

II. The InTouch Project

The "Labour Market InTouch: new non-routine skills via mobile game-based learning project", in short InTouch, aimed to define an innovative approach enabling new generations of workers to develop ten non-routine skills: Communication; Planning; Conflict management; Openness to change; Decision making; Teamwork; Flexibility; Strategic thinking; Initiative; Learning and improvement.

All serious games were designed according to the same scheme, made of an opening scenario (frame 1), a problem-based situation presenting the aim of the game (frame 2), three interactive frames (frames 3, 4, 5) where players are asked to choose among different options, and the last frame (frame 6) showing the closing scenario, the score, and giving feedback to the player. The narrative within the games is developed giving a short background story in the opening scenario, then it is influenced by user's action in the central frames, and ends up with the closing scenario. The central frames are developed according to the following types of interaction:

- *Branching story*: the story develops in different ways according to the choices made by the player and the final feedback and evaluation are the result of the combination of the choices.
- *Interactive map*: the user can choose three characters to talk to. Basing on the obtained clues, the player can choose one of the three available alternatives. Evaluation is based on the final decision and on the choice of the characters.
- *Multiple choice*: the user has to help the main character with three different decisions in a limited time frame. In the first decision point only three out of the five listed options are correct, in the second one only two, and in the third one only one. The final score and the feedback depend on how many correct answers the user chooses.
- *Quiz*: the player has to try to quickly answer three related questions, getting immediate feedback on the answer to each question and a summary at the end of game. Evaluation is based on a combination of the number of correct answers with the time taken to answer.
- *Task simulation*: the player has to prioritize three tasks in order to achieve a goal. Each task is associated with a question to be answered. The score is determined from the number of correct answers and from the order the user chose to prioritize the tasks.

The contents of the games were studied to be relevant to the learner in an enjoyable and interesting way. An effort was made to connect contents to learners' work experiences. Each game scenario is set in a working context well known to the SME's employees, with characters archetypes designed on real SME's employees. By playing the games users discover the problems and possible solutions in a real life environment. The games take place in situations and contexts characteristic of day-to-day activities, namely within a small company titled "InTouch". Games scenarios were obtained adapting situational cases referred to the ten non-routine skills to the "InTouch" company, composed by characters that were described in terms of their company role, personal information, a narrative short bio, and some other charming details such as star sign and hobbies. The characters of the games were further developed and updated in a dynamic narrative way through Facebook. This social media storytelling reported elements of the characters' lives, funny events from their past, additional information about their relationships, hobbies and photographic illustrations showing something weird about them. InTouch games, although short and simple, have thus a solid narrative structure in order to engage players, make them recognize narrative patterns referred to their work activities, and give them the right balance between fantasy and real working context situations.

In the development of the InTouch games attention was also paid to the ludic aspects. Even though challenges are not that complex, InTouch game design tried to respect requirements for the games to be relevant, explorative, emotive and engaging. Attention was paid to speed, level of difficulty, timing and range of feedback. Challenges of mastery and comprehension were inserted into games, together with strategy, so games become real living puzzles, with a perceived risk of failure to prevent boredom. Game mechanics were also made pleasant to create a positive climate which is ideal when it comes to increase retention and recall. An entertaining gameplay was achieved through the use of funny graphics, novelty of the interactions, surprise and humour in dialogues and scenarios.

III. Scope and Hypoteses

A summative evaluation was conducted measuring a set of game variables on a sample of players. For the scope of the present study the four game variables of interest are: (a) the players' willingness to play again, (b) the interest of the goal, (c) the fun of the gameplay, and (d) the realism of the game narration.

The interest of the goal is considered a primary element. It can be found starting from the beginning of the game, when the player faces the game scenario and mission. It is then interesting to observe how the further development of the game in terms of fun and narration can influence the causal relationship between the interest of the goal and the willingness to play again.

The present study explores the degree to which the data fit different nested causal models. In the “complete” model (with less degrees of freedom), indicated as Model A (Figure 1), the relationship between the interest of the goal and the willingness to play again is partially mediated both by the fun of the gameplay and by the realism of the game narration.

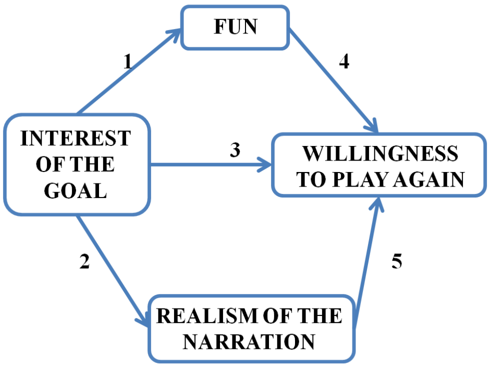

Figure 1. Graphical scheme of the causal Model A.

The fun of the gameplay and the realism of the game narration are hypothesized to positively influence the willingness to play again (paths 4 and 5). These hypotheses are based on the consideration that both the fun of the gameplay and the realism of the game narration are significant elements in determining the degree of satisfaction. It is also hypothesized that the interest of the goal positively influences the willingness to play again (path 3), since the engagement for the game mission can be considered as a natural predictor of the degree of satisfaction.

Some constraints of the complete model will then be released, suppressing one or more causal paths, to obtain all the other nested models. In this way, the partial mediation of the fun of the gameplay and of the realism of the game narration will be substituted by their full mediation or by the lack of mediation. The complete Model A will thus be confronted with the following alternative, theoretically possible models to assess relative fit compared to:

- Model B, where there is not mediation of the fun of the gameplay, path 1 is suppressed;
- Model C, where there is not mediation of the realism of the game narration, path 2 is suppressed;
- Model D, where there is not mediation either of the fun of the gameplay or of the realism of the game narration, paths 1 and 2 are suppressed;
- Model E, where there is full mediation both of the fun of the gameplay and of the realism of the game narration, path 3 is suppressed;
- Model F, where there is full mediation of the fun of the gameplay and there is not mediation of the realism of the game narration, paths 2 and 3 are suppressed;
- Model G, where there is not mediation of the fun of the gameplay and there is full mediation of the realism of the game narration, paths 1 and 3 are suppressed.

Table 1 summarizes which causal paths, indicated with numbers of Figure 1, are present for each model.

TABLE I. CAUSAL PATHS OF TESTED MODELS

	Path 1	Path 2	Path 3	Path 4	Path 5
Model A	YES	YES	YES	YES	YES
Model B	NO	YES	YES	YES	YES
Model C	YES	NO	YES	YES	YES
Model D	NO	NO	YES	YES	YES
Model E	YES	YES	NO	YES	YES
Model F	YES	NO	NO	YES	YES
Model G	NO	YES	NO	YES	YES

The comparison of nested models wants to establish if the hypothesized influence of the interest of the goal on the willingness to play again is better explained by partial mediation, full mediation, or no mediation at all of the other two considered variables (the fun of the gameplay and the realism of the game narration).

IV. METHODS

This section contains an illustration of the methodology that has been adopted in the present study: a description of the sample; the research procedure; the instruments and the statistical analyses that were adopted.

A. *Participants*

The target sample consisted of 54 workers of different SMEs (N = 9) from the seven countries participating in the project and operating in different business sectors (ICT, business support, education/training, etc.). The SMEs were selected on the basis of their willingness to participate in the study. Work positions were: 28 managers and 26 employees. In total 30 were males (56%) and 24 were females (44%). The mean age was 41.94 years (SD = 9.70).

B. *Procedure*

To test the developed kit of 30 mobile serious games the project partners held dedicated events (Learning Labs) in the seven countries participating in the project. During each Learning Lab a structured questionnaire was proposed to participants after the completion of the games. Participation to Learning Labs and questionnaire compilation were obtained through an informed consent procedure asking for active consent from participants. Questionnaires took approximately 30 minutes to complete. Project staff members introduced the questionnaires, giving instructions about their compilation, explaining that they were voluntary and responses were anonymous and confidential. Project staff members were at the workers’ disposal during the questionnaires’ administration to answer questions and give explanations. All participants to different Learning Labs responded to the same questionnaire packet.

C. Measures

- Demographics. An Identifying Information Form was used to collect demographic information: age, gender, working role.
- Game variables. An articulated grading grid was proposed to participants, after the completion of the games, asking them to express on a 10 point Likert scale their like about ten variables: the willingness to play again, the game duration, the game interface (graphics, colors, etc.), the fun of the gameplay, the quality of the instructions, the adequacy of the level of difficulty, the interest of the goal, the learning/educative content, the quality of the feedbacks, and the realism of the game narration. The present study is taking in consideration only four variables, namely, (a) the willingness to play again ("Would you like to play again?"), (b) the fun of the gameplay ("How fun was your interaction with the game mechanics?"), (c) the interest of the goal ("How interesting was the goal proposed by the game?"), and (d) the realism of the game narration ("If compared to your experience, how realistic was the narrative of the game about the 'InTouch' company?").

D. Data Analysis

1) Preliminary Analysis

As a preliminary analysis, skewness and kurtosis of all game variables were checked. Overall, all variables showed to conform to the normal distribution.

2) Correlation

As a first step the correlation matrix of all the variables measured by the questionnaire was calculated.

3) Path Analysis

All path models involving the aforementioned four variables (Fun of the gameplay, Realism of the game narration, Interest of the goal, Willingness to play again) were analyzed with LISREL, using maximum likelihood estimation procedures [16].

For each tested model χ^2 is reported, as an absolute fit index (good fit between zero value and two times the degrees of freedom). Three more fit indexes were also reported: the non-normed fit index (NNFI); the comparative fit index (CFI); and the root mean square error of approximation (RMSEA). Higher CFI and NNFI values (in the range from 0.97 to 1.00 for a good fit) and lower RMSEA values (in the range from 0.00 to 0.05 for a good fit) are assumed to evaluate model fit [17].

The Coefficient of determination (R-square) is reported, giving the percentage of variance of the willingness to play again explained by each model, to estimate the completeness of the considered set of predictors.

4) Comparison of Nested Causal Models

To establish which type of mediation (partial, full, or non-significant) was exercised by the fun of the gameplay and by the realism of the game narration, the comparison of the fit of alternative nested models was conducted analyzing for each pair of models the differences of the χ^2 values (indicated with $\Delta\chi^2$) between the less parsimonious model (i.e., the one with less degrees of freedom, in our case the complete Model A) and the more parsimonious one (i.e., in turn: Models B, C, D, E, F, and G). The significance of $\Delta\chi^2$ has successively been established looking at the p-value corresponding to the χ^2 distribution for a number of degrees of freedom given by the difference of degrees of freedom of the more parsimonious models and the complete one. Choosing a cut-off of $p = 0.01$, if the $\Delta\chi^2$ between two nested models is significant ($p < 0.01$), this implies that the complete model explains the data better; if there is no significant difference between two nested models ($p > 0.01$), this implies that the more parsimonious model explains the data equally well compared to the complete model, and must be preferred for its simplicity.

V. RESULTS

This section contains the numerical results obtained for the previously illustrated data analysis: correlation, path analysis, and comparison of nested causal models.

Table 2 reports correlation coefficients of (a) the willingness to play again, (b) the fun of the gameplay, (c) the interest of the goal, and (d) the realism of the game narration. The level of significance (p-value) is indicated in the table footnote.

TABLE II. CORRELATION MATRIX

Variable	Willingness to play again	Fun of the gameplay	Interest of the goal	Realism of the game narration
Willingness to play again	1.00	0.89*	0.60*	0.21
Fun of the gameplay	0.89*	1.00	0.35*	-0.12
Interest of the goal	0.60*	0.35*	1.00	0.19
Realism of the game narration	0.21	-0.12	0.19	1.00

b. *$p < 0.05$.

Table 3 reports the results of the path analysis for the seven tested models with the levels of significance of the causal paths (p-values) indicated in the table footnote.

TABLE III. PATH ANALYSIS COEFFICIENTS

	Path 1	Path 2	Path 3	Path 4	Path 5
Model A	0.35**	0.19	0.26*	0.83*	0.26*
Model B	--	0.26	0.26*	0.83*	0.26*
Model C	0.39**	--	0.26*	0.83*	0.26*
Model D	--	--	0.26*	0.83*	0.26*
Model E	0.35**	0.19	--	0.93*	0.32*
Model F	0.39**	--	--	0.93*	0.32*
Model G	--	0.26	--	0.93*	0.32*

c. * $p < 0.01$; ** $p < 0.05$.

Table 4 reports the results of the comparison of the fit of the seven tested models, with the level of significance of the difference between complete and nested models indicated in the table footnote.

TABLE IV. COMPARISON OF THE FIT OF ALTERNATIVE NESTED MODELS

Model	χ^2	NNFI	CFI	RMSEA	R^2	df	
A	0.00	1.00	1.00	0.00	0.95	1	
Alternative nested models							$\Delta\chi^2$
B	6.49	0.91	0.97	0.21	0.94	2	6.49
C	1.91	1.00	1.00	0.00	0.95	2	1.91*
D	9.39	0.91	0.96	0.20	0.94	3	9.39
E	27.79	0.31	0.77	0.50	0.89	2	27.79
F	28.85	0.53	0.77	0.41	0.89	3	28.85
G	31.09	0.47	0.73	0.42	0.89	3	31.09

d. *$p > 0.01$; R^2 = coefficient of determination; df = degrees of freedom.

Looking at the results of the comparison of the nested models, Model C explains the data equally well compared to the complete Model A ($p > 0.01$) and must be preferred, being more parsimonious.

For the selected Model C the effects of the three predicting variables (Interest for the goal, Fun of the gameplay, Realism of the game narration) on the Willingness to play again were calculated and are reported in Table 5, with the level of significance (p-values) indicated in the table footnote.

TABLE V. EFFECTS ON THE WILLINGNESS TO PLAY AGAIN (MODEL C)

Variable	Total effect	Direct effect	Indirect effect
Fun of the gameplay	0.83*	0.83*	--
Interest of the goal	0.58*	0.26*	0.32**
Realism of the game narration	0.26*	0.26*	--

e. * $p < 0.01$; ** $p < 0.05$

Both the fun of the gameplay and the realism of the game narration have significant direct effects on the will to play again (path 4 = 0.83; path 5 = 0.26); the interest of the goal has a significant total effect on the willingness to play again, obtained as the sum of a direct effect (path 3 = 0.26) and an indirect effect (path 1 · path 4 = 0.32) through the mediation of the fun of the gameplay.

VI. CONCLUSION AND FUTURE WORK

For all the tested models, the R-square values of the willingness to play resulted to be very high (about 90% of the variance explained). This can be seen as an overall confirmation of the right choice of the models' variables and their causal arrangement.

As hypothesized, both the fun of the gameplay and the realism of the game narration resulted to significantly influence the willingness to play again for all the models. Causal paths 4 and 5, in fact, are significant across all tested models. In particular the influence of the fun of the gameplay resulted to be more robust, with values of path 4 above 0.80, while the influence of the realism of the game narration, even though significant, was less pronounced, with values of path 5 around 0.30.

Furthermore, the fun of the gameplay resulted to significantly mediate the relationship between the interest of the goal and the willingness to play again. On the contrary, no significant mediation emerged for the realism of the game narration, insomuch as the causal Model C, where path 2 is suppressed, was preferred. As a whole, the relationship between the interest of the goal and the willingness to play again is partially mediated by the fun of the gameplay, and non-significantly mediated by the realism of the game narration.

Interpreting the fun of the gameplay as a ludic indicator, and the realism of the game narration as a narrative indicator, these results can be referred to the ludology/narratology debate. The results of the present study seem to corroborate a point of view that takes in consideration both positions, even though assigning ludology an higher relevance. This sort of reconciliation of the two different positions, however, is not gained through an assimilation of the realism of the game narration to the fun of the gameplay. As reported in Table 2, in fact, their correlation coefficient is non-significant (and slightly negative), indicating their substantial independence (or even slight juxtaposition). The fun of the gameplay and the realism of the game narration must therefore be considered as separately, and differently, contributing to determine the success of a learning game. The results of the present study seem to mostly corroborate Jenkins' proposal of "game space", whose structure facilitates narrative experience [13]. In this sense, the interest of the goal can be interpreted as a feature of the "game space" that can enhance the degree of satisfaction of the players, determining their retention in a direct way, and indirectly, thanks to its contribution to the fun of the gameplay.

The association of the fun of the gameplay and the realism of the game narration with the ludic and the narrative components of a serious games, however, is exposed to criticism of being both partial and spurious. While the significance of the results of the present paper is robustly consistent with the measured variables, it must be recognized that different types of narrative can be developed within a serious game, not limited to realistic ones. Having considered the realism of the narration is certainly only a partial representation of the narrative of a serious game. At the same time, fun in a serious narrative game can derive not only from the act of playing, but also from other components like the fact to learn something interesting or to take part in an engaging story. The fun of the gameplay can thus be referred not only, or at least not exclusively, to the ludic aspects of a serious game. To have a more comprehensive insight of the ludic and narrative dynamics within a serious games, a larger number of indicators should be analyzed and validated as referred to the ludic and to the narrative constructs.

The present work suggests to further deepen the study of the role of the fun of the gameplay as an important determinant of the effectiveness/engagement of serious games, analyzing different causal paths and relations between fun itself and other variables. A wider sample group and more specific analysis tools must be adopted to go beyond the limits of the present study. It must be underlined, in fact, the small analyzed sample size (n = 54) and the weak reliability of the measuring instrument. Instead of a generic self-developed questionnaire, with one item for each variable, a validated instrument should be adopted, mapping multiple items to variables through factorization.

Some of the limits of the present study are going to be addressed thanks to a Transfer of Innovation project, funded by European Commission, named InTouch-ICT, for the period 2013-2015. The InTouch-ICT Project is adapting previous project results to suit the learning needs of business professionals of ICT SMEs in Turkey, re-designing the existing m-learning kit to fit the requirements of Turkish ICT SMEs, and upgrading it with the most recent findings, both technological and methodological, in the field of mobile game-based learning.

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Towards Generating Multiple-Choice Tests for Supporting Extensive Reading

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***Abstract*— We propose a method for generating multiple-choice test for an English text selected by a learner and its answer, that are used to make a self-assessment whether the learner comprehends the text after reading it. In our method, the system extracts several important sentences from the text, and replaces one word in each of these sentences with its synonym (if possible). One of these sentences is then selected as a correct optional sentence, while further changes to the polarities or nouns in the remaining sentences are carried out to generate distractor optional sentences for the multiple-choice test. Our method has potential to make extensive reading in English more effective.**

Keywords; Aided Learning; Important Sentence; Paraphrase; Documents on Web; Extensive Reading.

I. INTRODUCTION

Reading extensive English texts is a good training for English learners [1]. They should read texts that are interesting and with an appropriate level to keep up and enhance the learning effect of extensive reading [2]. There are a huge number of English texts available through the Internet that could support such reading.

Learners, whose English abilities are not high, often do not comprehend the content or story of a text after reading it, even if they understood each individual sentence while they were reading it. To acquire a practical English reading ability, they must train their reading comprehension. Learners can do this training effectively when they use a text with accompanying comprehension test as reading material. At present, there is not much reading material like that on the Internet. Therefore, we have developed a method for generating a multiple-choice comprehension test for an English text selected by a learner, using a Natural Language Processing technology. In this paper, we describe how to create a multiple-choice comprehension test for a text and the evaluation for the method.

The rest of this paper is organized as follows. We explain the outline of our system for generating multiple-choice tests and introduce related works in Section 2. The method for extracting important sentences to generate optional sentences for the test is introduced in Section 3, and the method for paraphrasing them is introduced in Section 4. In Section 5 and Section 6, we present the experiments for extracting important sentences and paraphrasing sentences, and the results we obtained. Our final conclusions and future work are discussed in Section 7.

II. OUTLINE OF OUR SYSTEM AND RELATED WORK

The test consists of one sentence (the correct optional sentence) that is consistent with the English text, and several sentences (distractor optional sentences) that are inconsistent with the text. A learner selects a sentence consistent with the text from among optional sentences after reading the text. The system generates these optional sentences from the text selected by the learner as follows. First, it extracts important sentences from the text. We regard “important sentences” as sentences that we have to retain (even temporarily) to understand the content of the text. Second, the system changes elements in these extracted sentences, without changing their meaning, to ensure the test is not dependent on simply memorizing content. Finally, the system selects one sentence among them as the correct optional sentence, and carries out further changes to the polarities, subject or object nouns on the remaining important sentences to generate distractor optional sentences. Thus, the basic techniques for generating optional sentences in the test require a process to extract important sentences, and to change expressions in them without changing their meaning.

In automatic summarization, there are a number of methods to extract important parts or sentences and shorten sentences without changing their meaning [3]. However, state-of-the-art methods for automatic summarization are using machine learning. Therefore we need extensive training data of texts and their summaries to generate test using automatic summarization techniques for an English text selected by a learner among diverse texts available on the Internet. It is difficult and impractical to prepare such training data. There also are many studies on paraphrasing, although there is no free software or resource currently available for public use except the PPDB [4], as far as the

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authors know. Therefore, we attempted to generate a multiple-choice test using a method of extracting important sentences without training data and a method of paraphrasing based on a thesaurus.

There are a few studies on a system that generate questions about texts suitable for the proficiency level of English learners, analyze their responses, and give advice to lead them to a correct answer, after reading or listening to a text [5][6]. However, this system is designed to improve grammar and vocabulary for low-level English learners at junior high school in Japan. The purpose of our test is to support extensive reading in English for middle to high-level English learners who want to acquire a practical reading ability.

III. METHOD FOR EXTRACTING IMPORTANT SENTENCES

We extract important sentences in a text using the degree of importance of words based on the *Spreading Activation Model*. Matsumura et al. [7] proposed a method for extracting keywords based on this model. This method extracts the words expressing assertions of a document, taking into account the structure of the document (i.e., the strength of the relationship between words for each segment of the document). It is not dependent upon machine learning. Term frequency-inverse document frequency (TF-IDF) also has been used to extract important words [8] [9], and is not based on machine learning either. However, TF-IDF is not a measure of the importance of words that reflects the structure of a document. Hence, we believe the method proposed in [7] works better than TF-IDF to extract sentences we have to retain to understand the content of a text.

Here, we briefly explain the method for calculating the importance of words proposed in [7]. First, they divide a text into segments, and extract M most frequent words in a segment S_t. Let w_1, w_2, $\cdots$, and w_L be extracted words from the whole text. The co-occurrence frequency of each pair of extracted words in the segment S_t is used to calculate $R(t)$, the spreading activation matrix of the segment S_t. Thus, the (i, j)-element of $R(t)$ is the strength of the relationship between the word w_i and the word w_j in the segment S_t. The (i, j)-element of $R(t)$ is zero when w_i or w_j does not appear in the segment S_t. Let $\mathbf{a}(t)$ be the L-dimensional column vector, whose i-th element is the activity value of the word w_i in the segment S_t. The activity values of words are calculated according to

$$\mathbf{a}(t) = \big((1-\gamma)I + \alpha R(t)\big)\mathbf{a}(t-1),$$

where all elements in $\mathbf{a}(0)$ are 1. The parameter α is transmission rate, and γ is attenuation rate. Now suppose that the last segment number in a given document is n, then $\mathbf{a}(n)$ expresses the activity values of words after reading the document. Thus, the i-th element in $\mathbf{a}(n)$ expresses the degree of importance of the word w_i in that document. Matsumura et al. proposed the *sharp activity value* as another measure of a word's importance. It is the activity value of a word divided by the activity times of the word.

We conducted a preliminary experiment where only activity value or only sharp activity value was used as measure of a word's importance and importance of a sentence was calculated based on word's importance. However the precision was not so good. In this research, we use the following *mixo-activity value* as a new measure of a word's importance. The mixo-activity value m_w is defined as follows:

$$m_w = \max(a'_w, s'_w),$$

where

$$a'_w = \frac{a_w}{\max_w a_w}, \qquad s'_w = \frac{s_w}{\max_w s_w},$$

a_w is the activity value of the word w, and s_w is the sharp activity value of the word w. The ranges of activity values and sharp activity values are generally different. Then, in the definition of m_w, we use a'_w and s'_w that are transformed so that the maximum values are the same (equal to 1).

We define three measures of importance of a sentence using the degrees of importance of its words as follows (n is the number of words in the sentence) :

(1) The sum of the mixo-activity values of the words in the sentence.

(2) The value (1) divided by n.

(3) The value (1) divided by log(n+1).

The degree of importance of a sentence according to (1) tends to be high, when the sentence has many words. Therefore, we try to use the measure of (2), the mean mixo-activity value of words in the sentence. However, long sentences are often important. Then we also try to use (3), which will have a value intermediate between (1) and (2).

Thus, we propose three different measures of the importance of sentence using mixo-activity values as the measure of importance of words. These are Wm_i (i = 1, 2, 3), respectively. The number “i” in Wm_i corresponds to the measures listed above. We use all three measures to determine which is the best measure to extract the sentence that we have to retain to understand the content of the text.

IV. METHOD FOR PARAPHRASING SENTENCES

We propose the method of replacing one word in a sentence with its synonym, as a simple method for paraphrasing sentences. However, we cannot simply replace a word with one its synonym because a word generally has many synonyms with different meanings. We have to select an appropriate one among these synonyms, so that the paraphrased sentence has the same meaning as the original sentence.

We focus on a transitive verb and a head noun in its object noun phrase in a sentence. We replace these with their synonyms, if they exist. A transitive verb and its object noun phrase are generally strongly connected to each other. The strength of this connection can be estimated using point-wise mutual information (PMI). Let v be a transitive verb, np be its object noun phrase in a sentence, and n be the head noun of np. In addition, let v' be one of the synonyms of v, n' be one of the synonyms of n, and np' is what we get by replacing n in np with n'. For example, one of the synonyms of "provide" is "supply", while one of the synonyms of "example" is "instance"; hence, we get "supplies a perfect example" and "provides a perfect instance" from the original phrase "provides a perfect example". If there is a strong connection between v' and np, then "v' np" is likely a natural expression. Hence, "v' np" more likely has the same meaning as "v np" because v' is one of the synonyms of v. Also, if there is a strong connection between v and np', then "v np'" also will be a natural expression, likely to have the same meaning as "v np".

Therefore, we generate the paraphrased sentence of the original sentence s as follows:

(1) Extract a transitive verb v and its object noun phrase np in s. Let n be a head noun of np. If s does not have a transitive verb, we do not generate a paraphrased sentence for s.

(2) Find the synonyms of v and the synonyms of n using a thesaurus. We denote the synonyms of v as $v'_1, v'_2, \cdots, v'_J$, while the synonyms of n are $n'_1, n'_2, \cdots, n'_K$. We get np'_k by replacing n in np with n'_k. If neither v nor n has synonyms, we do not generate a paraphrased sentence for s.

(3) Calculate the strength of the connection between v'_j and np ($j = 1, 2, \cdots, J$), and the connection between v and np'_k ($k = 1, 2, \cdots, K$). We denote the strength of the connection between A and B as $Score(A, B)$.

(4) Find the following set C_V:

$$C_V = \{v'_j \mid Score(v'_j, np) \geq \theta,\ j = 1, 2, \cdots, J\},$$

where θ is a chosen threshold value.
Also, find the following set C_{NP}:

$$C_{NP} = \{np'_k \mid Score(v, np'_k) \geq \theta, k = 1, 2, \cdots, K\}$$

If both C_V and C_{NP} are empty sets, we do not generate a paraphrased sentence for s. Otherwise, find the following words v^* and np^*.

$$v^* = \arg\max_{v'_j \in C_V} Score(v'_j, np),$$
$$np^* = \arg\max_{np'_k \in C_{NP}} Score(v, np'_k).$$

If $Score(v^*, np) > Score(v, np^*)$, the paraphrased sentence of s is what we get by replacing v with v^* in s. While, if $Score(v^*, np) \leq Score(v, np^*)$, the paraphrased sentence of s is what we get by replacing np with np^* in s.

As described earlier, the strength of the connection between sentence elements can be estimated using the PMI. The PMI between v and np are defined as follows:

$$PMI(v, np) = \log \frac{P_{V,NP}(v, np)}{P_V(v) P_{NP}(np)}, \qquad (1)$$

where

$$P_{V,NP}(v, np) = \frac{f_{V,NP}(v, np)}{\sum_{v,np} f_{V,NP}(v, np)},$$
$$P_V(v) = \sum_{np} P_{V,NP}(v, np),$$
$$P_{NP}(np) = \sum_{v} P_{V,NP}(v, np).$$

$f_{V,NP}(v, np)$ is the frequency of co-occurrence of v as a transitive verb and np as v's object noun phrase in a corpus.

PMI defined by (1) is not reliable when $f_V(v)$ or $f_{NP}(np)$ is small, because in this case the statistical fluctuation of PMI is large. To consider this, we define H_0 that is threshold value for a word, and we select the appropriate synonym in step (4) that have $f_V(v)$ and $f_{NP}(np)$ higher than H_0.

In this research, we use Wikipedia [10] as a corpus to calculate $f_V(v)$, $f_{NP}(np)$, and $f_{V,NP}(v, np)$. We prepare the body text data of Wikipedia, and parse it to count the frequency of co-occurrence of v as a transitive verb and np as v's object noun phrase.

V. Experiment on Extracting Important Sentences

We defined the three measures of the importance of sentence, Wm_i ($i = 1, 2, 3$) in Section III. Next, we need to evaluate which measure works best to extract "the sentence that we have to retain to understand the content of the text" in an experiment.

A. *Evaluation Data*

First, we chose randomly twenty English texts with about 1,500 words from "The Free Library" [11]. We also chose three test subjects (S, H, P; S is a graduate school student, H is a research student, and P is a professional translator) to have them read these texts and extract five important sentences from each text. We explained to the test subjects that "important sentence" means the sentence that we have to retain (even temporarily) to understand the content of the text. We labeled these extracted sentences as *important* and the remaining sentences as *unimportant* for each subject, and calculated the κ statistic of their inter-subject agreement. Table 1 shows these results.

Generally, there is moderate agreement when $0.4 < \kappa \leq 0.6$, good agreement when $0.6 < \kappa \leq 0.8$, and nearly perfect agreement when $0.8 < \kappa$. Table 1 shows that there is low agreement between subjects, suggesting that it is very difficult to select five important sentences from each text with on average about 57(1130/20) sentences. There also are clear individual differences between subjects. Hence, we assume that any sentence extracted as an important sentence by at least one test subject is important. Using this criterion, we generated our evaluation data, where each sentence was labeled as important or unimportant. We used these data to evaluate the performance of the proposed method below.

TABLE I. κ STATISTIC BETWEEN TEST SUBJECTS

	S	H	P
S		0.273	0.286
H	0.273		0.273
P	0.286	0.273	

TABLE II. PRECISION FOR EXTRACTING IMPORTANT SENTENCES BY EACH MEASURE

Measure	Wm_1	Wm_2	Wm_3
Precision	0.41	0.43	0.47

B. Experiment and Result

We carried out a morphological analysis of each sentence in the text, and removed stop words, using the stop word list in the SMART system [12]. We extracted the basic form of a word with the software tool Tree Tagger [13].

Next, we carried out spreading activation, and extracted five important sentences using the three measures: Wm_i (i = 1, 2, 3) for each text. We set M, the number of words extracted from each segment, to 20% of the number of words by type in the segment S_t and also set a parameter α, transmission rate, to 1.0. We tried some parameter-setting for a parameter γ, attenuation rate. We performed parameter sweep across 0.1, 0.3, 0.5, 0.8 and 1.0. We evaluated the precision of each measure using our evaluation data. Table 2 shows our results when $\gamma = 0.3$, that is the best result.

C. Discussion

The precision of extracting important sentences using the three different measures ranges from 41 to 47%. Given that the average number of sentences in these texts is 57, and the average number of important sentences is 10.6, then these measures work fairly well. We calculated the κ statistic between the judgment by the measure Wm_3 and the judgment by each test subject. Table 3 shows the result. Comparing Table 3 with Table 1, we found that these κ statistics are not so low. From this point, we also think that the measure Wm_3 works well.

However, the precision of 47% is not sufficient to use in a practical system to generate a multiple-choice test and its answers, if the evaluation method is appropriate.

As we described in the subsection "Evaluation Data", we had three test subjects extract five important sentences for each text. Then, we assumed that the sentences that we had to retain (even temporarily) to understand the content of the text were the sentences extracted by at least one test subject as important sentences. That is to say, we regarded that the sentence that no test subjects selected as important sentence was not the sentence that we had to retain (even temporarily) to understand the content of the text. However, the sentence that no test subjects selected as important sentence is not always inappropriate for the sentence used in the multiple-choice comprehension test. In the sentences that were selected by the system and were evaluated as unimportant based on the evaluation data, there would be sentences that we had to retain even temporarily to understand the content of the text. The evaluation criterion in this experiment might be too strict, and we have to change the evaluation method, for example, increasing the number of the test subjects.

TABLE III. κ STATISTIC BETWEEN THE JUDGMENT BY THE MEASURE AND THE JUDGMENT BY EACH TEST SUBJECT

	S	H	P
Wm_3	0.197	0.183	0.183

VI. EXPERIMENT ON PARAPHRASING SENTENCES

We proposed a method to paraphrase a sentence by replacing a transitive verb or a head noun in its object noun phrase with its synonym selected according to the strength of their connection, where the strength of the connection between a transitive verb and its object noun phrase is estimated by PMI between them. In this section, we evaluate the performance of the proposed method.

A. Evaluation Data and Tools

We collected articles from "The Free Library", and manually extracted one hundred fifty pairs of transitive verbs and their object noun phrases. When we extracted noun phrases, we removed adverbs, prepositional phrases, and relative clauses to extract noun phrases with the structure "(DETERMINER) (ADJECTIVE) NOUN". We generated candidates of paraphrased expressions for each of these extracted pairs of transitive verb and its object noun phrase using WordNet [14] as a thesaurus to find synonyms for the transitive verbs and nouns. We generated 10 candidates on average for each original expression.

Next, we asked an English editing company to evaluate these candidates and classify them as one of the following four categories:

- Natural and similar meaning
- Unnatural and similar meaning
- Natural and different meaning
- Unnatural and different meaning

Only expressions evaluated as "Natural and similar meaning" are acceptable as paraphrases.

B. Evaluation Method

We define the precision P of the method, as the ratio of the number of the acceptable expressions generated by this method to the total number of the expressions generated by the method. We define the gain G of the method, as the ratio of the number of the expressions generated by the method to the number of all test pairs (150). Parameters in the proposed method are thresholds θ and H_0. When we set θ

(and H_0) to high values, the selected expressions tend to be correct. However, in this case, the method does not generate a paraphrase for many of the original expressions. When we consider our purpose, it is not necessary to paraphrase all of the extracted important sentences. It is sufficient to appropriately paraphrase only one important sentence for a given text and select this as the correct optional sentence, so that the test is not just a simple memorizing test. If we generate a multiple-choice test composed of five optional sentences, then a *G* value in the range 10 to 40% is sufficient. However, the precision *P* must be nearly 100%.

In our experiment, we set the goal gain to 10, 20, 30, and 40%, and varied the threshold θ and H_0 for each measure, and find the values of θ and H_0 so that the gain *G* for the training data is equal to or higher than the goal gain, and the precision *P* is as high as possible. With these threshold values, we seek the precision and the gain for the test data. We evaluated this procedure using a 5-fold cross validation. In this procedure, the thresholds were varied as follows:

$$\theta = 1, 2, \cdots, 50$$

$$H_0 = 1,\ 10,\ 100,\ 1000,\ 10000$$

C. Results

Table 4 shows the result. We think the precision around 80% at best is fairly good, even though it is simple method, and not based on machine learning. However, the precision must be nearly 100% to generate a multiple-choice test. We discuss further possible improvements to our method in the next section.

D. Discussion

We have to improve our method of paraphrasing sentences to generate a multiple-choice test. At present, most of the unacceptable expressions selected by our proposed method were labeled as “Natural and different meaning” by a proofreader at an English editing company.

By replacing a transitive verb or a head object noun in a verb phrase with its synonym, we expected that we could get a verb phrase with the same meaning as the original verb phrase. In many cases, this is true, if what we get by replacing these words is a natural expression. However, there were many exceptions, as our results show. One of our issues is that we have to select an appropriate expression among expressions estimated as natural using a measure of the strength of the connection. There are studies on disambiguating word sense using the distribution of words around a target word. We think there is potential to select an appropriate expression using this technique. We expect that the candidate expression estimated as natural more likely has the similar meaning to the target verb phrase if it has the similar word-distribution around it to the word-distribution around the target verb phrase.

TABLE IV. GAIN AND PRECISION FOR PARAPHRASING BY 5-FOLD CROSS VALIDATION

θ	H_0	*G*	*P*
20	1	40.00%	72.07%
23	1	32.67%	75.31%
28	1	18.67%	77.27%
34	10	10.00%	81.82%

VII. CONCLUSION

We proposed a method for extracting important sentences and paraphrasing them to generate a multiple-choice test for an English text. This test is used to make a self-assessment whether a learner comprehends the text after reading it, and would make extensive reading in English more effective. We evaluated the proposed method with a small-scale experiment and were able to show the potential of our proposed method. Unfortunately, the performance of extracting important sentences was insufficient to form the basis of a practical system to generate a multiple-choice test. The evaluation criterion might be too strict in this evaluation. We have to change the evaluation method. The performance of paraphrasing was insufficient, too. We would carry out further improvements for paraphrasing sentences in our future work. The PPDB [4] that is the large corpus for paraphrasing sentences has been released since 2013. We are going to try an improvement of paraphrasing using the PPDB.

ACKNOWLEDGMENT

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Preparing Higher Education Tutors for Delivering Online Courses

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***Abstract*—This paper identifies that academic staff need to be suitably prepared to deliver wholly online courses, and outlines the steps taken towards achieving this, at one Higher Education institution in the UK. E-learning, whether partially (blended) or wholly online, is not simply about the technology, but also requires an understanding of the pedagogical considerations, and the skills that are needed, to effectively facilitate them. Through the use of a formal questionnaire, and collation of informal comments made on a social network, evaluation is made of a staff development course designed specifically to promote effective facilitation of high quality online courses. The results determined that the course is fit for purpose and achieves its aims. Future cohorts are already over-subscribed as a result of positive commentary by participants. Further developments will be made, based upon constructive feedback by participants. Whilst possibly not unique, this course demonstrates action being taken in an educational institution to recognise that effective online delivery requires specific knowledge and skills that are different from those used in the traditional classroom.**

Keywords – staff development; distance learning; facilitating online delivery; higher education.

I. Background

The way that education is delivered is constantly evolving, albeit at varying pace. Learners are now immersed in a digital world, with information and multimedia entertainment available at their fingertips. With technology becoming integrated into daily living, its involvement in the way we learn is unavoidable [1].

Yet despite its inevitability, 'e-learning' for want of a better phrase, cannot happen without due consideration [2]; it comes with both technical and pedagogical considerations which many academics are not conversant with [3], and poor implementation by well-intentioned individuals can be blamed for much of the bad press associated with digital innovation. But this is no different to traditional delivery methods, where a badly presented subject is not well received by the learners. Unfortunately it is all too easy to blame the technology, and learners' are then reluctant to undertake what they fear will be similar experiences in the future.

This can be addressed by ensuring that course development and delivery is carried out by academics with the relevant skills and knowledge, by querying their 'digital literacy'; "*those capabilities which fit an individual for living, learning and working in a digital society*" [4]. The abilities of staff involved in education supported by technology, is a specific consideration for Higher Education in the UK, as a precept in the 2010 QAA Codes of Practice, where it states that "*Staff who provide support to learners on FDL* [Flexible and Distributed Learning] *programmes have appropriate skills, and receive appropriate training and development*" [5]. This is clarified further in the superseding Quality Code document [6] when considering the appointment, support, and continuing development of staff:

> *"Individual staff members are able to access appropriate and timely support to develop inclusive forms of learning, teaching and assessment which are supported by technology."* (p.14)

> *"Higher education providers also recognise the importance of digital literacy for staff and make available suitable development opportunities*." (p.15)

To address this, the University of Huddersfield has taken a strategic approach to digital literacies, with the Enabling Strand 'Professional Development of Colleagues' within its Teaching and Learning Strategy 2013-2018 [7], stating '*TD3: Achievement of relevant level of digital literacy skills'*. This is to be determined through evaluation against pre-determined Standards during the annual appraisal process.

These criteria take the form of a Grid of Digital Literacies for Staff (DLS), which identify specific skills and knowledge that are set within four ascending levels of ability. The lower levels focus primarily on the use of the institution's VLE (Blackboard™) to promote "*100% use of Virtual Learning Environment*", which is a Foundation indicator within the afore-mentioned Teaching and Learning Strategy. There is then progression within the Grid, with advancement implied through increased, varied use of technology, both within and external to the VLE, with appropriate evidence of personal/professional development activities to underpin their introduction.

Specific attention is paid within the DLS Grid to learning modules delivered 'wholly online'. Additional benchmark statements are identified for both delivery and course design, and demonstration of achievement can be through completion of specific modules on the University's MSc Multimedia and eLearning course (or equivalent), or a claim for Accreditation of Prior Experiential Learning (APEL). A third alternative, but only for wholly online delivery, is the Facilitating Online staff development course discussed in this paper.

This paper will begin in Section 2 by outlining the structure of the course, identifying the framework it is adapted from, and the regular weekly pattern adopted within it. Following a description of the methodology in Section 3, the data collected from a formal questionnaire and an informal social network is discussed in Section 4. Limitations of the study are then identified in Section 5, followed by Section 6, the conclusions, which also outline future work to be carried out in this area.

II. COURSE OUTLINE

The Facilitating Online staff development course runs over a five-week period introducing participants to the approaches of online facilitation and the various tools and technologies, which can support this. The emphasis was on the practical skills rather than theoretical understanding, with a particular focus on how to achieve social interaction and engagement from the participants, rather than examining theoretical models. Participants were asked to dedicate five hours per week to the course and participate in a number of practical and collaborative tasks that emphasise the skills required of an online facilitator and the support that they will need to provide to their students in the future. The course was designed for participants from a variety of academic disciplines and with differing technical capabilities to share experiences and evaluate different approaches. One of the key objectives of the course was to give the participants the perspective of being on online student, as often the online tutors do not have that personal experience to draw on [8].

The course was adapted from a Facilitating Online course devised by Carr et al [9] from the Centre for Educational Technology, University of Cape Town, created with a Creative Commons Share Alike licence for adaptation and reuse. It is loosely based around the Salmon 5-step model [10], consisting of a series of five stages that participant's progress through when using communication tools in an online course. The content and tasks described in the original course were substantially modified to bring them up to date, to make the course more appropriate to our context. Each week represented a different stage:

- **Week one: Accessing** - was about getting comfortable with the learning environment and aims and objectives of the course. It was also an introduction to some of the course tools we would be using and to each other, so involved setting up a profile and introducing themselves to each other to start making connections and building social presence and trust.
- **Week two: Participating** – was about exploring the different types of participant who may engage in an online space and to start thinking about how a facilitator would manage these participants and build community. We also asked the participants to reflect on what type of participant they were in this course.
- **Week three: Facilitating** – was about developing online facilitating techniques and comparing face-to-face facilitation strategies to those that can be used online.
- **Week four: Applying** – was about applying the skills learned so far on the course to produce a design for an online activity that can be facilitated, sharing that with the group and providing feedback to others. The idea of building trust between tutors and participant and between participants was explored.
- **Week five: Evaluating** – was about evaluating both the participant's skills in facilitating online and the course as a whole and reflecting on their personal development plans for the future. The participants also evaluated another participant's activity design in a peer review process.

The course was mainly set within the institutional VLE Blackboard™ and the tools included discussion forums, group and individual blogs, group wikis, and quizzes. A social network was also set up using Yammer™ for discussion, sharing of information/resources, and for taking part in some of the tasks, which also promoted social learning amongst the participants. A weekly synchronous webinar using Adobe Connect™ was also used, mainly as a discussion space where interaction and engagement by participants was encouraged.

The structure of the course was identical each week to model good practice to the participants and establish a pattern of expected participation, so each week consisted of the following areas of content:

- An introductory video from one of the course facilitators to introduce the week's topics and activities and to demonstrate to participants the importance of the human element and online students feeling connected to the tutor, which Shin [11] labelled as 'transactional presence'.
- Pre-reading for the week's topics, which included a mixture of journal articles, blog posts, videos, websites etc., to take up to two hours to engage with. Supplementary reading and resources were also provided each week, that were optional for anyone who wanted further recommended reading.
- A short task taking no more than 30 minutes, often a more light-hearted task to ease the participants into the week's activities.
- A longer task doing something more substantial like contributing to a group wiki, which would take participants about an hour.
- The weekly webinar, held each Thursday but at different times each week to accommodate different working/teaching schedules. This also took an hour. This was recorded for anyone who was unable to attend the webinar in person, so that they could catch up later.
- Reflection in their personal blogs on the learning that week based on the reading, tasks and webinar, this was expected to take around 30 minutes for each person.

We provided motivation, to both engage with and complete the course, in three specific ways.

Firstly we issued praises on Yammer™ for various achievements. All participants who completed all the activities for each week would get a praise, and in addition the praises could be earned for a few extra activities like being the first to post on a discussion forum or for posting up an interesting resource for the others. We also gave out praise for anyone attending the webinar in person to encourage synchronous participation. Each week we had a leader board showing who had the most praised for that particular week and overall. This received mixed reaction (see later) but it did allow staff to evaluate the ideas of earning badges and leader boards as possible motivators for their own students.

Secondly, we mapped the learning outcomes of this course onto a Digital Literacy Framework (mentioned in the introduction) and identified that successful completion of the course, followed by the actual implementation and evaluation of their 'project', served as sufficient evidence of achieving the wholly online delivery section of the Framework.

Finally, the tutors encouraged engagement in the course by having a significant presence at the beginning of the course, frequently posting to the Yammer™ network, commenting on discussion board posts, wikis and blog posts; this was reduced as the course progressed. This active facilitation also served as a demonstration of good practice to the participants, showing the importance of tutor presence in the early stages of a course, to promote discourse and encourage communication, until such time as the participants have gotten to the point of 'self sufficiency' in terms of having a communicating community. There is, however, a fine line between the facilitator having a strong presence in order to promote communication, and creating a sense of dependency that stifles communication not involving them.

III. METHODOLOGY

This research has been carried out to determine the effectiveness of the Facilitating Online staff development course in meeting its aims. The first cohort ran in March 2014 with a cohort size of 11. These participants were all members of academic staff from across the University, (5 out of the 7 Academic Schools were represented). There were 8 females and 3 males in the cohort. Formal evaluation data was collected via an anonymous survey from within the Blackboard™ VLE as part of the course evaluation and review process. In addition, the informal unsolicited qualitative comments made by the participants within the social network Yammer™, were collated and analysed. All data was anonymised, categorised and summarised and no individual can be identified from any qualitative comments included. The participants all gave written permission for their data to be included in the study. Ethical clearance was also obtained from the School's Research Ethics Panel (SREP), to conduct and report on the study.

IV. RESULTS & DISCUSSION

A. Course Administration and Induction

All (100%) of the participants (n=11) found the administration and induction process satisfactory. This included both institutional course instructions from the staff development department, and a welcome email from the course team.

Qualitative comments provided in the questionnaire supported these findings, indicating the process was '*clear and straightforward*'. In addition, constructive suggestions were made for there to be a pre-reading list made available ahead of the course, and also a pre-course checklist of what will be needed.

One respondent commented that their own practice would be influenced by their experiences of the course, as they could now see a problem with the way they had previously been inducting online students.

When asked how they would best describe the organisation and management of the course, using a 4-part Likert scale ranging from 'poor' to 'excellent', all participants except one chose the latter; with the exception suggesting it 'requires slight improvement'. This same pattern of responses occurred when the participants were asked how they would describe the facilitation of the course.

B. Course Navigation / Structure

In general, positive feedback was received on the navigation of the course. The navigation restrictions inherent within BlackBoard™, particularly difficulties encountered when trying to return to an area of content, were criticised by respondents, but the fact that this is built into the VLE and could not be altered, was also identified by them.

The participants welcomed the structured plan for each week that was repeated throughout the course, because the consistency '*prevented confusion*', became '*comfortable*', and '*helped speed up the process of understanding*'.

The delayed release of content using the Mark Review tool, which involves self-identification of having completed each stage, was well received, as it emphasised the need to complete the content in a specific sequence. The use of Learning Modules, another BlackBoard™ resource, also emphasised this sequential approach to the content, and surprisingly, this tool was something that none of the participants were previously aware of, despite having experience of using the VLE as tutors.

The resources provided at the start of each week received positive feedback, with the introductory 'talking head' video for each session, featuring the course tutors, helping to 'humanise' the activities.

One area that the participants felt may require reviewing, is the individual project development and evaluation activities, as these felt a little rushed. This is something the course team will consider, but any change has to recognise that the participants need the personal development of the earlier weeks before moving on to design their own online activity.

C. Interaction

Contact from the course team via email and the social network, were identified in the questionnaire as the methods that most encouraged interaction by participants (identified by 73% of respondents respectively), see Figure 1. The immediate intimation would be that this is due to their 'invasive' nature with notifications appearing on desktop and mobile devices. However, Yammer posts from peers were not considered as much of an encouragement as posts from the course team (55% compared to 73%), and emails

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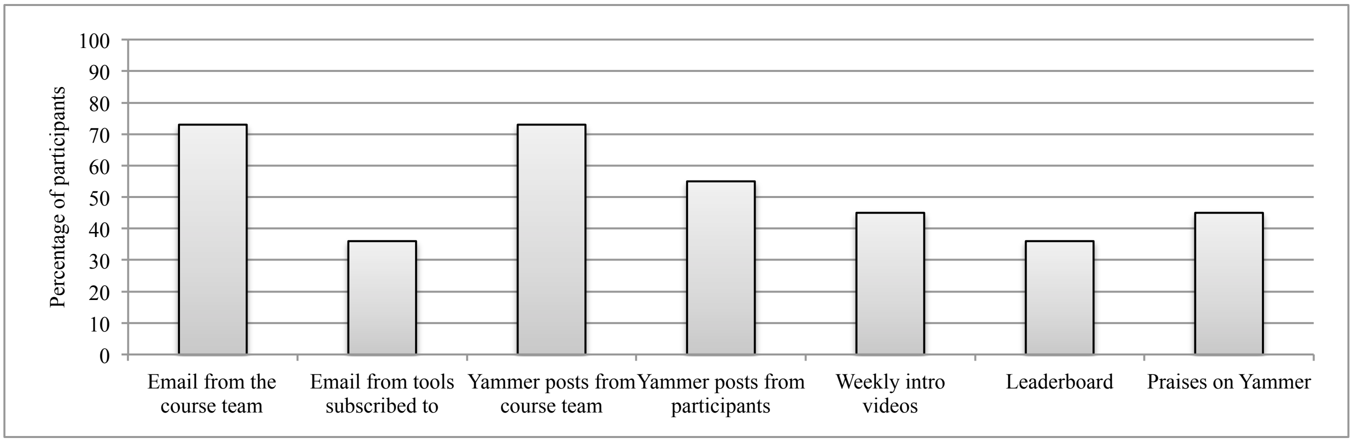

Figure 1. Distribution of the communication tools that encouraged interaction with the course

from the tools on the VLE, instigated through a subscription process, that indicated activity had taken place, were even less valued (36%). This could indicate that the participants were filtering the notifications and allocating different levels of importance to them, or possible never even switched them on; this may be because they did not want them or just never worked out how.

Asynchronous content on the VLE, such as the videos and the leader board, were not as likely to encourage interaction (45% and 36% respectively), with the praise system on Yammer similarly appealing to some, but not others (45%)

D. Course Resources

The participants were provided with an array of resources to assist them with the course, and some were better received than others; see Figure 2.

A screencast on how to navigate the BlackBoard™ space was generally found to be useful (64%), even though the participants all had experience in using the VLE themselves as tutors. Yet the screencasts on how to use some of the tools used on the course, (blogs, wikis, discussion boards, Yammer™ and Adobe Connect™), were, in the main, found less useful (18-28%), despite many of the participants using these tools for the first time.

Indeed, it appears that resources that facilitated the participants' navigation around the course area within the VLE, were considered overall to be the most useful, whether these were presented as a screencast, a Videoscribe™ video, or through the use of shortcut links.

Apart from the screencast, resources associated with the webinar were also found to be useful by the majority of the participants, in terms of both pre-session setup checking, and for post-session reviewing of the videos.

When asked to comment further, one participant suggested the introduction of a light-hearted '*fooling around with tools*' session at the start, may help with familiarisation and to test equipment functionality. It was also thought that the help area might have benefited from being highlighted more, as some participants ignored it, assuming it was generic BlackBoard™ help.

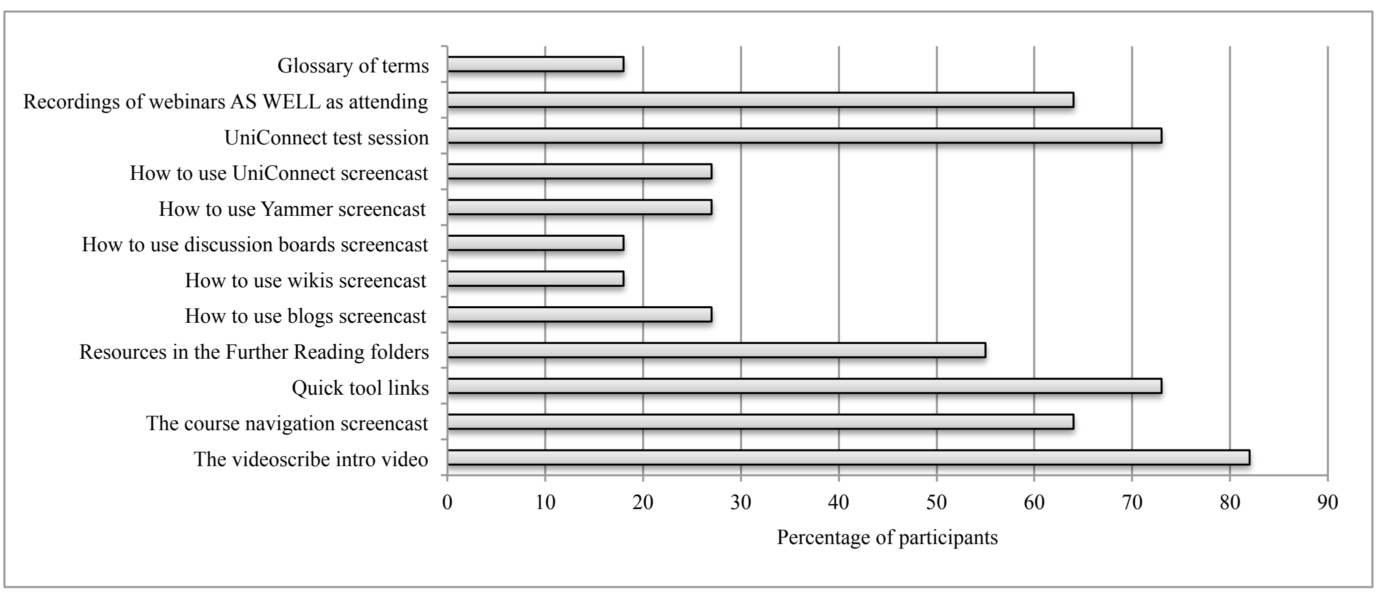

Figure 2. Distribution of the resources and tools used within the course delivery, that were found useful to the participants

The range of resources, from academic papers to more informal 'bite-size' multimedia content, was well appreciated, however some participants acknowledged on the social network that they could have made better use of the pre-reading, generally due to time limitations they themselves had placed on this activity, that were less than the indicated two hours. Others, however, commented that they found this resource to be a '*welcome distraction*', providing them with a reason to be reading, rather than dealing with emails and other daily tasks. It's worth noting that the participants continued to use the term 'reading', despite the pre-reading resources comprising a range of media, including audio and video.

E. Time Management

The participants generally acknowledged in the questionnaire that the timescales employed within the course were correct for the expected workload, or thereabouts, with 55% identifying it as '*exactly what was needed*', and a further 36% finding it was '*almost enough*', but they would have preferred more. Only one participant felt that the time allocated to tasks was '*nowhere near enough*', and this would appear to be specific to their own learning needs.

When asked to comment further on the time allocated for tasks, several participants acknowledged that they felt pressured to complete within the timescales, but at the same time accepted that if the course was longer they may not have subscribed to it, and increasing the course length may still not resolve the perceived problem, due to procrastination. Many participants stated that they had started the course under-estimating the time that would be needed, despite it being made very clear to them in the induction and pre-course materials.

One participant suggested making the course 'week' from Friday to Thursday, rather than starting on Monday, as this would allow the weekend to be used more by those who chose to do so.

Many of the participants used the social network to regularly apologise for their tardiness (despite it usually not being apparent until flagged in this way), which in turn caused discussion about having greater appreciation of the pressures faced by their own students.

F. Online Communication

One of the early tasks on the course was for participants to introduce themselves on the Yammer™ network, and to include their reasons for taking the course. This identified that the cohort consisted of tutors simply wanting to develop their understanding in advance of any developments, as well as those who were already involved in the delivery of online courses.

When asked in the questionnaire about the efficiency of the course tools and activities in encouraging their participation, the majority of respondents (73%) rated them as '*excellent*'. The remainder suggested they '*required slight improvement*', but without further qualitative commentary it is difficult to determine exactly what they intended by this response, as almost every activity the participants carry out requires some form of interaction/reaction. It may be that it is the peer-to-peer element that they felt needed further development?

On the social network it was interesting to note that several of the participants, with experience in using online communication tools, felt able to admit that they had previously given little thought to the concept that there might be different types of online participant; indeed several suggested they had believed it to simply be a case of 'active' or 'inactive'. As a result, their own practice would now change, to reflect this new understanding.

Other less-experienced participants generally defined themselves as 'lurkers', and as this trend became apparent it promoted discussion by the participants themselves on this classification, and its relationship to confidence/competency levels. These discussions raised awareness of this subject and will inevitably be beneficial in the participants' own practice.

The participants provided very positive reviews about the weekly webinars, which provided regular synchronous contact with the participants. Comments in the questionnaire such as '*proved invaluable*', '*very helpful*', '*extremely useful*', '*an excellent way to finish one week and re-enthuse us to start the next*', '*it made the group bond together*' and '*I felt part of a community*', all indicate that this was an important part of the course structure. After each week's live webinar, the participants also used the social network to provide unsolicited positive commentary on the experience, remarking on the relaxed yet informative nature of them. Also, those participants who had previously facilitated their own webinars made a point of highlighting particular practices from the sessions, that they now intended to use themselves.

Indeed, for some, the positivity around the webinars led to negative comments in the questionnaire, where attendance had not always been possible for them: '*there was only one which I could not attend and I was really disappointed and actually felt quite out of the loop*', and '*I found the recorded versions good… but frustrating because it was passive*'.

One participant was unable to attend any of the webinars due to work commitments on Thursdays. As a result they suggested, on the social network, that the course team should identify in advance when the majority of participants will be available to attend the webinars; but they also acknowledged that this will inevitably still result in some people missing out.

Participants also commented on how the weekly webinars helped keep them focused on the course, with both the live sessions and the recorded videos of the webinars, assisting with this.

G. Benefits from the Course

When asked what they found particularly useful about the course, some of the participants acknowledged that they couldn't single out one particular thing, and that all of it was of use. Others identified the webinars and group activities as being useful, with individual participants finding benefit from the pre-reading, the telephone tutorial, from peer feedback, tutor support, and the fact that the participation was compulsory (even though the latter was not something the course team could enforce). It is worth noting that within the responses provided by the participants, there is no obvious preference identified for either synchronous or asynchronous activities.

The high standard of the course and the support provided by the course team was praised by participants, both in the questionnaire and on Yammer™, which is to be expected as the course tutors are trying to be exemplars of the genre – teaching effective online facilitating through online facilitation. Informal comments on the social network indicated that areas of good practice built into the course had been acknowledged by the participants, with the need for scaffolding, signposting, and regular interaction all being particularly highlighted, as well as realisation that up to now, some of the expectations that had been placed on their own students had been too high, in terms of tasks and timescales. One participant's comment particularly indicates this point: '*the course has shown me how a DL [distance learning] course should be set up*'.

In addition, all participants identified that they felt they had achieved the course objectives.

H. Course Enhancement

When asked if they would leave anything out of the course, the participants' responses were very clear, that nothing should be removed.

When asked if they would include anything else in the course, the participants provided some very constructive suggestions. A 'warm up week' was one idea, but this would of course then extend the course to 6 weeks. Providing examples of what other universities are doing in this field was another suggestion, which may be something that could be added to the pre-reading for one of the weeks.

Despite the screencasts being rated low when asked if they had been useful, some participants asked for further screencasts to be provided, featuring some of the analytical tools available in BlackBoard™, which had been demonstrated during the webinars. The intimation was, that these would particularly be useful as post-course resources, rather then during it.

Other requests focused on specific elements of the course that the participants considered examples of good practice, that they wished to utilise, such as tutor control within the wikis, the Learning Module and Task Review resources in BlackBoard™, and the icebreaker games and music that were used at the beginning of the webinars.

One participant suggested that rather than adding to this course, that maybe an advanced course was needed to further develop participants' skills and knowledge.

V. LIMITATIONS

This is a small-scale study and the data was drawn from a specific course with a limited number of participants. The study may have been influenced by factors specific to the student groups, which are not immediately evident from the findings. Also, experiences external to the course content and delivery may have contributed to the outcomes and opinions.

VI. CONCLUSION AND FUTURE WORK

This paper has described the development and evaluation of a staff development course for higher education tutors, to promote effective delivery of online courses. Whilst recognising that such courses may inevitably already exist in other institutions, this course was specifically aimed at promoting good practice within this University, to raise awareness of the ways in which online delivery differs from the traditional face-to-face classroom, to reinforce that it is not simply a case of transferring practices from the latter to the former.

The course is based upon an established framework, which was then brought up-to-date and made relevant to the current digital environment. Scaffolding is provided through a repetitive weekly structure, that utilises the same tools that the participants have available to use in their own courses. This is supported with an obvious online 'tutor' presence in all of the communication tools used, and regular timetabled live interactions.

The evaluation indicates that the course is successful in achieving its aim, with participants, who are experienced academic tutors, acknowledging their raised awareness and new knowledge, of what is required in presenting their courses wholly online. As a result, for many participants their existing practice is to be reviewed, with further consideration given to the tutor's role, and the student experience.

This paper includes the evaluations of one cohort, but at the time of writing another cohort is due to conclude, with a further two already planned. There has been very little official promotion or marketing of the course; instead, word of mouth and positive commentary by participants has resulted in significant numbers signing up for the course.

The constructive feedback provided by the participants in their evaluations will inform future work that is to be carried out, in developing the course further.

One example of this, is that the next course will run from Friday to Thursday, with this change to the 'course week' providing the opportunity for participants to make greater use of the weekend, if they choose to, which may reduce some of the time-related pressures previously identified.

The significant importance that participants placed upon attendance at the webinars, and the negativity it caused when this was not possible, has also been noted. Whilst it is accepted that the day of the week on which these are held should not change, in the future the induction process will include calendar invites being sent for all of the webinars; the timing of the events will then be amended/confirmed to promote the maximum attendance for each specific cohort.

Future cohorts will also continue to evaluate the course, which will provide further data upon which to gauge how successful any changes are, and to determine whether an 'advanced' course really is required, as was suggested in this evaluation.

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Developing a Computer Ethics Course for Online Learners

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***Abstract* – Online learning is still a very contentious topic throughout the halls of academia. Advocates state that students who complete online courses learn as much as those in a face-to-face environment; earn equivalent grades; and, are equally satisfied. However, other researchers note that online students are less likely to complete their courses thereby negating the positive impact. Yet, online education is continuing its upward growth and in higher education, new degree programs and courses are being added on a regular basis. The Babson Survey Group reported that in 2011, online course enrollment hit an all-time high with more than 6.1 million students. The reported also stated that approximately thirty-one percent of all higher education students now take at least one course online. With the cost of education rising and employers looking for students with more depth in the subject area, there remains a debate regarding how to best deliver the educational experience to students. The aim of this paper is to present the development and results of a pilot study involving an online computer ethics course at a two-year institution. The paper positions the course within the context of the college's computer science curriculum, describes the rationale for course development and presents the next steps toward making the course a requirement for computer science majors.**

Keywords – computer ethics; learning content management system; online learning; undergraduate computer science

I. INTRODUCTION

The United States Department of Commerce, Economics and Statistics Administration in its July 2011 report stated that science, technology, engineering, and mathematics (STEM) occupations are projected to grow by 17.0 percent between 2008 and 2018, compared to 9.8 percent growth for non-STEM occupations [1]. Additionally, STEM workers command higher wages, earning 26 percent more than their non-STEM counterparts. Moreover, STEM degree holders enjoy higher salaries, regardless of whether they are working in STEM or not [1]. By 2018, the bulk of STEM jobs will be in Computing (71%) followed by traditional Engineering (16%), Physical Sciences (7%), Life Sciences (4%) and Mathematics (2%) [2]. These statistics provide an impetus for more students to choose STEM areas as fields of study; however, the number of students choosing STEM disciplines, inclusive of computer science is steadily decreasing.

According to The New York Times' Christopher Drew, studies note that approximately 40 percent of students who choose to purse a STEM area either switch their major in college or do not graduate at all [3]. This statistic, as stated by Drew, is twice the combined attrition rate of all other majors [3]. A great deal of research has been conducted on the reasons as to why students choose not to study STEM. It has been suggested that societal stereotypes, environmental and cultural factors, a lack of visible role models, different interests and experiences, and academic un-preparedness are some of the reasons [4] – [7]. While these reasons are well-documented, more research is now being conducted on what happens to students during the first two years of college which deters them from pursing their goals of becoming a scientist, engineer, mathematician or computer scientist.

One article posits that there has been a dramatic shift in the way in which students learn [8]. It suggests that most high school classes are small in nature allowing a teacher to work with approximately thirty students at any given time. This stands in stark contrast of the large lecture halls consisting of 200 students that a new college student might face. In this type of environment, most professors cannot offer individual attention to all students enrolled in the course, often leaving some students to teach themselves, which in high school they have not learned how to do [9]. Therefore, the paradigm of how to best offer course content to students and especially STEM majors is continuously being studied.

In the report entitled Distance Education at Degree Granting Postsecondary Institutions 2000-2001, from the National Center on Education Statistics, noted that during the 2000-2001 academic year, 56 percent (2,320) of all 2-year and 4-year Title IV-eligible, degree-granting institutions offered distance education courses for any level or audience. Moreover, there were an estimated 3,077,000 students enrolled in all distance education courses offered by 2-year and 4-year institutions during the 2000-2001 academic year [10]. Since that report, it has been noted that online course enrollment in the United States hit an all-time high in 2010 with more than 6.1 million students and according to the report from the Babson Survey Group, this number will only increase [11]. The report also stated that approximately thirty-one percent of higher education students now take at least one course online and that academic leaders believe that students are satisfied with this type of content delivery method [11].

This paper focuses on the development of an online course in computer ethics for a two-year institution. The paper describes the reason for course development and presents the next steps toward making the course a

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requirement for computer science majors. Also presented are results from the pilot offering of the course. The paper is organized into the following sections. Section II provides the rationale for the course which introduces the Complete College plan. Sections III and IV introduce the course and the pilot study. Sections V and VI present the results and discussion from the pilot study. Section VII presents next steps and concluding thoughts.

II. COMPLETE COLLEGE PLAN

A. *Complete College America*

In response to the concern that the U.S. is lagging behind other countries in its production of college-degree holders, Complete College America emerged in 2009 as a national non-profit organization whose mission is to work with states to increase the number of Americans with career certificates or college degrees [12]. Since its inception, 34 states, including the District of Columbia have become Alliance members and are now participating in working to significantly increase the number of students who are successfully completing college.

To become a member of the Alliance, the state's governor in partnership with its colleges and universities pledge and work together to meet the mission of Complete College America [12]. More specifically, when a state becomes an Alliance member it makes college completion a top priority and commits to do the following [12]:

- Set completion goals
- Collect and report common measures of progress
- Develop action plans and move key policy levers

B. *Complete College Georgia*

The state, Georgia, in which the course was developed and piloted is an Alliance member and has adopted the mission of Complete College America. Georgia notes that in order to improve its economy that another 27% of its citizens must join the already 34% of the states' population who currently hold an associate's degree or higher [12]. To meet this goal, not only must the colleges and universities enroll more students, but they must retain the ones presently enrolled and remove barriers that impact student success. To improve low completion rates, colleges and technical schools have committed to [13]:

- Build and sustain effective teaching
- Explore and expand the use of effective models
- Promote and increase distance education
- Focus on adult and military outreach
- Implement STEM initiatives

C. *Georgia Perimeter College*

Georgia Perimeter College (GPC) is a two-year institution located in the Atlanta-metro area, part of the 33-member schools of the University System of Georgia (USG). GPC offers Associate degrees in Arts, Sciences and Applied Sciences [14]. GPC typically hosts the largest freshman and sophomore enrollments in Georgia, making it the top producer of transfer students to 4-year institutions within the state. It has five campus locations and services approximately 22,000 students. Roughly 10 percent of the student body takes all their classes online [14]. The number of students choosing one of the STEM disciplines is roughly 10 percent [15].

To help meet the goals of Complete College Georgia, the Academic Advisory Committee on the Computing Disciplines (AACCD) determined that two-year institutions needed to offer at least one additional computer science course that could be transferred to a 4-year institution in order to make transferring students more competitive and that would give students additional depth in the discipline. The AACCD is an advisory committee of the Board of Regents (BOR) of the USG. Advisory committees are formed around the courses of the core curriculum, and the degrees and major offered by BOR institutions. As part of their responsibilities, the advisory committees study the curricula and programs of instruction in the discipline or disciplines within the purview of the committee; make reports and recommendations concerning the improvement of instruction and the curriculum; and, make recommendations to the Academic Affairs System Office concerning new programs proposed by USG institutions [17].

In response to the charge from the AACCD, the GPC's computer science curriculum committee proactively engaged in selecting an additional course that: 1) is required by transferring institutions and can easily be transferred; 2) provides students with additional depth in the discipline; and, 3) can be taught by existing faculty. A survey of surrounding 4-year institutions was conducted and it was determined that a course in computer ethics would meet the criteria. Also in the survey, it was determined that computer ethics could be offered as early as the second year for students, unlike make of the other computer science courses, thereby making it a viable option for a 2-year institution. Moreover, it was a course that could be offered online to a large population of students that a traditional face-to-face course may not be able to do in its initial offering.

III. COURSE DEVELOPMENT

A. *Course Description*

CSCI 2900-099 - Ethical and Social Issues in Computing, is a three hour course dedicated to the study of social, ethical, and legal effects of computing on society and its users. Ethical concepts, professional codes of ethics, and the influence of computing on individuals, organizations, and the global economy will be addressed. Students will utilize critical thinking and problem solving skills to analyze and debate case studies on topics some of which include privacy; intellectual property; computer crimes; system failures and implications; and, the impact of technology on society [18].

Prerequisites for the course are sophomore standing and CSCI 1301- *Principles of Computer Science* I with a “C” or better, or permission of the Instructor and Department Chair. It was decided that CSCI 1301 would be the course prerequisite because it emphasizes structured, top-down development and testing of computer programs. At the conclusion of the course, students would be able to utilize critical thinking and analytical skills to successfully analyze, develop and implement programs in a modern programming language.

The course utilized the College’s Desire 2 Learn (D2L) learning management system as its online portal. This allowed the instructor to disseminate information, engage students in discussions and perform student assessments.

B. Topics Covered

The topics covered in the CSCI 2900-099 include [18]:

- Basic concepts and historical overview of computer ethics
- Introduction to issues and themes in ethical computing
    - Privacy
    - Freedom of Speech
    - Intellectual Property
    - Computer and Network Crime
    - Evaluating and Controlling Technology
    - Error, Failures and Risks
- Professional ethics and responsibilities

C. Learning Outcomes

By the end of the course, a student should be able to [l8]:

1. Explain and evaluate the ramifications of technological advances brought by the advent of the computer on individuals, organizations and society
2. Identify ethical and legal issues related to computer use
3. Develop solutions based on the computer professional code of ethics
4. Effectively and succinctly communicate through speech, writing, and presentation the themes of the course

D. Student Assessments

Since this was designed to be a sophomore level course, it was decided that student assessments would include the following: debate presentations, class participation, one programming assignment, a term paper, two exams and one final exam.

IV. PILOT STUDY

A. Participants

The course was designed for and utilized by students who have chosen computer science as a major. During the pilot study, summer 2014, the course enrollment was twenty-two students with nineteen students completing the course. Participants ranged in age from 20 to 48 years with the median age being 28. All students had sophomore standing and had completed the prerequisite of CSCI 1301. Students also self-reported that they either had full-time or part-time jobs, which was one of the reasons for enrolling in an online course.

B. Class Participation

Class participation accounted for 2 percent of the total course grade. Each week on the discussion board the instructor would post a question related to the course topic and it was expected that students would submit a posted response to the question and debate presentation prepared by classmates. The discussion board was designed for students to express their opinions, ideas about the material presented, to ask questions and answer the questions of fellow classmates. As part of the post, students were also expected to provide:

- A brief summary of the topic
- The presentation that best describes your position on the topic (provide the reason why)
- Point(s) from the presentation(s) with which you either agreed or disagreed

C. Class Debates

One goal of the course is to help students identify ethical and legal issues related to computer use so that they can develop solutions based on the computer professional code of ethics. Therefore, five case scenarios were assigned on various course-related topics and students were expected to present arguments and solutions.

The guidelines for class debates on case scenarios stated that each student would be assigned a part of the topic and was expected to prepare a presentation that would be posted by the assigned due date. Based on the student’s assigned part, each was required do the following on which they would also be assessed:

- Analyze the situation.
- Discuss how the use of this technology impacts your given role.
- Use analogies and similar cases where possible.
- Identify possible risks or consequences.
- Present your opinion of the situation (even if it differs from your given role).

The presentation should be no less than ten (10) minutes and no more than fifteen (15) minutes. The debate presentation counted for ten percent of the total course grade. The presentation should include at least three (3) references from which the information was gathered. Students were encouraged to be creative with technology beyond the use of PowerPoint to promote interaction and advanced technology use. Students were assessed on their use of technology, style and delivery of the content. Sample topics for class debates are presented in Table 1.

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TABLE 1. DEBATE OVERVIEW

Debate	*Course Topic*	*Debate Topic*
#1	Privacy	Surveillance and Expectation of Privacy: Google Street View
# 2	Intellectual Property	The Fight for the TV Airways: Aereo Technology
#3	Crime	Identity Theft and Credit Card Fraud: The Target Corp. Scandal
#4	Evaluating and Controlling Technology	Electronic commerce: Amazon.com
#5	Errors, Failures and Risks	The Health Care Industry's use of Technology and Therac-25

D. *Programming Assignment*

The programming assignment which counted for five percent of the total course grade was designed to engage students' critical thinking and problem solving skills while also focusing on the course content of ethics. Consequently, it was decided to utilize content students were introduced to in the required course, *CSCI 1300 – Introduction to Computer Science*. This breadth-first course introduces students to a variety of topics with one being information security inclusive of a brief overview of encryption algorithms. Using this introduction, it was decided that students would implement a version of the shift cipher. The task was to work with any character on the keyboard, allow the user to determine the shift, make some changes to the input, then display the new code on the screen. Students were given a shift algorithm and asked to develop the program using either C++ or Java. Students were told that the assignment makes use of basic elements that they learned in CSCI 1300 and CSCI 1301 which included, but not limited to:

- Input/output statements
- Arithmetic operators
- Assignment statements
- Relational and logical operators
- Control structures
- Data structures

E. *Term Paper*

To allow students to develop a better understanding of the field, the opportunity to research current topics related to ethical issues in computing and to also foster better writing skills, a term paper was assigned. The task was to choose and watch one of the instructor-selected Twilight Zone episodes. The episodes are based on an ethical/societal computing issue discussed during the course. Students were informed that the term paper should summarize the topic that is being presented; then use supporting references to analyze, evaluate, interpret and summarize the information they have uncovered. The episodes that were chosen from which the students could select were: I Sing the Body Electric, The Old Man in the Cave and The Brain Center at Mr. Whipples. Students could watch the episodes for free on hulu.com for free. The term paper accounted for eight percent of the total course grade.

F. *Exams*

There were two online exams given. Each consisted of twenty-eight questions that were either true/false or multiple choice. Additionally, there were two essay questions. Students were given two hours to complete each exam from the time they started until the time they ended. They were also informed that they would only have one attempt per question. The final exam followed the same pattern as the two course exams; however, there were additional essay questions. Additionally, students were required by the institution to come to one of the campuses to take the final exam. The final counted for twenty-five percent of the total course grade and the course exams accounted for fifty percent of the total course grade. These percentages are determined by the computer science curriculum committee and are required for all computer sciences courses taught.

V. RESULTS

This section presents the results of student assessments, as well as an anonymous online survey that students were asked to complete at the end of the course.

A. *Student Performance*

In a face-to-face course, class participation is often noted by student interaction and class involvement. However, in an online course, class participation is a little harder to gauge which is why posting to the discussion board was utilized. To ascertain if students understood the required reading material as well as viewed their classmates' presentation, the instructor monitored the discussion posts. Figure 1 shows the number of students participating in the posts. Figure 2 shows the number of students participating by discussion post.

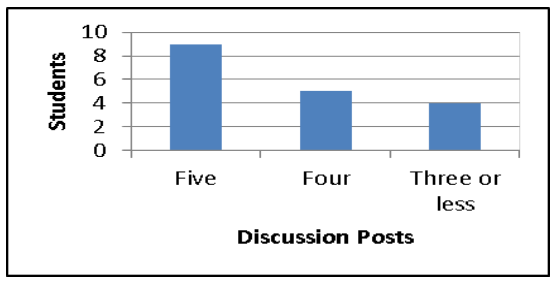

Figure 1. Students participating in posts

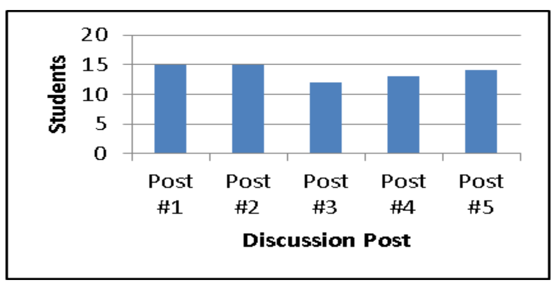

Figure 2. Students participating by post

Figure 3 shows the results of student performance on the class debates and term paper.

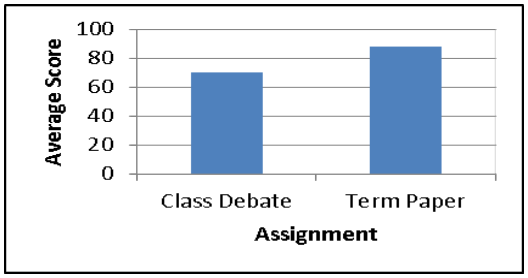

Figure 3. Average score on selected assignments

B. *Student Survey*

An online anonymous survey consisting of ten questions was created to get a better understanding of students' perception of the newly created online course. Presented are some of the results from the ten questions that the students were asked to complete.

Figure 4 shows the results of the students' perception on the ease of participating in class through using the discussion board.

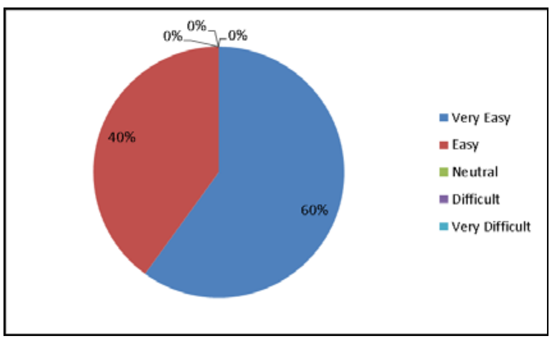

Figure 4. Participation using discussion forum

Figure 5 presents the results on students' perception on the ease of researching and writing the term paper.

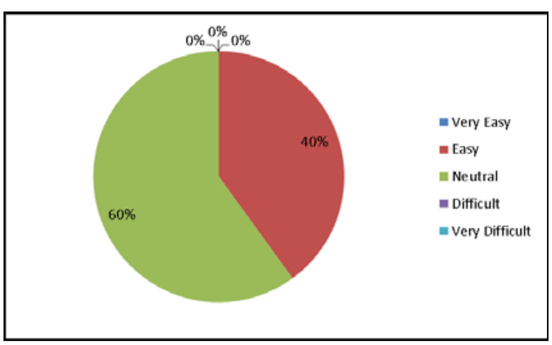

Figure 5. Researching and writing term paper

Figure 6 presents the results when students were asked in comparison to other computer science courses about the amount of time they spent on the newly developed online course.

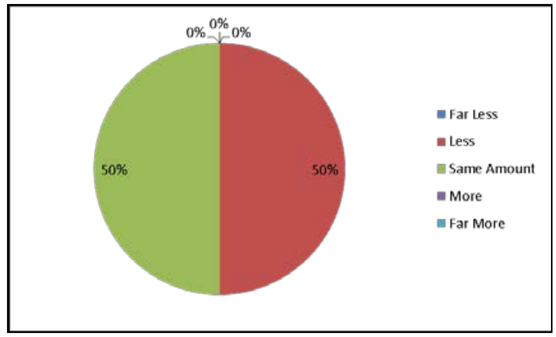

Figure 6. Time compared to other CS courses

Figure 7 presents the results when students were asked if they enrolled in the course again the type of delivery mode they would choose.

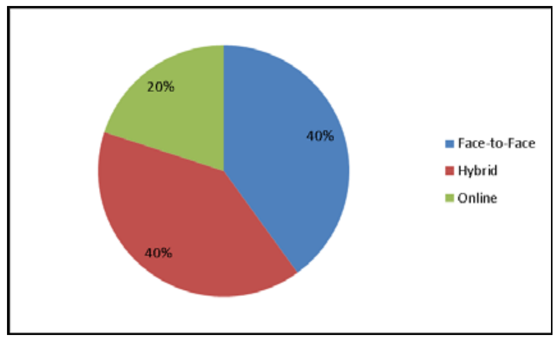

Figure 7. Delivery method

The next section provides an overview of the results presented, followed by concluding thoughts.

VI. Discussion

The results revealed that students participated in the discussion posts on a regular basis and utilized them as a way to establish their contribution to the course just as if they were in a face-to-face class. The results also revealed that the two assignments that one does not typically find in a computer science course, class debates and a term paper, were well-received by students which resulted in high passing scores on both assignments.

The anonymous online survey results revealed that students thought that the course was well-developed, that the amount of work was appropriate, and that the time they spent was comparable to other computer science courses that they had previously taken; hence the responses shown in figures 5 and 6. This led the instructor to believe that the thoughtfulness in which the course was designed was comparable to courses that had been previously designed and taught face-to-face. However, one unexpected result was the response to the question related to deliver mode. Students were asked if they had to enroll in the course again, which delivery method they most likely choose. The results revealed that only twenty percent would choose the online method again. The author finds this result to be one for future investigation because when polled, fifty percent of the class stated that they had taken the majority of the courses online because they enjoyed the flexibility of online learning. Moreover, many of the students self-reported that they either had full-time or part-time jobs, which was one of the reasons for enrolling in an online course. Therefore, the author thought that a larger percentage of the students would agree again to take the course online.

VII. CONCLUSION

In summary, the purpose of this paper was to describe the development of an online computer ethics course and present the results from a pilot study of its initial offering. The paper described the uniqueness of offering the course at the two-year college level, which is not typically done. Additionally, the paper described how material was conveyed in an online learning environment.

Future work includes making this course a requirement for computer science majors. This includes preparing and presenting a proposal for the college curriculum committee. Once approved, the proposal is presented to the Faculty Senate, and after review and approval, forwarded to the President for review and approval. However, prior to moving forward with requiring this course for computer science majors, some challenges must be addressed.

The first challenge noted by the author was the use of D2L and its compatibility with some of the software that the students used. Many of the students used open source software to complete their debate presentations. This software was not compatible with D2L often yielding no sound or picture, thereby making it difficult for the instructor to grade and for peers to adequately view the presentation. Another challenge was communication. Since this was the author's first time teaching an online course, the traditional method of office hours was not an option. While the author did establish "virtual" office hours, because of students' varying work schedules, many did not attend and instead attempted to communicate with the instructor outside of "normal working" hours. The author is rethinking the concept of office hours for the next course offering. It is anticipated that the course will again be offered in summer 2015.

In closing, as online learning continues to grow, so does the debate on how best to offer online learners a rich educational experience. By looking carefully at the course offering, the subject content and thoughtfulness in preparation of course material, we may find our answer and the answer of how to increase the number of students choosing a STEM discipline as a major.

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Smart Science Laboratory for Improving Learning Interest

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***Abstract*—We propose a smart science laboratory in this paper. There is a lack of scientific experiment and investigation in science education for elementary, middle and high school students in Korea. Teachers solely focus on transmitting knowledge and there is a lack of laboratory apparatuses for rapidly developing science areas. Because of these shortcomings, students lose interest in science as they progress through the education system. The smart science laboratory consists of virtual and remote laboratories, a local data collection procedure and hybrid visualization to overcome this problem. We hope we can increase students' interest and satisfaction in science using the smart science laboratory that can support and supplement science education in schools today.**

Keywords-virtual laboratory; remote laboratory; science education; simulation.

I. Introduction

Traditional instructions such as lectures and teacher demonstrating an experiment in front of a class do not encourage students to think and to solve given problems. Researches show that there are advantages when students conduct investigations themselves for the purpose of science inquiry compared to traditional instructions [1, 2]. Investigations provide students with opportunities to interact directly with the material world, collect data, and learn scientific theories [3]. Hands-on physical investigations typically fill this need. Korean government tried to build up-to-date physical laboratories for several years. Due to the fact that science and technology evolves so quickly, it is difficult to constantly build up-to-date laboratories that can keep up with the current state of science and technology for all elementary, middle and high school students.

Virtual laboratories have been developed to replace or supplement physical laboratories. The concept of virtual laboratories implies the replacement of real measurements with simulation [4]. Virtual laboratories have been compared with physical laboratories and demonstrated that they can achieve similar objectives to physical ones. The research in [5] demonstrated that virtual laboratories can replace physical ones for acquiring conceptual knowledge. Many research studies have also shown the advantages of virtual, interactive exploration of unobservable phenomena compared with physical ones. Students can experiment unobservable phenomena, such as chemical reactions and electricity, using a virtual laboratory [6, 7]. Students can vary the properties of rays to examine the unobservable light behavior in OptiLab [8]. The National Aeronautics and Space Administration (NASA) Education provides professional materials and educational materials about astronomy, weather, geology and ocean through genuine multimedia content and simulations that a user can modify variables [9].

For some experiments it is still difficult to replace physical laboratories with virtual ones. It is necessary to manipulate real equipments in the experiments. Many researchers have developed remote laboratories to overcome the limitation of virtual laboratories. Students can access real equipments and collect real data through remote laboratories [10-12]. iLAB is remote laboratory. It started from the research at Massachusetts Institute of Technology (MIT) with the goal of controlling professional scientific equipments in graduate school [13].

Many useful virtual and remote laboratories have been developed and provided students with science inquiry learning. Many specialized research institutes such as NASA and MIT have developed educational content that provides laboratory and scientific investigation experiments utilizing computing technologies. Korean students can obtain useful information from that content but they could decrease the interest in the content and its intuitiveness. The data covered in these virtual and remote laboratories are not from Korea but from foreign countries. These virtual and remote laboratories target specific topics and meet the goal of the education system in which those laboratories are developed. It is necessary to develop the virtual laboratory that can be adapted to the Korean science education system.

The goal of a proposed research is to develop a smart science laboratory that can supplement physical laboratories that are vital facilities in Korean science education and also foster advanced science education and reinvigorate science education. The desired effect of this is to boost interest and increase satisfaction among students in science education. The developed smart science laboratory has three characteristics.

1) Combine virtual and remote laboratories
2) Provide students with a way to collect local data
3) Provide a hybrid visualization that combines simulations and videos

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In Section 2, the proposed smart science laboratory is described. Section 3 describes content developed for the smart science laboratory for the experiments and its results. Finally the conclusion is provided in Section 4.

II. PROPOSED METHOD

The proposed smart science laboratory combines virtual and remote laboratories to capitalize on the merits of each approach. When the scientific inquiry requires to modify model characteristics, such as time scale, or to observe not easily observable phenomena, such as the birth of typhoon, a virtual laboratory is applied. A remote laboratory is used if a real procedure or experiment result is helpful to students.

A. Virtual Science Laboratory

The proposed virtual science laboratory consists of three procedures: a local data collecting procedure, a visualization procedure on web and app environment, and an interaction procedure suitable for elementary, middle and high school students.

Mainly, public data are used in the proposed virtual laboratory. Public data of natural phenomena, such as changes in the contour of autumnal leaves in Korea, were used to create the corresponding simulation. We also added ways to collect data related to the simulation, such as photos of autumn leaves in local areas with location information, using students' mobile devices. The system compares public data and students' local data. If two types of data are matched, the system uses the result to verify the simulation results. If students' data are not a match with the public data, then the system suggests possible causes for the differences. The smart mobile device is also used to collect data, such as information on food additives, that are not available to the public yet. The system uses image processing techniques that allow students to easily collect data. For now, students can only capture images of food packaging with their smart mobile devices that makes it unnecessary to manually type the name of the additives into a mobile device or a website.

The visualization procedure utilizes the hybrid visualization approach that shows users the simulation result of the collected data and pre-created videos selectively depending on the goal of the learning. When users need to experiment with various conditions, simulations with given variables are created and shown to users. When the reality of the experiment is more important than the direct manipulation of the experiment, we show pre-created videos to users. The interaction was developed to meet the features of elementary, middle and high school students. For elementary school students, a simpler user interaction method was provided.

B. Remote Science Laboratory

Students can attend the scientific experiments and examine the results remotely using the smart remote science laboratory when they cannot be on site. To achieve this goal, we developed the system so that users can change samples and alter variables in the scientific experiment using the LabVIEW [14] program. The remote experiment done by a user is recorded and stored in a database. The system also provides ways to request the scientific experiments when it is difficult or dangerous for novice users to involve the experiments directly. Students can view live or recorded videos of the experiments being conducted by an expert. We provide this passive approach to increase the diversity of the scientific experiments. Students can view any experiment done by other students through recorded videos. Students can plan their new experiments after viewing the recorded experiments.

III. EXPERIMENT

We asked 100 teachers from elementary, middle and high school using a questionnaire on what type of content would be suitable for the proposed smart science laboratory. Teachers considered the following three experiments useful for their students.

1) Experiments that cannot be observed visually
2) Experiments in the area of physics, earth science and other related areas
3) Experiments with real data and relevant to people's lives

Based on these survey results we created two types of content, which involve typhoons and food additives, for the virtual laboratory. A spectroscope and high-speed camera were selected as the equipment for the remote science laboratory.

The typhoon simulation consisted of the birth of a typhoon, the direction of typhoons and typhoon forecasting. The process of how a typhoon is created was simulated and shown to students. Students can simulate different typhoons by modifying water temperatures and the originating locations of a typhoon. Students can also simulate the direction of a typhoon by adjusting temperatures, the originating position and positions of North Pacific High and Jet Stream around Korea (Figure 1). The typhoon simulations created by one student were recorded and shared with other students. Students are also able to predict the direction of well-known typhoons with the supplied information. The system could provide users with the partial position of typhoons and users can predict the position of the typhoon on the following day and compare the estimation with the actual position of the typhoon.

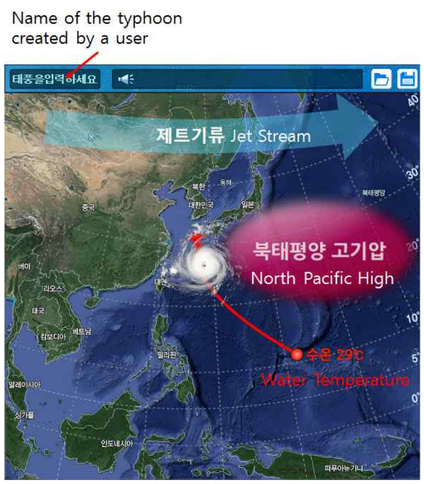

Figure 1 Simulating the route of a typhoon

The food additive simulation consisted of searching food additives, simulating effects of additives and a food additive diary. Students can search additives for the specific food products by entering the name and barcode of the food product on the website. The system will search for additives included in the food from the database and display the additives to users. When the additives of a target food are not found in the database, the system will ask users if they wish to add the additive to the database. The numbers of additives collected by each student and each school are recorded and shown to all students. The school that adds the most additives to the database receives a special prize. This may increase engagement with students in the process of collecting additives of new food product. These data will be useful to other users because food additive database has not been opened to public yet. If the student has a smart mobile device, he/she can capture images of the name and the barcode of the food using the camera on a mobile device. The image processing procedure will detect the name of the food from the captured images.

In food additive simulation, students can select a food additive and its amount then the food additive simulation part presents the simulation result to students. Students can simulate with various settings of the experiments to understand the changes caused by them. Figure 2 shows how food with/without food preservatives changed over time. Students can modify time variable and watch the simulation results of food with/without preservatives. The comparison videos are also provided to students to provide more realistic experimental results for the selected food additives. This hybrid visualization could improve students' understanding of food additives. My food additive diary records amounts and types of food additives users ate on each day. To use my food additive diary, students only need to capture images of the cover of food packaging instead of typing food additives using a keyboard. We applied image processing techniques so food additives can be automatically collected from the image captured by students.

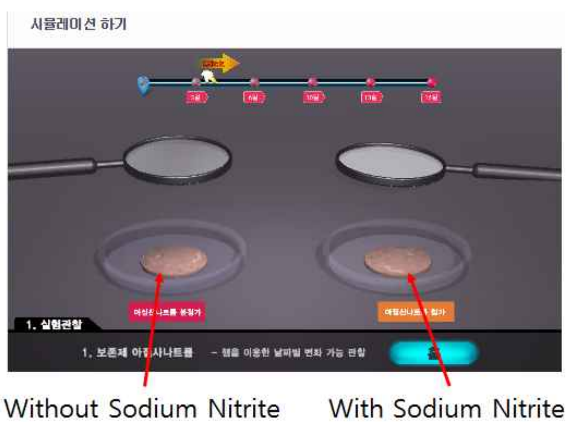

Figure 2 Simulating the effect of food additive

The LabView program was used to change the samples of the spectroscope experiments and to modify the spectral region and degree of precision of the experiments through the app and website in the spectroscope remote science laboratory. The results of the experiments were stored in the database and users can monitor the experiment procedure through live videos. It is a time-consuming procedure to find the optimal lab setting for capturing data with a high-speed camera. This also made it difficult to view the experiment in live view and to modify variables in the experiment. For the high-speed camera remote science laboratory, we developed an online procedure to requesting an experiment. When it is possible to capture the experiment with the high-speed camera, the procedure is recorded and edited so students can view the procedure and results online. The recorded procedures and results are stored and shared with other students.

The resulting content was exhibited in 2014 World IT Show in Korea from Oct. 20th to Oct. 23rd. Users provide positive feedbacks about the developed content. Figure 3 shows an elementary student with his mother experimented with the food additive content. He captured the image of the cookie packing using the camera attached to a smart mobile device and viewed the food additives included in the cookie.

Figure 3 An elementary student using food additive content in the show

IV. CONCLUSION

The goal of the proposed research is to develop a smart science laboratory that helps students gain experience in a lab environment to undertake scientific investigation. So far, the basic platform and sample content has been developed. The sample content was tested by ordinary people at the 2014 World IT Show in Korea and received favorable feedback. However, we have not yet tested the platform and content on students. We will select six schools to test the platform and content after developing more content. The resulting user test will be used to modify the platform and its content so students in many schools can use the smart science laboratory. Through the smart science laboratory, we hope to foster interest in science among students so that more students will be willing to enter the field of science.

ACKNOWLEDGMENT

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Service-Oriented Development of Content and Knowledge Provision Tool

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Abstract— This paper presents the service-oriented development of Content and Knowledge Provision tool, one of the core services developed within IntelLEO, an FP7 project in the area of technology-enhanced learning. The project aims at enhancing cross-organizational Learning and Knowledge Building practices at the workplace. Content and Knowledge Provision tool enables employees to upload different kinds of learning resources into a knowledge repository, annotate them, and (re-)discover relevant learning resources by performing semantic search over the knowledge repository. Hence, this service effectively serves as a content management system and semantic search engine within the IntelLEO.

Keywords-Service-Oriented Architecture, Semantic Web, knowledge management, workplace learning.

I. INTRODUCTION

Semantic Web technologies offer a new approach for information and knowledge management that is largely based on the creation and use of semantics-rich metadata. The main idea of Semantic Web is to create a layer of machine processable data on top of the existing Web in order to enable advanced, automated processing and use of Web content [1]. The primary motivation for applying these novel technologies in existing software systems is to facilitate semantic interoperability and/or integration of software products made by different vendors with existing systems. Thus, Semantic Web technologies complement and further improve the capacity of Service Oriented Architecture (SOA) to enable flexible linking of resources related to traditional architectures and, , encourage reusability of these resources. In particular, Semantic Web technologies facilitate the implementation of the SOA concept by enabling semantics-driven identification and integration of required services, and sharing of data between them [3].

One system that implements the SOA concept through the use of Semantic Web technologies has been developed within the Intelligent Learning Extended Organization (IntelLEO) project [4]. This project investigated the IntelLEO paradigm – a learning community emerging as a temporal integration of two or more different business and educational communities characterized by different organizational cultures (industrial, research, and educational) [5]. In fact, an IntelLEO is a kind of extended organization focused on cross-organizational learning and knowledge building. Accordingly, the main goal of the project was to enhance Learning and Knowledge Building (LKB) practices in an IntelLEO. The software framework developed in the scope of the IntelLEO project encourages LKB activities, and makes it easier for learners to initiate and/or take part in these activities within an IntelLEO. The framework is composed of a set of services that interoperate through the common ontology framework. One of these services is the Content and Knowledge Provision (CKP) tool that makes use of Semantic Web technologies and the SOA concept to enable employees to upload different kinds of learning resources into a knowledge repository, annotate them, and (re-)discover relevant learning resources by performing semantic search over the knowledge repository. CKP tool enables employees to allocate learning activities in the form of unstructured documents and knowledge sources in order to acquire some new knowledge required for performing their workplace activities. On the other hand, this tool helps in efficient and effective communication and exchange of information within an extended organization, enabling the management and exchange of learning resources between employees during their learning and work-related practices.

This paper presents the SOA-development of the CKP tool and shows how it allows employees to effectively use knowledge and content from the extended organization's knowledge/content repositories as well as from all over the Web, without wandering and wasting their time on irrelevant resources. The rest of the paper is organized as follows: the next section presents the IntelLEO framework as a SOA-based system. Section 3 describes the CKP tool layered architecture, whereas Section 4 shows the CKP tool evaluation. Section 5 presents related work, whereas the last section gives the conclusions and indicates directions for future work.

II. INTELLEO AS A SOA-BASED FRAMEWORK

The IntelLEO framework (Fig. 1) comprises several core services that can be thought of as abstractions for grouping the framework's principle functionalities – each core service consists of a number of functionality-specific services. The framework also integrates a set of interlinked ontologies – the IntelLEO ontologies – that allows for unified knowledge

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representation within an extended organization (i.e., an IntelLEO) and semantic interoperability of services.

The data layer of the IntelLEO framework (the bottom most layer on Fig. 1) consists of one or more data repositories (typically, one repository for each organization that participates in an IntelLEO) storing data relevant for the IntelLEO services in a format compliant with the IntelLEO ontologies[23]. The use of ontologies allows for representing and storing data together with their semantics, so the meaning of each piece of data is unambiguously defined, and therefore, data can be more easily shared and (re-)used by different services.

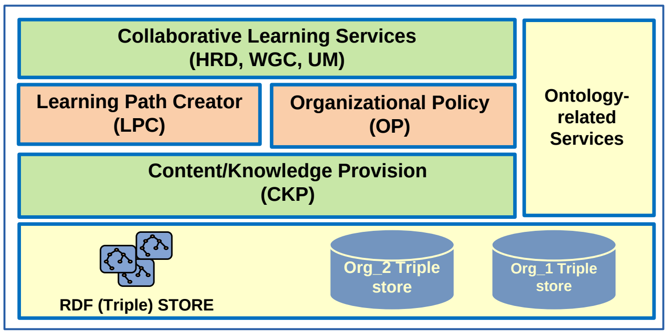

Figure 1. IntelLEO Framework

The core services of the IntelLEO framework can be divided into two main groups. The first group – Learning and Knowledge Building Services – is composed of the following services: 1) Services for Collaborative Learning (green boxes in Fig. 1), in particular Human Resource Discovery (HRD), Working Group Composition (WGC) and User Monitoring (UM); and 2) Content/Knowledge Provision (CKP). The second group – Harmonization Services (orange boxes in Fig. 1) – includes: 1) Learning Path Creator (LPC); and 2) Organizational Policy (OP) Service. These services are often orchestrated from applications to interact and interoperate with each other. In this paper we focus on the Content and Knowledgde Provision functionality of the IntelLEO framework implemented in the CKP tool. Description of all other components of the IntelLEO framework can be found in the project deliverables, specifically [2] and [6], available at the project's Website

III. CKP Tool Layered Architecture

Like the overall IntelLEO framework, the CKP tool is also organized in a SOA manner, with its own specific services forming a layered architecture shown on Figure 2.

A. Persistence Layer

The CKP tool uses the persistence layer of the overall IntelLEO framework (Fig. 1). In fact, this layer is used by all the IntelLEO core services. It provides generic services for storage and retrieval of data originating from LKB activities in an extended organization, as well as data about various kinds of knowledge and learning resources that were used in or resulted from those activities. The data are represented and stored as Resource Definition Framework (RDF) triples compliant with the IntelLEO ontologies. In other words, the IntelLEO ontologies serve as models for storing data in the RDF [24] repositories of the Persistence Layer. This means that data are stored with explicitly defined meaning, and, also, that semantics of connections among data items are made explicit (through ontologies). This further implies that the semantics of the data are directly available for processing by any software component accessing those data through the services of the Persistence Layer.

The services of this Layer hide all the specificities of working with ontologies, RDF, and other related technologies of the Semantic Web stack. So, when needing to access or store data in the repository, the CKP tool (or any other software component) simply works with ‘regular‘ Java classes and interfaces and all the tasks related to the storage, retrieval and update of ontology instance data are handled by the services of the Persistence Layer.

In the following section, we present how the CKP tool, in particular, its Service Layer, makes use of the semantics-rich data of the Persistence Layer to provide users with advanced content/knowledge management and sharing functionalities.

B. Service Layer

Services of this layer allow for personalized content/knowledge retrieval. This means that these services provide users with learning/knowledge resources compliant with the particularities of their learning context (e.g., their present learning goals and competences). These services include: Semantic Annotation service, Tagging service, Service for computing relevance of a learning resource, and Retrieval service.

Semantic annotation service (Fig. 2) provides automatic semantic annotation of learning resources by making use of the annotation services of the KIM platform [8].

The main challenge for using KIM platform in the CKP tool was the extending of PROTON [25] ontology, an upper-level ontology within KIM, with the concepts and the relationships from the , domain ontology - an ontology that formally specifies a specific subject domain, used in the CKP tool. Semantic annotations obtained from this process were clearly specified, easy to understand, and served as a basis for useful applications in the CKP tool.

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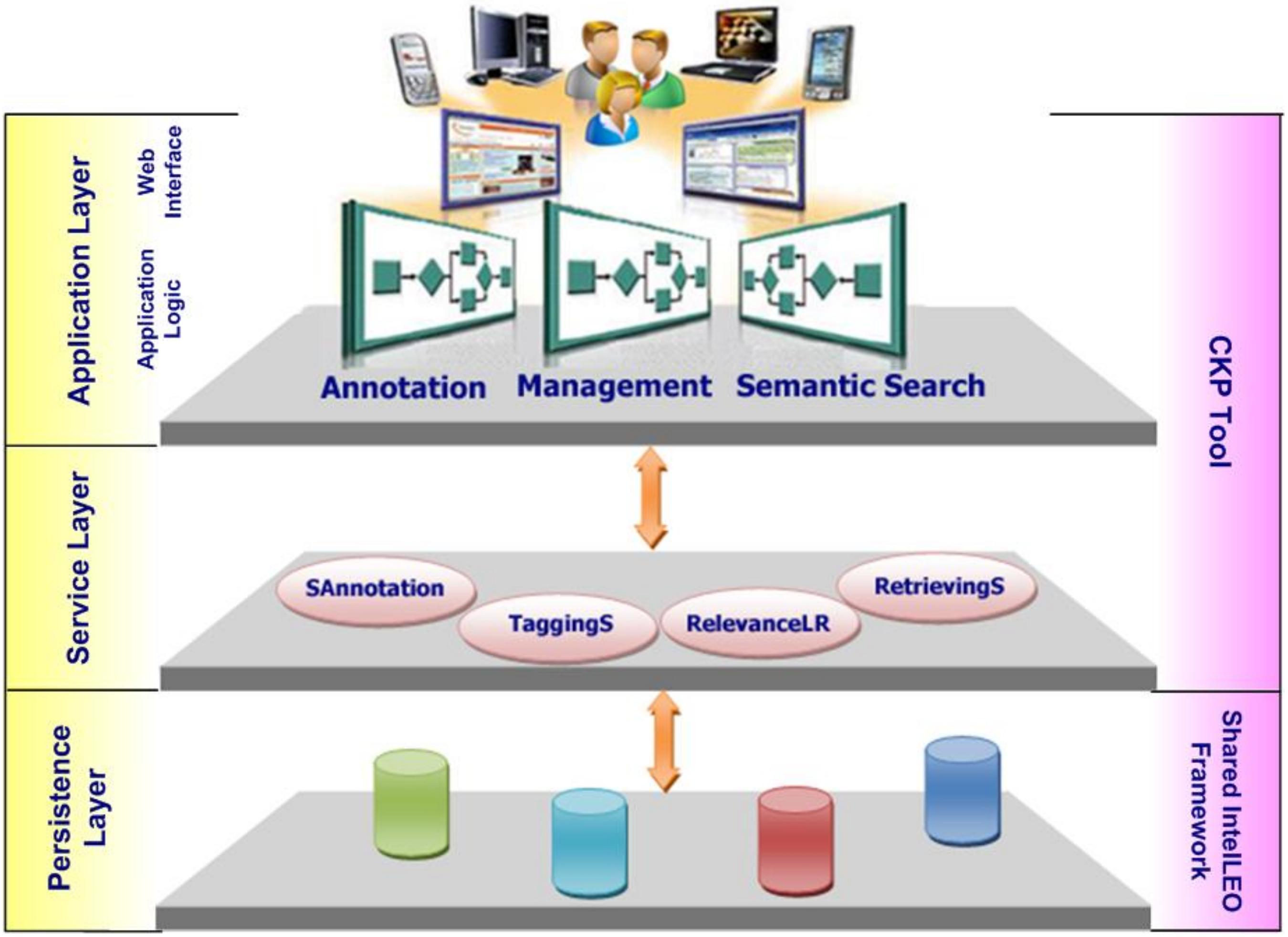

Figure 2. Layered Architecture of the CKP tool

In other words, the main task of the Semantic Annotation service was to retrieve semantic annotations gathered by the KIM platform, to add these annotations to the specific learning resource as well as to transfer them to the user interface of the CKP tool. Tagging service (Fig. 2) helps to add additional information to a specific learning resource in the form of tags or keywords. The process of adding tags is important both for users who perform the tagging (reflection on the content in order to find the terms that best describe it), and members of the extended organization who might want to use specific learning resources in the future (easier search and discovery).

Service for computing relevance of a learning resource (Fig. 2) computes semantic similarity between the given learning resource and a specific learning goal.. In particular, the relevance is computed as semantic similarity between a resource and a specific learning goal.

Semantic similarity is computed using information retrieval techniques, namely TF-IDF [26] and Cosine Similarity [27]. This further means that semantic similarity between a learning resource and a learning goal is calculated by measuring similarity between the term vector found in the learning resource and the term vector of the considered learning goal. Term vector is used to represent both learning resource and learning goal as a vector of identifiers [9].The concepts used for creating these vectors are obtained through semantic annotation of both the learning resource and the learning goal. Each concept forming a vector of the learning resource is associated with its frequency (i.e., number of occurrences) in that learning resource. On the other hand, a learning goal is composed of competences, and these competences can be complex, i.e., composed of sub-competences. Let us explain this through an example. Suppose we have learning goal LG1 that is composed of competences C1 (annotated with concepts T1 and T2) and C2 (annotated with concepts T3 and T4). Competence C1 is composed of sub-competences C1.1 (annotated with the concept T5) and C1.2 (annotated with concepts T6 and T7), while the competence C1.1 is composed of sub-competences C1.1.1 (annotated with concept T8) and C1.1.2 (annotated with concept T9). Presented in the form of a tree, the LG1 learning goal and the associated competences look as follows:

LG1

- C1(T1, T2)
  - C1.1 (T5)
    - C1.1.1(T8)
    - C1.1.2(T9)
  - C1.2 (T6, T7)
- C2 (T3, T4)

Values associated with concepts T1 – T9 are calculated having in mind the distance between the competence a concept is associated with and the learning goal. In particular, the following simple formula is used: $V_{Tn} = 1/k$, where T_n represents the concept (T_n=1,9), V_{Tn} is the value for that concept, and k is the distance between the competence the concept T_n is assigned to and the learning goal (LG1). Accordingly, the values for concepts T1 – T9 are as follows:

- V(T1) = 1
- V(T2) = 1
- V(T3) = 1
- V(T4) = 1
- V(T5) = 0,5
- V(T6) = 0,5
- V(T7) = 0,5
- V(T8) = 0,33
- V(T9) = 0,33

Finally, the semantic similarity between the learning resource d1 and the specific learning goal d2 is calculated by multiplying the vector of concepts of learning resource v(d1) and the vector of concepts of specific learning goal v(d2) as follows:

$$\text{sim}\ (d1, d2) = v(d1)*v(d2) \qquad (1)$$

The output is a number between 0 and 1 and it presents the relevance of learning resource for specific learning goal. In addition, this relevance is presented in the form of star-scale in user interface (Figure 6A) indicating if the learning resource is relevant for a specific learning goal.

Retrieval service (Fig. 2) enables seamless retrieval of stored learning resources based on the input that can be a domain-specific concept or tag(s). This service queries the repository of learning resources looking for learning resources that are annotated with domain concept(s) or tag(s) given in the user's request. The result is a list of the ranked search results. If none of the available resources directly matches the user's request, this service identifies semantically related domain concepts or tags, finds resources annotated with them and suggests those as potentially useful resources. In order to find similar domain concepts, the service looks for concepts that are more general or more specific to those given in the user's request. In particular, it makes use of skos:narrower and skos:broader relations for structuring the domain concepts in concept hierarchies. These relations are defined by the SKOS (Simple Knowledge Organization System) ontology [10]. It defines classes and properties for modelling specific subject domains in the form of thesauri, taxonomy, or classification scheme.

To rank the retrieved learning resources, this service makes use of semantic similarity between each of the retrieved learning resources and the user's profile. Semantic similarity is calculated as Cosine similarity between the vector of a specific resource and user's profile vector. The vector of a resource comprises all tags and the semantic annotations (concepts from the domain-specific ontology for the learning resources. The user's profile vector comprises all domain concepts and tags related to the user, his personal learning goals, his competences and learning paths he is following. In addition, it contains concepts and tags that reflect the user's personal priorities, including general interests, learning history, and acquired competences. Each personal priority contains a weighting factor that affects the value of domain concepts and tags associated with that priority. If the search was done upon request of some other service (e.g., some of the IntelLEO services), similarity is computed between the retrieved resources and some other kind of learning asset (e.g., competence, learning activity, learning path), as requested by the service on whose behalf the search was performed..

C. Application Layer

Application layer is the connection to the "external world" and comprehends Web interface and application logic that uses the functionality of the Service Layer (Fig. 2). This layer implements three types of functionalities gathered from the application cases involved in the IntelLEO project: annotation of learning resources, management of learning resources, and semantic search of a repository of learning resources (Fig. 2). These functionalities are offered through a Web-based interface (see the next section).

D. Implementation

Regarding the actual implementation, the CKP Tool, as well as whole IntelLEO solution is implemented in the Java programming language, to be independent from the underlying platform, and is based upon a number of open source frameworks. Specifically, the Service Component Architecture (SCA) framework Apache Tuscany [15] was used to facilitate the implementation of loosely coupled Core Services. In terms of user interfaces, to achieve cross-browser compatibility, Apache Wicket [16], a Java-based web framework, was used in combination with

Javascript framework JQuery [17]. This approach allows for the IntelLEO platform to be installed and run on different target platforms, and enables users to access the IntelLEO platform from different operating systems and with the majority of common web browsers, as was proved during the evaluation phase.

IV. EVALUATION

The CKP tool was evaluated in an empirical study that lasted two months and included three application cases of the IntelLEO project. The first case (AC1) was about an IntelLEO comprising a big multinational corporation in the automotive sector, a research institute and a university. The second application case (AC2) involved an IntelLEO formed by an SME providing IT services in the e-Engineering and e-Manufacturing sectors, and a university-based research group. The third Application Case (AC3) was about an IntelLEO focused on teacher training; the participating organisations were a Teacher Association and a university. The objective of the evaluation study was to collect feedback from end-users, in the three application cases, concerning the usability and usefulness of the overall IntelLEO framework and its individual components as well as to test to IntelLEO hypotheses, which suggested that a synergy of collaboration and harmonisation services increases the individual motivation for LKB activities, a pre-requisite of organizational responsiveness [7].. The evaluation details are presented in [11]. In the text bellow we present a short overview related to evaluation procedure of the CKP tool, compliance with the scope of this paper.

The study was organized through a series of tasks, set in a specific learning scenario, that the participants had to complete. The tasks were the same in all three application cases to allow for comparison of the results obtained in heterogeneous settings. The study was conducted with participants from AC1, AC2, and AC3. Most of them had university degree (83.3%). In terms of occupations, 31% of participants are teachers, 8% are researchers, 23% are students, 15% are technical employees, 17% are engineers and 6% are categorized as "others".

They interacted with the services of the IntelLEO framework in five tasks. The forth task was related to the CKP tool; hence, we present the part of the study procedure and the results only for that task. At the beginning of the study session, the participants were familiarized with the learning scenario that was adapted to the particularities of each application case. The fourth task in the learning scenario was to share a learning/knowledge resource by making use of the bookmarking/annotation features of the CKP tool. To complete this task, the participants were asked to navigate to the given URL, initiate the CKP tool, and bookmark/annotate the corresponding Web page (e.g., by adding some tags and/or selecting some of the automatically generated tags, and/or choosing related learning goal(s)). After completing the task, the participants were asked to fill in the corresponding questionnaire. For each feature of the CKP tool, the questionnaire presented the participants with the corresponding screenshot and a question statement, asking them about the perceived usefulness of the tool's presented at that screenshot. Answers were provided in the form of a 5-point Likert scale (5 – strongly agree; 1 – strongly disagree).). An example for a statement would be "When I want to plan my personal learning goals, it is useful to tag an online resource with my personal learning goal." The objective of this investigation was to find out how useful and relevant are the developed services and functionalities for end-users in the three ACs, and also to examine how useful and relevant the CKP tool and its functionalities are in performing this task, especially w.r.t the motivational and pedagogical challenges of learning in the workplace.

Evaluation of the CKP tool has shown the importance of CKP tool functionalities for learning and knowledge building (LKB) activities. The users have identified several benefits of the CKP tool for workplace learning. Respondents highlighted the fact that colleagues collaboratively create one repository of learning content, which is annotated and updated bottom-up, but accessible and useable by the whole organization. The requirement to structure and document one's work-relevant knowledge has been highlighted by users of all three ACs, too. This documentation serves 1) to have one's own knowledge available at a later stage, and 2) to profit from the reciprocal knowledge exchange between colleagues to split up the burden of documenting important lessons learned among several colleagues. They indicated that the links between knowledge and content must be fully exploited by using a shared repository of learning resources.

V. RELATED WORK

To support the learning and evolving the knowledge of employees at the workplace, the CKP tool focuses on providing distributed services for the semantic annotation, managing and semantic search of learning resources in extended organizations. Many tools/services have supported knowledge management at the workplace and they were used as a basis for content and knowledge provision within extended organizations.

The objective of K-NET project [28] is to support knowledge sharing and reuse within an organisation. Unlike the CKP tool, as well as the whole IntelLEO project, this project does not consider the specificities of learning in an extended organisation.

The European Integrating Project MATURE [29] is focused on providing technology that would allow an enterprise to make a significant shift in its organisational (learning) culture and move towards enterprise 2.0, which is characterized by enhanced collaboration and a culture of employee participation [20]. Unlike the CKP tool, this project does not provide means for achieving the goals of harmonization of personal and organisational goals, neither supports learning and knowledge building activities in an extended organizations.The latest trends in knowledge management are about using social software for conversations and collaboration, for knowledge elicitation, creation and sharing, for identifying experts and getting access to expert opinions worldwide. However, despite their numerous positive sides, social software tools also have one major drawback: the knowledge (i.e. knowledge objects) they capture is not accessible for machine processing. Therefore, there is a need for enriching these tools with formal semantics that can be leveraged by machines for supporting learning and knowledge building activities. Specifically, there is a need for annotating semantically knowledge objects created using social software tools.

There are a lot semantic annotation platforms, such as Action [21], AnnoTex [22], Self-teaching SVM struct [14], ASCUM [13] based on the domain ontologies. On the other hand, there are very popular bookmarking tools such as Delicious [18], Diigo [19] etc. The CKP tool implemented features for collaborative tagging in a form of an Internet browser plug-in (Firefox) are similar to other bookmarking systems at a glance. However, the key difference is that CKP can compute the relevance of the tagged resource with the learning goals and competences, and recommend learners to tag learning resources with them as well. This tool also differs from the other retrieval and content management services in a few ways. First, by using the CKP tool within the IntelLEO software solution, employees can store, annotate and (re-)discover heterogeneous resources (e.g., documents, discussions, blog posts, and wikis). The annotation is done automatically by using the concepts of appropriate domain-specific ontologies. Secondly, it allows employees to find job-specific experiences and "know-how" (in the form of, e.g., annotated wiki pages, blog posts, discussions) that are not freely available on the Web. These can originate from a member of the extended organization, a colleague from the same organization, or can be a documented self experience. Annotations of these resources with the concepts from specific domain ontologies facilitate their discovery and retrieval. The IntelLEO CKP tool also aims at addressing well known drawbacks of traditional search paradigms related to difficulties in finding relevant information [12] by improving existing search interfaces with semantic search capabilities, thus allowing the search to be based on domain topics and not only keywords. Finally, the CKP tool offers a measuring the semantic similarity between learning resource and the specific learning goal which is a novel approach. It is a very important in determining the relevance of knowledge asset related to learning goal/competency that has to be achieved

VI. Conclusion and Future Work

This paper presented the development process of the Content and Knowledge Provision tool by using the SOA concept. The tool is designed as a core service of IntelLEO, a new workplace learning paradigm being developed within an FP7 research project in the area of technology-enchanced learning. The concept of CKP tool requires technologies to support sharing, harmonization, building, and extension of content/knowledge among individuals, industries and universities, and effective combination of content and organizational knowledge systems (at both universities and workplaces in organizations). The management of content and knowledge has a key role for both collaborative LKB and harmonization of individual and organizational objectives.

This interface of the CKP tool includes all the advantages of the bookmarklets features. However, this service is much more than a simple bookmarking system or a mere Learning Management system; it combines all features in one single solution, thus improving exponentially the way those facilities can support workplace learning. The objective was to formally represent the semantics of the knowledge captured through social software tools, so that it can be leveraged by machines for supporting LKB activities in extended organizations.

In the future, we plan to implement the integration of the CKP tool with the Delicious bookmarking tool so that users can automatically save a bookmark to both Delicious and the CKP tool Additionally, this integration should provide users with the ability to have recommended concepts and most frequently used tags, as well as the ability to search through colleagues' bookmarks (both on Delicious and CKP).

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Content Co-creation and Refinement for Microlearning Settings

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***Abstract*—This paper describes an approach to creating and refining e-learning contents. As mobile devices such as smart phones become popular, learning can be conducted without the constraints of time and place, and the learning activity may become fragmented into many small learning sessions. In such microlearning activity settings, e-learning contents tend to be small making it easier to create contents by the collaborative efforts of many people. In order to facilitate such collaborative creation activities, we make use of the framework of a domain ontology and propose an interactive refinement process for when a problem is found in its contents. In addition, by letting learners participate in the refinement process of the domain ontology, the learning activity is expected to be more effective.**

Keywords–e-learning; domain ontology; linked data; crowd-sourcing.

I. INTRODUCTION

As high-speed Internet environments become ubiquitous, Massive Open Online Courses (MOOCs) [1] are becoming increasing popular. Mobile devices such smart phones allow users to learn almost anytime and anywhere. Microlearning [2], where small contents are often used in a learning activity, is attracting much attention. For example, mobile phones were utilized for microlearning interactions to rehearse names and faces for a social event [3].

It usually takes considerable effort to create e-learning contents, involving many human resources. When the power of a large group of people is utilized, as is often seen in an Internet environment (e.g., the Wikipedia project), smaller e-learning contents are easier to handle.

In this paper, we focus on content creation by a large number of people. In order to produce high quality contents, we propose an approach to refining the contents. The refining process is conducted interactively between a user and a system, and is initiated when a problem is found in the contents. In order to extract necessary information from a user to fix the problem, the system produces a list of choices using the domain ontology, from which a user selects the appropriate one. By aggregating answers from many users, we can obtain useful information to refine either the contents or the domain ontology. When the user is a learner, this interaction process can also contribute to the learning experience.

In addition, in order to achieve an effective learning process, (micro-) contents need to be presented in accordance with the context of a learner. A *scenario* is introduced, which is created for each learner in the learning activity, and executed so that proper contents can be shown to the learner.

The remainder of the paper is structured as follows. The next section discusses some related works, and Section III presents the data model for the proposed e-learning contents. Section IV describes the refinement process of the domain ontology and e-learning contents, and Section V presents the prototype implementation. The final section concludes this paper with directions for future works.

II. RELATED WORKS

The hot topic of *crowdsourcing* is a method to harness collaborative human efforts [4]. CrowdLearn is an approach to apply the concept of crowdsourcing to the creation of educational contents [5]. It aims to create educational contents that follow the Sharable Content Object Reference Model (SCORM), a collection of standards and specifications for web-based e-learning. Contents are created collaboratively by using the SlideWiki [6] platform. This system has been further extended to handle personalization and multilingual contents [7]. The primary function of CrowdLearn is to make full-fledged e-learning content; however, this paper targets e-learning contents used in more casual settings.

Related to the ontology refinement in e-learning settings, there is a system for learning a concept map [8] using a game-like tool called *Termina* [9]. In a concept map, terms that represent a particular concept are linked to other terms representing other concepts. Making a learner aware of the concept map of the target domain provides an opportunity to learn the target domain in more depth. Since a concept map is related structurally to a domain ontology [10], refinement of the domain ontology by a learner can contribute to the learner's learning experience in a similar way.

III. DATA MODEL

We use Linked Data [11] as an underlying data model for presenting e-learning contents. Linked Data is based on the Resource Description Framework (RDF) [12], which is the standard in the Semantic Web. A Uniform Resource Identifier (URI) is assigned to a thing that is represented, and the data is represented as a triple consisting of the subject, predicate, and the object.

An example of a simple learning content is shown in Fig. 1. This figure shows a multiple choice type quiz targeted at studying the JavaScript programming language. It has tags that correspond to the contents of this quiz (`ex:for`, `ex:javascript`), which indicate that this quiz is related to the *for* command sentence in the JavaScript programming language.

Since we assume that the contents are basically of small

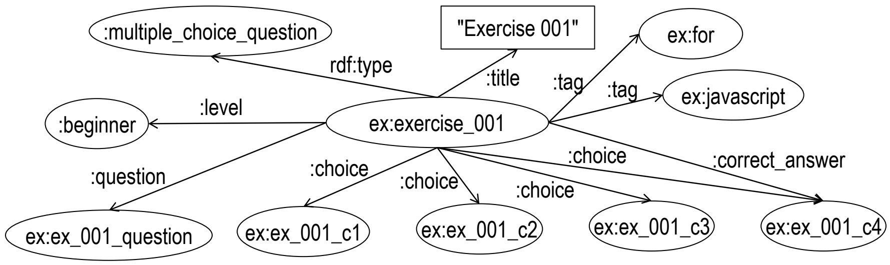

Figure 1. Example exercise

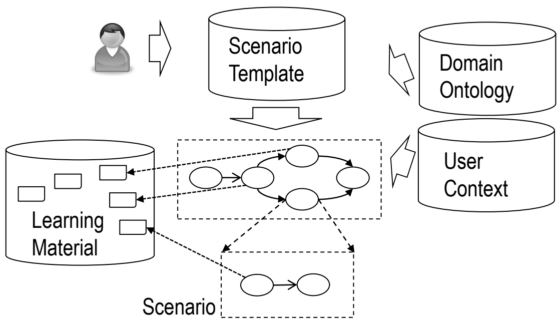

Figure 2. Scenario creation and execution

size and independent of each other, the context of the user (learner) needs to be considered when contents are presented to the user. The context of the user includes the kind of learning contents they have studied and to what extent they understand them. In order to tackle this problem, a scenario is created, according to which the learning contents are presented to the user. A given scenario is created based on a template scenario, along with the domain ontology and the user's context (Fig. 2).

Part of an example domain ontology is described as shown in Fig. 3. In this example, the concept of *control structure* is represented, under which concepts such as *if*, *while*, *for*, or *switch* are defined.

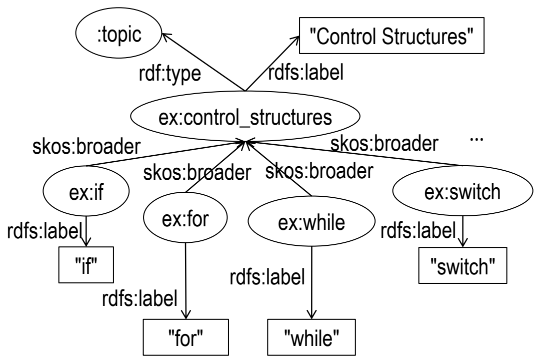

Figure 3. Part of example domain ontology

A scenario template is intended to be used to define an overall flow of presenting e-learning contents to a user. It is selected based on the intention and situation of the user. The selected scenario template is then instantiated with the domain ontology. For example, if the user intends to study the JavaScript programming language, its domain ontology is used. If the user selects a particular topic, say, *control structure*, the exercise related to the topics under *control structure* will be selected.

In addition, the context of the user, such as their level of understanding, is taken into consideration to finalize the scenario. For example, if the user is a beginner, the scenario will be finalized with a link to the beginner-level exercises.

As with a subroutine in a programming language, a scenario can be invoked from another scenario, creating a hierarchical structure of scenario execution. For example, the scenario that presents the e-learning contents of *control structure* to a user may invoke another scenario to present the contents corresponding to the topic of *if*. After its execution, another scenario presenting the contents of the topic of *for*, for example, may be invoked.

When a scenario is executed, all the scenarios that may be invoked are not necessarily instantiated from the beginning; a scenario is instantiated just before it is invoked. In the above example, the scenario for *for* will be finalized only when the topic of *for* is presented.

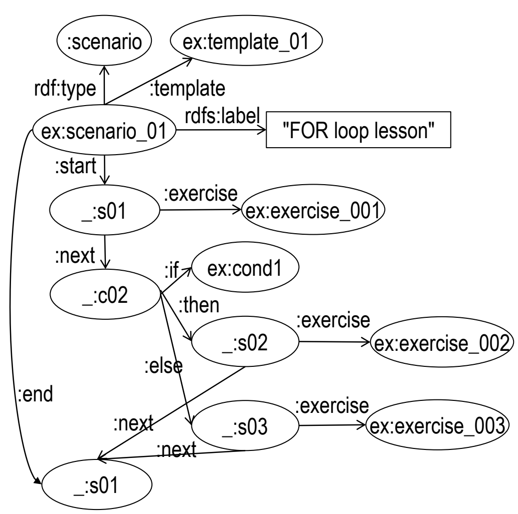

Figure 4. Example of an instantiated scenario

An instantiated scenario is a collection of links to the e-learning contents. A simple example scenario of a learning session regarding the *for* loop is shown in Fig. 4. Fig. 5 shows a serialized RDF representation in Turtle syntax of the example depicted in Fig. 4.

In this example scenario, the exercise represented by `ex:exercise_001` is presented first. The exercise presented to

```
ex:scenario_01 rdf:type :scenario ;
  :template ex:template_01 ;
  rdfs:label "FOR loop lesson" ;
  :start
    [ :exercise ex:exercise_001 ;
      :next [ :if ex:cond1 ;
              :then [ :exercise ex:exercise_002;
                      :next _:s01 ; ] ;
              :else [ :exercise ex:exercise_003;
                      :next _:s01 ; ] ;
            ];
      ];
  :end _:s01 .
```

Figure 5. Example scenario in the Turtle representation

the user next (`ex:exercise_002` or `ex:exercise_003`) depends on its result.

IV. Content and Ontology Refinement

Based on the data model presented above, the tag to the e-learning content is automatically attached as follows. First, keywords are extracted from the sentences in the contents, using a morphological analyzer. Then, the extracted keywords are compared with a label of the concepts in the domain ontology. A tag represents a concept defined in the domain ontology.

Tag information is viewed when learning contents are searched for. Thus, the correctness of the tag is important. When an incorrect tag is found by a user (a teacher or a student), a refinement process is initiated. This refinement process is basically an interactive process between the user and the system. When an error is detected, the system finds modifications that are needed to fix the problem (Fig. 6).

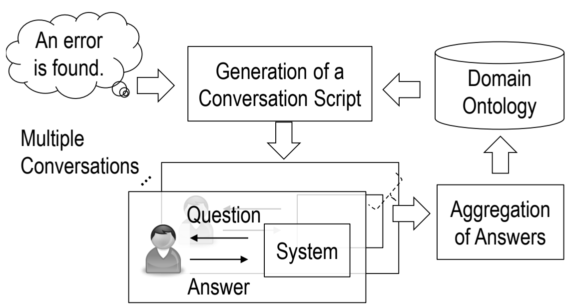

Figure 6. Refinement of the domain ontology

Let us suppose that the cause of the problem is an incorrect domain ontology. Since the domain ontology is also represented as an RDF graph, the problem stems from an incorrect or missing link. In order to identify the cause of the problem, the system tries to obtain the information necessary to fix the problem from a human user. This is done by first presenting a choice list to the user, from which the user is expected to select the appropriate answer. From the information provided by the user, the system recalculates the tag and presents it to the user. If the user confirms the revised tag, the process terminates; otherwise, the system tries to find another set of choices to present to the user. Fig. 7 represents this sequence in a Unified Modeling Language (UML) diagram.

Let us consider a simple example in the domain of the JavaScript programming language. Let us suppose that there is an exercise regarding a *ternary operator* (conditional operator), which is described using `?:`. This operator is similar to the *if-then-else* control structure in the sense that an expression written with a ternary operator can be expressed in the *if-then-else* control structure. If the exercise related to the ternary operator appears during the learning session of the *control structure*, it should be treated as an error. For the sake of the example, let us suppose that the concept of *ternary operator* is defined as a sub-concept of *control structure*. In this case, the cause of this error is an incorrect structure in the domain ontology. The best possible fix would be to change the upper concept of *ternary operator*. The system would present a list of concepts at the same level as *control structure* from which a user can choose the proper upper concept of *ternary operator*. When the user selects, say, *operators*, the concept of *ternary operator* will be changed to a sub-concept of *operators*. With this modification, an exercise tagged with *ternary operator* will no longer be shown under the topic of *control structure*.

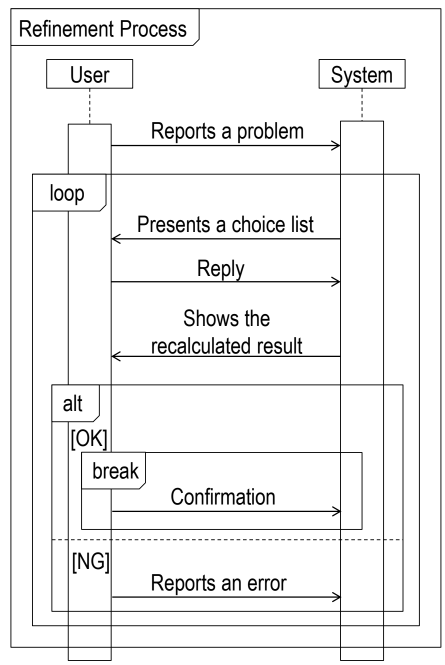

Figure 7. Interaction between a user and a system

If the user is a teacher, the update to the domain ontology is performed immediately. If the user is a student, the update is not immediately made to the domain ontology. Instead, a temporary area is set aside to store the update of the domain ontology. After the answers from multiple users are aggregated, and the majority of users concur, the change is made to the domain ontology itself.

V. Implementation

The system itself can be divided into two parts: content creation and refinement, and content presentation to the user. As mentioned before, the e-learning contents are represented using the RDF. In the prototype system we are currently implementing, we use the Fuseki server of the Apache Jena project [13] as a back-end RDF store. As for the front-end Web server, we use Node.js, which handles user authentication

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among other things (Fig. 8). Basically, e-learning contents are stored in the RDF store. The RDF query and update language SPARQL [14] is used to retrieve and update the contents from the Web Server using HTTP. The user interface is implemented using HTML and JavaScript. In order to push data from the Web server to the browser, we use WebSocket—more specifically the *socket.io* library—for easier implementation.

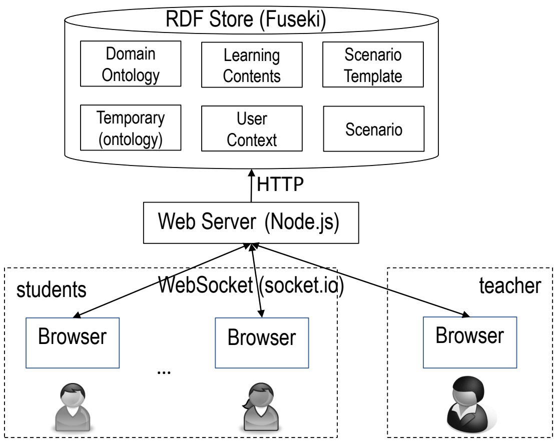

Figure 8. System implementation overview

As for the content creation and refinement, we consider the user and the system as a *software agent*, and define an agent interaction protocol [15] for the refinement of the domain ontology and e-learning contents. The interaction protocol is executed cooperatively by the programs at the Web server and the browser. Since WebSocket is used for communication between the Web server and a browser, bi-directional communication can easily be implemented.

As for the contents presentation, the system implements an engine that executes a scenario such as the one shown in Fig. 5. According to the user's context, a scenario template is selected and instantiated dynamically using a domain ontology. The instantiated scenario is stored in the RDF store and retrieved using SPARQL query language.

The execution of a scenario is conducted cooperatively by a Web server and a browser, and is specified as an interaction protocol between the system and the user. In microlearning settings, the execution of a scenario will likely often be interrupted as the situation of a user changes dynamically. The execution status will be stored at the Web server so that, when the user restarts the learning session, the interrupted execution of a scenario can be resumed. Alternatively, the user may choose to initiate a complete new learning session.

VI. Conclusion and Future Work

This paper presents an approach to supporting the creation and refinement of e-learning contents. Since the main target of the proposed system is microlearning, we mainly consider creating smaller, independent contents. In order to provide a coherent learning experience while utilizing independent contents, we also consider a scenario by which the learning contents to be presented can be specified.

Currently, we are implementing the environment for educational content creation and playback described in Section V. As for the contents themselves, we are working on the domain of programming languages such as JavaScript. In addition to typical educational contents, we are also considering transferring other types of knowledge. For example, we have implemented a FAQ knowledge base for troubleshooting often needed in rental apartments [16]. The proposed framework is intended to take care of such kinds of knowledge contents in future applications.

Regarding future directions, we plan to diversify and extend the interaction protocols available to deal with refinement of domain ontologies and learning contents. Using the extended interaction protocols, we also plan to evaluate how effectively learner's participation contributes to the refinement process from the viewpoint of the learner's experience.

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Hybrid Course Delivery: Impact on Learning and Assessment

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Abstract—Technology is influencing education, blurring the boundaries of delivery modes. A combination between online and traditional teaching style, the hybrid/blended course, may present a solution with many benefits. This paper provides definitions of the different delivery approaches, and then evaluates four years of data from a course that has been converted from traditional face-to-face delivery, to a hybrid system. It is determined that the revised course, in hybrid delivery mode, is at least as good, if not better, than it previously was.

Keywords – Hybrid, e-Learning, Higher Education, Evaluation, Assessment

I. BACKGROUND

The Gartner Group Research Institute in the United States anticipated that the world's e-Learning sales would grow 14.5% annually from 2006 to 2011 [1]. Over a similar timescale, government policies in the UK also indicated that the effective use of technology-assisted student-focused learning is essential for the future of higher education [2]-[5]. In a review of higher education and the future role of the university, Ernst & Young [6] have suggested that "… campuses will remain, but digital technologies will transform the way education is delivered and accessed, and the way 'value' is created by higher education providers, public and private alike." (p. 4).

Greater, and smarter, use of technology in teaching is also widely seen as a promising way of controlling costs [7]. When compared to other service industries, higher education stands out as being particularly affected by what has been described as the ''cost disease''[8]. Universities have large costs for infrastructure and labour, with reliance on expensive face-to-face provision. The urgent need to boost university productivity has been noted by many [9]-[11].

Lectures are accepted as being a very inexpensive way of presenting new ideas and concepts to students. Additionally, lecturing has been described as an ineffective tool for promoting theoretical understanding [12], as it rarely stimulates student thinking beyond the short-term memory [13]14]. The passive role assumed by students in lectures is too focused on the subject being delivered, rather than the learners and their individual needs [15]. But, teaching the same content can be made more interesting, and students can become active, independent learners, if different delivery methods are used [16].

Implemented proficiently, online or hybrid/blended provision has the capacity to lower costs and at least sustain, if not boost student outcomes [17]-[19]. Hybrid/Blended learning can ease some of the economic strain on students, as it reduces commuting expenses and allows for a flexible timetable that may better accommodate the students' personal circumstances [20]. Cost simulations, although speculative, have indicated that adopting hybrid models of instruction in large introductory courses has the potential to reduce costs quite substantially [7].

This paper begins in Section 2 by introducing definitions of the terms in use for educational delivery. The *"Fundamentals of the Internet and the World Wide Web"* (CSCI 1150) course is then described in Section 3. The methodology for data collection is outlined in Section 4, with Section 5 exploring the evaluation of said data in terms of student outcomes and attrition rates. The relationship between assessment weighting and online student interactions in discussion forums is also measured. Section 6 identifies the limitations of this study, with Section 7 concluding that CSCI 1150, in hybrid delivery mode, continues to provide as good, if not better provision, than the previous traditional face-to-face delivery method.

II. DEFINING HYBRID/BLENDED LEARNING

The boundaries of educational modes are blurring due to the introduction of technology [21]. A wide range of terms are in use to describe ways in which students may engage with their studies, including on-campus, face-to-face, off-campus, open education, distance education, external study, online education, e-Learning, flexible learning, blended learning and hybrid. There is limited consensus on the meanings of these terms [22][23] resulting in confusion for academics, administrators and students.

For each method of engagement, there are distinct attributes that help define them, for example, it is suggested that an on-campus mode relates to "courses that deliver material face-to-face and students interact with instructors face-to-face" [24], whilst distance learning can be described as "the various forms of study at all levels which are not under the continuous, immediate supervision of instructors collocated with their students in the same physical location but which, nevertheless, benefit from the planning and guidance of a supporting organization" (p.4) [23].

The terms Blended learning and Hybrid learning are being used interchangeably with increasing frequency in academic writing, but again, there is no consensus on their

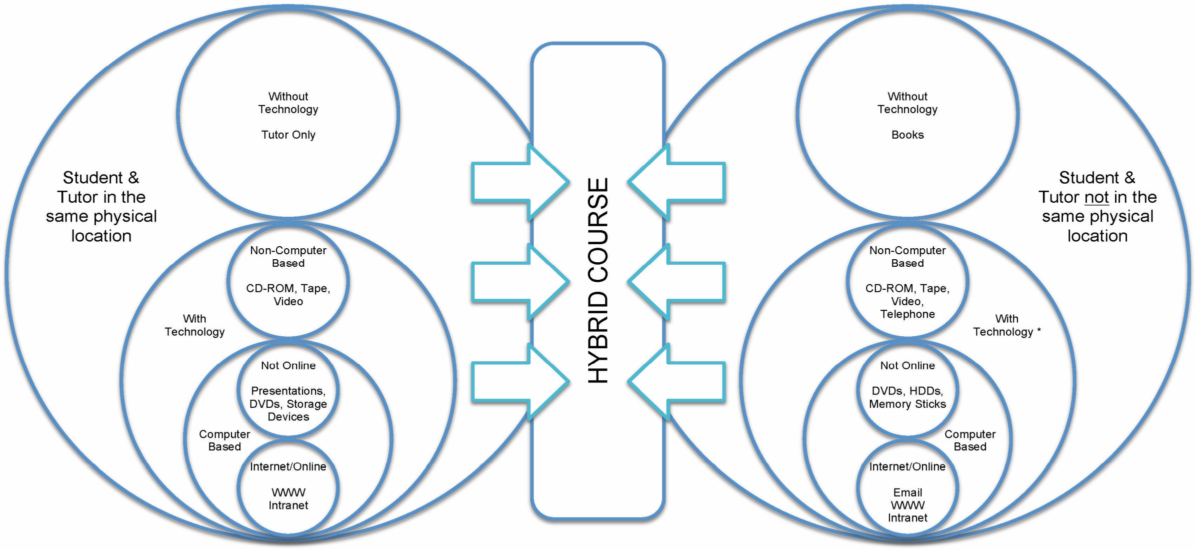

Figure 1. Hybrid courses in relation to traditional and online delivery

meaning [25]. In their most basic form, *Hybrid* is defined as being of "mixed character; composed of different elements" [26], whilst *Blended* is "an unobtrusive or harmonious part of a greater whole" [27]. In an educational context, a Hybrid/Blended course does not necessarily use a computer and the Internet, but it is increasingly common for this to be the case.

Further defining these approaches, but mixing the two terms, Blended learning has been described as a hybrid instructional approach combining aspects of e-learning and a traditional classroom environment [28]. An alternative description, favoured by the authors, is "courses that deliver material both face-to-face and online … [where] … students interact with instructors both online and face-to-face" (p.142) [24]**.** Research shows that this combination may promote learner-centred and active learning [29], however it has been suggested that this hybrid mixture of off-campus and on-campus activities is difficult to explain to prospective students [30].

A potential solution to the confusion is to define courses specifically by their construction. The public University System of Georgia (USG) [31] defines the following:

- *Fully online*: All or nearly all the class sessions are delivered via technology (96% to 100% online).
- *Partially online*: Technology is used to deliver more than 50% of class sessions (51% to 95% online).
- *Hybrid:* Technology is used to deliver at least one class session up to 50% of class sessions.
- *Campus/on-site:* No class sessions are replaced by online technology.

The relationship between traditional, online, and hybrid courses, is displayed in Figure 1.

III. COURSE DESIGN

The *CSCI 1150* course had traditionally been taught face-to-face, in both spring and fall semesters. In 2011, a Desire-to-Learn (D2L) component was developed, (a tool the students have previous experience of), where the content was made available online, with PDF 'slides' that closely followed the associated textbook. Students were also provided with access to interaction tools (e.g., e-mail, chat, discussion forums) as well as a set of assessment tools (e.g., quizzes, assignments and exams).

The course content has been refined in subsequent years (2012-2014) to include additional required reading material, as well as a better-defined set of discussion forums, (one per textbook chapter) where students are encouraged to interact during the semester.

This refinement aims to provide fresh stimuli to the course, in order to promote students' learning through questioning, investigating, challenging, seeking feedback, and learning through interactions with peers and tutors [32]. Technologies such as discussion forums can provide the opportunity for learners to be active in creating their own knowledge and understanding by allowing them to create, own, retrieve and exchange information within them [33]. The face-to-face sessions are then used to explore the course content, and the online interactions, in order to further develop the students' understanding. This overall course design may be seen as consistent with the "flipped classroom" [34], and is presented in a 50:50 ratio, causing it to be described as Hybrid delivery under the University System of Georgia [31].

From spring 2012, the course assessment has also been completed online, with each element assigned a proportion of the overall grade: Assignments – 40%; Quizzes – 10%; Midterm exam – 25%; Final exam – 25%. This was then further supplemented from fall 2013, with the online forum interactions being rewarded 2%, of the weighting, reducing the Midterm and Final exams to 24% each. The online interaction based on Discussion Forums weighting has subsequently been increased to 10% in spring 2014, causing the Midterm and Final exams to be reduced to 20% each.

A. Automatic vs. Manual Grading

A learning management system like D2L provides advantages to both instructor and student. It is possible to automate the process of quiz/exam delivery as well as grading, subsequently freeing significant instructor time.

The online quizzes for the hybrid course have 10 questions each, which are automatically generated from a database of 3000+ questions, all of which have the same difficulty level. The quizzes are automatically graded, immediately after the deadline, providing students with instant access to both the grade and the correct solutions. Students can then use this information to identify where they went wrong, which can then be discussed with the instructor.

The drawback in automating the process of delivery and grading come from the fact that some type of problems, such as those requiring essay-type answers, are difficult to automate, as they require manual grading for optimum accuracy and to provide personalized feedback. For this reason, the manually graded assessment has greater weighting in the overall final grade.

B. *Deadlines and Penalties*

Each assessment component has strict completion deadlines. Assignments have to be completed in 3 weeks, with a deadline enforced through the D2L submission system. Late submission was not accepted, and failure to submit an assignment would almost certainly result in dropping a grade, as the assignment weight was 10% of the final outcome.

For the Quizzes, each weighted at only 1% of the final grade, there is a 2-3 week timeframe during which each can be taken, offering the students flexibility in their learning.

As previously identified, the Midterm and Final exams were also given online, with a 12-hour window where they are 'live' and can be taken. Each exam consists of 10 problems, with 80% of the responses being manually graded. Each exam is weighted at 20%, with no late submissions permitted.

The final, newest element of assessment, which is based on the interactions in the discussion forums, has a one-month timeframe where posting is allowed to a particular forum. After the expiration time the students can still read, but not post, to the specific forum, providing a continuous source of information. The discussion forum contributions are weighted at 10% of the final grade, with contributions evaluated subjectively by the instructor; being measured both quantitatively and qualitatively.

C. *Interaction*

Two types of written discussions are frequently used in a hybrid course: synchronous and asynchronous. Whereas synchronous discussion requires participants to log in at a predetermined time and simultaneously join the discussion, asynchronous activities allows users to organize, read, and post messages at their own pace, as dictated by their preferred schedule.

Where online/hybrid course designers have opted for the use of discussion forums, they play an important role, often making up the major part of the students' activities and providing evidence of attendance, class participation, and sometimes assessment [35]-[38]. The delayed element to asynchronous communication, can allow participants more time to consider their responses, promoting deeper consideration and reflection of the subject [39][40]. Despite this, it has also been argued that scholarly thinking regarding assessment of online discussion has not kept pace with the growing popularity of such practices [41].

The asynchronous interactions in CSCI 1150 employ e-Mail, a News system, and Discussion Forums, the latter consisting of one primary thread per textbook chapter. The News system is an efficient tool for the instructor to provide students with updates about the course, however it is a unidirectional communication tool - from instructor to students.

Online synchronous interaction was implemented in CSCI 1150 through a Chat channel. It has been observed that the channel is mainly used immediately prior to the Midterm and Final exam period, serving as an emergency notification tool for the student if/when something goes wrong with the online exam session.

The other synchronous interaction occurred in the traditional in-class face-to-face meetings. As part of the Hybrid course, students meet with their instructor once a week, for a 75-minute session, where they can discuss and ask/answer questions. Attendance is not mandatory and it has been observed that by the middle of the semester an average of 60% of the students attend these sessions.

Online interaction was stimulated through the relationship between this activity and the assessment. Ten per cent of the final grade is awarded for the discussion forum posts, with each student being expected to provide at least three posts per thread, each of 200 words or more, as well as responding to classmates' questions. At the end of the semester, the student with the highest number of quality posts receives a further 10% towards their final grade; the other students receive lower additional percentages, representative of their contributions.

IV. METHODOLOGY

The CSCI 1150 course, a service course at Armstrong State University, Georgia, USA was observed over a period of 4 years, through seven semesters (Spring and Fall, 2011 to 2014). The course was delivered by traditional face-to-face methods in 2011, and was then converted to Hybrid delivery for 2012-14. There is no entry requirement for the course.

The average class size was 25, and the students included in the data collection ranged from 19 to 42 years of age, with a female to male ratio of 1.7 to 1. The analysis of the experimental data is straightforward. The outcomes for students previously undertaking the course in the traditional format are compared to the outcomes for students undertaking the hybrid formats.

The data collected consists of the students' final grades, failure rates and withdrawal rates. To further evaluate the hybrid delivery method, the students' asynchronous

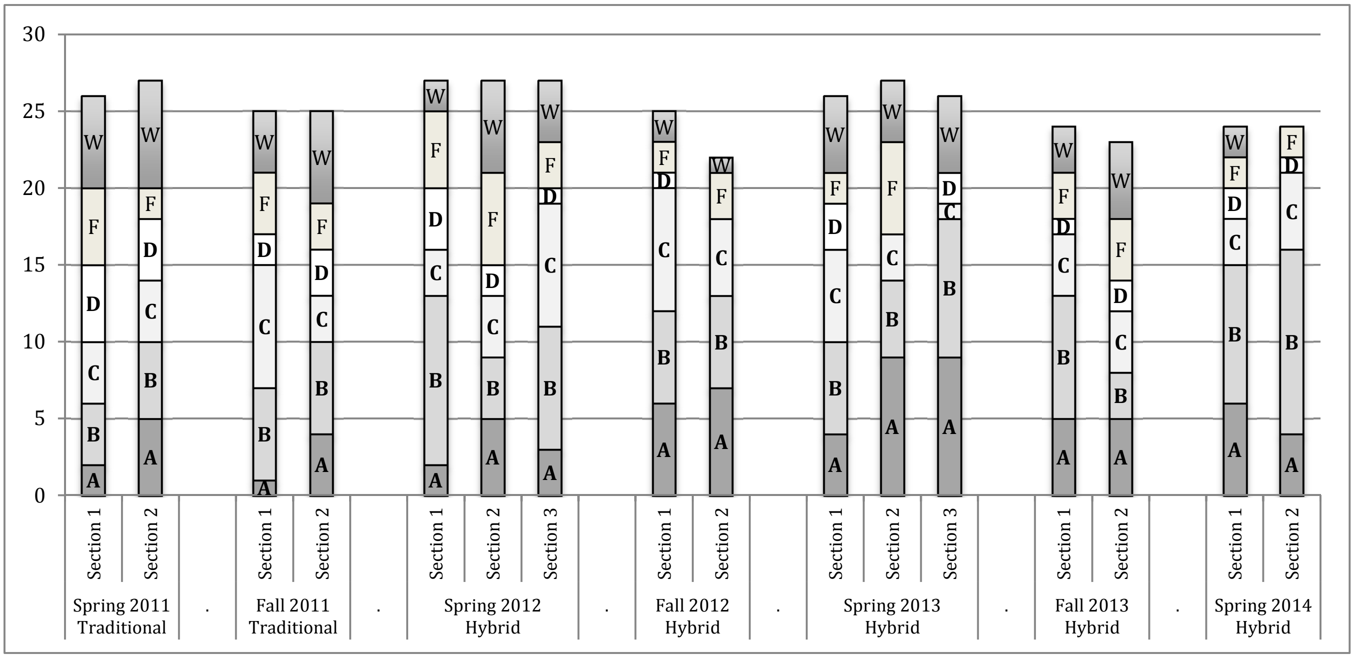

Figure 2 Total Number of Enrolled Students, Number of Each Final Grade and Number of Withdrawals, per Cohort. (Grades A-D, F=Fail, W=Withdrawn)

interactions are also investigated. The rate and volume of posts in the online forum are analysed in consideration of the changes in the course structure.

V. COURSE EVALUATION

The final outcomes for the students are displayed in Figure 2, and these show no significant difference between the traditional course that was delivered in 2011, and the subsequent hybrid delivery, with the course mean grade fluctuating between B and C (except for the anomalous D mean for the Spring 2011 Section 1). There is, though, some suggestion, albeit slight, that the course outcomes may be improving, with a median of grade B appearing more regularly in the recent hybrid courses (Table 1); but whether this is due to the delivery method, or some external factor, cannot be determined.

The goal of a blended/hybrid learning experience is "to provide a mix of both on-line and face-to-face experiences which support each other in achieving desired learning outcomes" [42], and whilst Universities are already experimenting with this style of learning, "the term is still relatively new therefore leaving many to question how the mixing of online and mobile learning with face-to-face interaction will actually improve student experience now and in the long term" [43].

However, it has been demonstrated that traditionally delivered, subject-intense courses can be converted to a 'blended/hybrid' delivery approach with "*as good, if not better outcomes*", if they are well-designed with high quality content and regular interaction [44]. Students in the hybrid format pay no "price" for this mode of instruction in terms of exam scores, and overall performance [7].

In other sectors of the economy, the use of technology has increased productivity, measured as outputs divided by inputs, and has even often increased output. Bowen at al [7] showed that a hybrid-learning system did not increase outputs (student learning) but could potentially increase productivity by using fewer inputs.

When considering the course attrition rates, it is important to note that students are allowed to withdraw without penalty before an identified deadline – usually just after the Midterm exam. This allows failing students to leave with a 'clean record', meaning they can retake the course in the future, should they wish to. Despite this, there is positive

Table 1. MEAN AND MEDIAN GRADES FOR THE COHORTS

	Mean Grade	Median Grade
Spring 2011 Section 1	D	D
Spring 2011 Section 2	C	C
Fall 2011 Section 1	C	C
Fall 2011 Section 2	B	B
Spring 2012 Section 1	B	B
Spring 2012 Section 2	C	C
Spring 2012 Section 3	C	C
Fall 2012 Section 1	C	B
Fall 2012 Section 2	C	B
Spring 2013 Section 1	C	C
Spring 2013 Section 2	C	B
Spring 2013 Section 3	B	B
Fall 2013 Section 1	B	B
Fall 2013 Section 2	C	C
Spring 2014 Section 1	C	B
Spring 2014 Section 2	B	B

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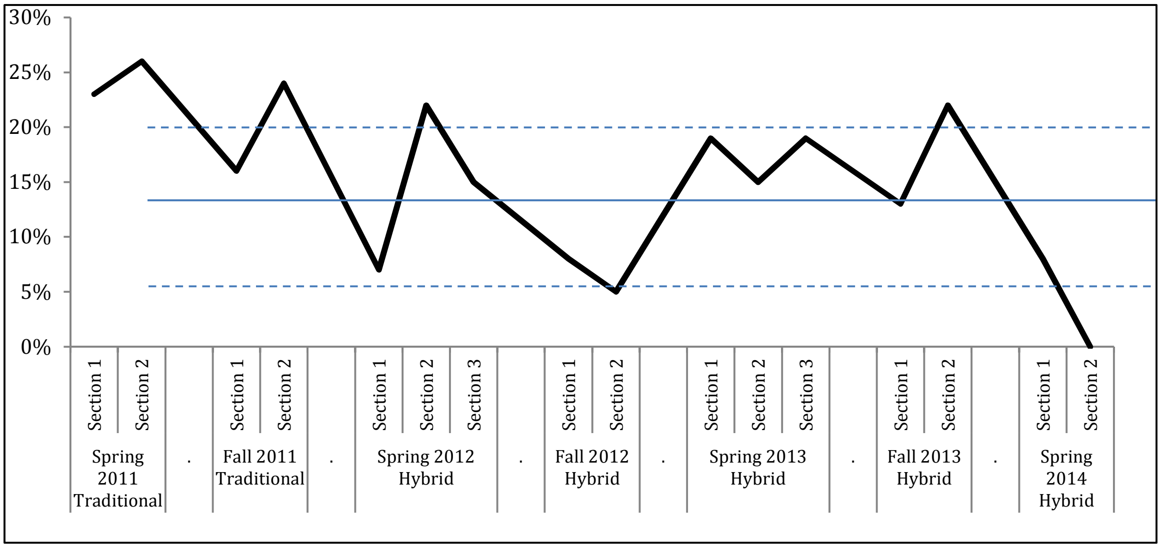

Figure 3. Course Attrition by Percentage of Total Enrolled Students (showing Mean and SD)

indication that attrition rates are reducing, as illustrated in Figure 3. However this is unlikely to improve significantly under the current withdrawal policy.

As previously identified, asynchronous interactions through e-mail are primarily exchanged around (1-2 days, before and after) a major deadline for an assignment or exam. For example 76.5 % of the e-mails received for sections 1 and 2 during Spring 2014, were specifically targeted on questions around major assessment components. Students also tend to interact little amongst themselves using the e-mail system, with only 36% of the e-mails sent being student to student communications.

For the online interactions measured only through the Discussion Forums (from Fall 2012 to Spring 2014), a quantitative analysis of the forum contributions (number of authored posts and number of read posts) reveals, unsurprisingly, that there is a direct dependency between the grading weight of the online interaction and the number of posts in the forum. Evidence shows that the higher the assessment grade percentage, the higher volume (and quality, in the instructor's opinion) of forum posts made by the students, as shown in Figure 4.

VI. LIMITATIONS

This is a small-scale study and the data was drawn from a specific course, with a limited number of participants. The study may have been influenced by factors specific to the student groups, which are not immediately evident from the findings. Also, experiences external to the course content and delivery may have contributed to student outcomes and opinions.

VII. CONCLUSIONS AND FUTURE WORK

In this paper, Hybrid/Blended learning is discussed in the context of the existing terminology. The design and main components of a course that was morphed from a traditional format to a hybrid one, is then described.

The course analysis and evaluation focuses on the

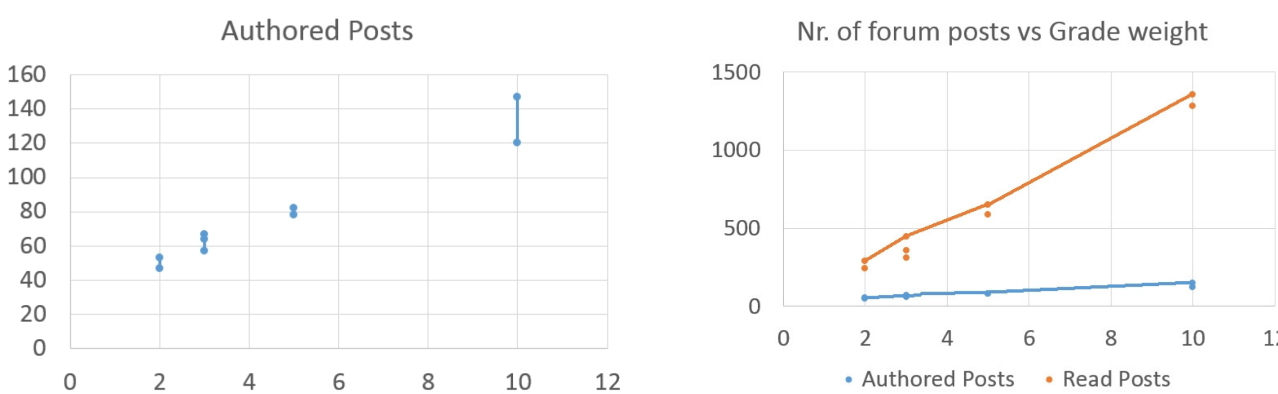

Figure 4. Relationship between the grading weight (2 , 3, 5, 10%) of the final grade and the number of authored/read posts in the forums

outcomes for students that undertook the course in the traditional format, and the outcomes for students undertaking the revised hybrid formats. It is shown that students in the hybrid format pay no "price" for this mode of instruction in terms of pass rates, exam scores, or performance. Moreover, they can be motivated to interact online with slight adjustments in the grading policy, which promotes participation, and improves students' computer skills.

The evidence supports the hypothesis that well-designed interactive hybrid systems in higher education, have the potential to achieve at least equivalent educational outcomes as traditional courses, while opening up the possibility of freeing up significant resources that could be redeployed more productively. This alone is cause for this style of delivery to be recommended.

The course structure will continue to be reviewed, in consideration of student outcomes, to promote higher final outcomes.

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How Interactive is your Virtual World?

Examining Student Engagement on Virtual Learning Activities

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***Abstract*—This paper is part of our ongoing research on the ways interaction affects student immersion within a virtual world and, consequently, student engagement with the educational activities that take place within it when a hybrid learning method is used. We confirm and further enhance our hypothesis investigating student feelings and thoughts about the interaction taking place within a virtual world when that is used in higher education. Specifically, 111 university students, both at undergraduate and postgraduate level, who used our "in-house" OpenSim virtual world for roughly 8 weeks, were asked to indicate their opinion and feelings about the virtual world and the various kinds of interaction they had. The results of this study validated our initial hypothesis that interaction plays a crucial role in student engagement, underlying that the nature and the design of the educational activities substantially affects student engagement.**

Keywords-OpenSim, Virtual World, Virtual Learning, Interaction, Engagement.

I. INTRODUCTION

One of the most overwhelming achievements of the technological evolution in the past decades (early '80s) lies in the field of virtual reality [1]. Virtual worlds were initially introduced as computer-aided 3D artificial environments, remotely or locally accessible to individual people and capable of simultaneously hosting their actions and interactions [2]. Even though their initial purpose was to provide an alternative for leisure (computer games) [1], within the last decade virtual worlds have massively progressed and serve various purposes such as socialisation, recreation, exploration, collaboration and education [3] [4]. This is attributed to the unique features of virtual worlds, like Second Life (http://secondlife.com/) or OpenSimulator (http://opensimulator.org/wiki/Main_Page), as they allow users to modify, design, and control the virtual environment [5].

Several studies have been conducted with the focus being on the use of virtual worlds in education [2] [4] [6] [7]. Researchers and educators [5] [8] agree that the 3D element, the use of avatars (users' virtual representations), the manipulation and development of environmental content, the embodied / real time communication (verbal/non-verbal) and the interaction, are some of the core features which turn virtual worlds into appropriate for learning activities. In [9], the author claims that the next generation of learners will be "learning in technology" whilst, other researchers [4] [10] agree with this statement and also add that virtual worlds allow learners to "learn by experiencing" the subject. The aforementioned claims are based on Vygotsky's [11] constructivist theory according to which learners construct their knowledge in virtual worlds by experiencing it as active participants [7].

A wide range of traditional learning styles has been identified and employed within virtual worlds under different learning approaches [12] [13] [14] [15]. This is attributed, to some extent, to the wide and complex network of interaction which can be developed within virtual worlds [6]. Even though the importance of interaction upon learning activities has attracted the interest of researchers and educators, as shown from the related literature [16] [17] [18], very few attempts have been made to develop and introduce frameworks and taxonomies for the evaluation of the educational activities [13] [19].

In an attempt to fill this gap, de Freitas et al. [16] and Childs [17] presented and assessed their framework for the evaluation of the learning affordances of virtual worlds. After assessing their own framework, they concluded that even though studying virtual worlds as a distance learning tool can be a sound method to extract some results, there is still need for further investigation with regard to the use of virtual worlds in hybrid-learning approaches (students' virtual and physical simultaneous co-presence) [18]. Likewise, Bronack, Rield and Tashner [13] developed their social constructivist framework and evaluated it using distance education environments with some quite encouraging conclusions.

Virtual worlds are, indeed, a great example of a tool to support distance education, but several approaches have also been made to utilise virtual worlds as a supplementary material to traditional learning. Camilleri and de Freitas [15] used a hybrid-learning approach to investigate and understand the level of engagement of learners with virtual worlds. The conclusions drawn from their experiments highlighted some of the benefits that student engagement has (e.g., development of working presence, increased collaboration and enthusiasm for learning). They also suggested that further research should be conducted in order to better understand how student engagement can be achieved and measured, as this is a key-factor to design successful educational activities within virtual worlds. The link between engagement and learning is believed to be interaction, as described by Childs [17] (e.g., interacting with the world, interacting with others, interacting with the avatar, finding and searching).

The above studies constitute a rather small example of the existing literature about interaction and engagement within virtual worlds. However, most of them are focusing either on distance education or, when a hybrid-learning approach is used, on the inner side of the virtual world disregarding the interaction occurring within the physical classroom. Specifically, a very limited –almost nonexistent– number of studies exist about the interaction occurring within the physical classroom, while a hybrid-learning approach is utilised [20] [21], or as a combination of the interaction occurring both within the virtual world and the physical classroom at the same time. This gap in the existing literature has been identified and suggested for empirical investigation and evaluation by several researchers [12] [16] [19] [20] [21].

We believe that interaction related to the use of the virtual world when occurring within the physical classroom affects student engagement with the virtual world. Therefore, we focus our ongoing research to that direction aiming to define, understand and map the way interaction (in-world and in-class) affects student engagement (positively or negatively).

Our initial attempt to identify and categorise the structural elements of learner engagement was made by Christopoulos and Conrad [22]. Based on that study, the conclusions that immersion and engagement are not inherent features of a virtual world were drawn and triggered further research that resulted in our previous attempt to investigate this subject [23]. That study allowed us to develop a taxonomy which mapped and described how interaction can be defined and understood in relation to learner engagement. In this research, we validate and further enhance our taxonomy aiming to generalise our findings on the kinds of interaction that affect student engagement.

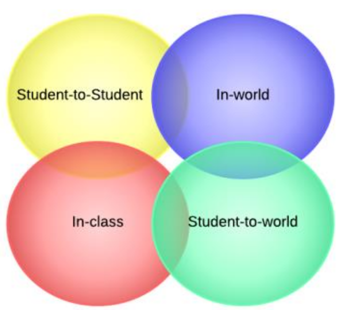

Figure 1. The four dimensions of interaction.

For clarification purposes, Figure 1 illustrates the four dimensions of interaction and the conjunctions that they may form. The term student-to-student interaction includes any kind of interactivity between students, either that may take place in the virtual world through avatars (e.g., chatting, emoticons, gestures, etc.), or in the physical classroom between the physically co-located students (e.g. talking, commenting, exchanging ideas, sharing thoughts etc.) On the other hand, student-to-world interaction seen from the in-world perspective includes all the possible interactions a user can have with the 3D content of a virtual world (e.g. building, scripting, using 3D objects, exploring etc.), whilst, seen from the in-class perspective, includes the use of the virtual world's technology per se. All kinds of the investigated interaction are analysed under this point of view in this paper.

The paper is structured as follows. First we provide a general overview of virtual worlds and the theoretical framework from which our main hypothesis is derived. We contextualise it within existing work with regard to higher education in virtual worlds, interaction and its effects on student engagement. In Section II, we briefly describe the situation in which the study has been conducted, and the research method followed to investigate this subject. In Section III, the reader can find the analysis of the findings in detail, while Section IV highlights and summarises the most important dimensions of interaction and its impact on student engagement. Finally, Section V concludes the paper.

II. MATERIALS AND METHODS

A. *Description of the Context of the Survey*

The examined practical sessions took place from February until June 2014 with a cohort of undergraduate and a cohort of postgraduate students, both of which were using a virtual world in the context of similar units. The institutionally hosted OpenSim virtual world of the University of Bedfordshire was used as an innovative tool for students to deal with, in the concept of working and collaborating in groups with task division, similar to circumstances taking place in companies. Each group had to choose an emerging technology subject, run a research about it, create a virtual show case for its promotion, and document all the aspects of their work. During these practical sessions students were simultaneously co-present in the physical classroom and in the virtual world. The questionnaires were distributed to the students after the completion of the course.

B. *Survey*

The use of surveys as a research method in studies related to education has several advantages. Surveys are considered to be one of the most sufficient methods to gather opinions of a large-scale sample. They are used to reveal participants' feelings, thoughts and beliefs about the subject under investigation, and also to justify their actions and behaviors. Furthermore, they allow researchers to draw accurate conclusions and make generalisations through the statistical analysis of the collected data. Finally, they are thought to be participant friendly, since participants are used to answering surveys with multiple-choice answers based on the Likert scale methodology [24].

C. *Structure and Sample*

The survey consisted of thirty (30) statements on a five-point Likert scale (Strongly Agree to Strongly Disagree) and was divided in two parts: the first part (14 statements)

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examined students' interaction with the content of the virtual world in the context of the practical sessions, and the second part (16 statements) examined students' interaction with other users of the virtual world in the context of the practical sessions.

Among the students who participated, forty-seven (47) were undergraduates and sixty-four (64) postgraduates. More than 4/5 of the participants were male (91), while less than 1/5 were female (20). More than half of the participants (59.45%) were aged 18-25 years old, several were 26-35 years old (38.75%), only two were 36-45 years old, and none was older than the age of 45.

III. Results and Discussion

Student-to-world interaction had slightly more positive results than student-to-student interaction, and at the same time statements regarding student-to-student interaction gathered more neutral and negative responses than those regarding student-to-world interaction.

The majority of the participants agreed to all the statements provided, while in all cases the total of positive responses ("Strongly Agree" and "Agree") was higher than the total of negative responses ("Strongly Disagree" and "Disagree"). Moreover, participants responded neutrally ("Neither Agree nor Disagree") very frequently. However, the number of statements that gathered considerably more negative responses was not negligent either. It is worth mentioning that in several statements the sum of negative responses is higher than the amount of neutral responses (see Tables I and II).

TABLE I. The findings of the questionnaire regarding student feelings about their interaction with the world.

	Interacting with the content of the virtual world in the context of the practical sessions…				
	Strongly Agree	***Agree***	***Neither A. nor D.***	***Disagree***	***Strongly Disagree***
1	17.11%	43.24%	22.52%	5.40%	11.73%
2	12.61%	36.93%	20.72%	17.11%	12.63%
3	23.42%	33.33%	18.91%	13.51%	10.83%
4	16.21%	43.24%	18.91%	11.74%	9.90%
5	21.64%	39.63%	15.31%	11.71%	11.71%
6	18.94%	37.83%	19.81%	12.61%	10.81%
7	22.52%	42.34%	16.21%	9.00%	9.90%
8	25.25%	45.04%	17.11%	3.60%	9.00%
9	21.65%	41.44%	17.11%	9.90%	9.90%
10	21.62%	38.73%	18.04%	11.71%	9.90%
11	19.81%	33.33%	24.35%	12.61%	9.90%
12	18.01%	38.73%	24.32%	10.84%	8.10%
13	17.11%	39.64%	17.14%	16.21%	9.90%
14	11.71%	34.23%	28.82%	13.51%	11.73%

TABLE II. The findings of the questionnaire regarding student feelings about the interaction with their fellow-students.

	Interacting with other users of the virtual world in the context of the practical sessions…				
	Strongly Agree	***Agree***	***Neither A. nor D.***	***Disagree***	***Strongly Disagree***
15	15.31%	43.24%	17.11%	12.63%	11.71%
16	16.21%	38.73%	12.61%	17.14%	15.31%
17	17.11%	39.65%	20.72%	11.71%	10.81%
18	15.31%	37.83%	17.11%	15.34%	14.41%
19	16.21%	40.54%	15.31%	16.21%	11.73%
20	16.24	38.73	21.62%	13.51%	9.90%
21	16.24%	40.54%	19.81%	13.51%	9.90%
22	18.04%	36.93%	19.81%	12.61%	12.61%
23	17.14%	33.33%	27.92%	11.71%	9.90%
24	15.32%	42.34%	20.72%	10.81%	10.81%
25	25.23	33.33%	23.44%	6.30%	11.71%
26	16.21%	41.44%	18.93%	11.71%	11.71%
27	18.91%	36.93%	24.32%	9.00%	10.81%
28	19.81%	38.73%	21.62%	8.10%	11.71%
29	17.11%	32.43%	24.32%	14.41%	11.71%
30	18.91%	31.53%	30.63%	7.20%	11.71%

What follows is the analysis of the answers to the statements, some of which are examined in pairs so that a direct comparison is possible. In each pair, the first statement is about Interacting with the content of the virtual world in the context of the practical sessions, while the second one deals with Interacting with other users of the virtual world in the context of the practical sessions.

Statements 1 and 15 (…is a good reason for me to use a virtual world). The findings clearly demonstrate that participants used the virtual world for both kinds of interaction it offers. However, when thoroughly comparing the positive with the negative responses, we can see an indication that they would opt to use a virtual world slightly more for the interaction occurring with the world itself and less for the interaction occurring with others.

Statements 2 and 16 (…made me feel I am actually present in the virtual world). Because of the sporadic nature of these responses, no conclusion that students were truly immersed can be safely drawn. In fact, the number of the neutral as well as the negative responses was considerably high, too. However, the sum of the responses with positive values provides an indication that interaction can actually have a strong impact and important outcomes on students' engagement and immersion. Nevertheless, the nature and the design of the activities play an important role and, therefore, clear and careful design for the enhancement of both kinds of interaction ought to be set as a priority.

Statements 3 and 17 (…made me "experience" the knowledge). As shown by these findings, both kinds of

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interaction may have a significant impact on the experience of the learning material. However, the fact that the number of neutral and negative responses was not low raises concerns about the cases and the conditions when a virtual world can truly help students "live" the lesson and learn by doing and interacting.

Statements 4 and 18 (…was real-time and that helped me have real-time awareness and feedback of the results of my work). Even though responses demonstrated as more important for the students the advantages such as the real-time awareness of their work had, it became apparent that a significant number of students used the virtual world as a medium to host their meetings, provide feedback to other team members and fellow-students, and also discuss matters that were non-related to their project.

Statements 5 and 19 (…made the learning material more attractive for me). It seems that both student-to-student and student-to-world interaction can have a very positive impact on the attractiveness of the learning material accessed in the virtual world. Indeed, students used to enjoy working with their teammates in-world and to collaborate trying to perform their tasks.

Statements 6 and 20 (…made me participate gladly in the practical sessions). Indeed, for most of the participants the opportunities given to them to interact with this tool increased their willingness to participate and engage gladly with their assignment. However, taking into consideration the server's data logs, it became apparent that the number of students who were using the virtual world initially was decreasing significantly over time. This explains, to some extent, the high percentages of the neutral and negative responses.

Statement 7 (...was interesting since I had the opportunity to see my creations 'alive'). These results clearly demonstrate that the interactive 3D content of a virtual world and, even more so, the students' opportunities to create and alter it according to their needs and preferences can be an interesting part of the use of a virtual world. Besides, coding in a virtual world differs dramatically from coding on a compiler and that is the element that makes a virtual world interesting to use.

*Statements 8 and 25 (...was fun).*The use of a virtual world to assist the learning process, to give students the feeling of actually participating in it, and, by extension, to make it more amusing and entertaining is something which was acknowledged by most of the participants. Indeed, not all the students learn the same way and this is where special attention should be given.

Statements 9 and 26 (…made the practical session more attractive for me). These findings clearly demonstrate that the use of the virtual world had a very positive impact on the attractiveness of the practical session. It is really interesting that the unique element of student interaction with the 3D content of the world that cannot be replaced by other features of the physical classroom contributed more, compared to student interaction with their classmates, on the attractiveness of the procedures that take place during the sessions. It is supposed that the innovative nature of this tool was the main reason why students were attracted to it and the practical sessions, by extension.

Statements 10 and 27 (…made learning easier for me compared to just studying). A quite large portion of students agreed that this tool had a positive impact on their engagement and that they learned a lot of things along the way. Indeed, several educators and researchers have focused on the advantages of the so-called learning by doing. However, for a significant number of students it had no impact, and in several cases the results were not positive at all.

Statement 11 (… pleased me a lot, especially when I was building and scripting). These results, though encouraging, raise serious concerns about the use of virtual worlds in educational context. Despite the fact that most of the students considered building and scripting as a pleasant part of their student-to-world interaction, a noticeable number of others probably considered it as just one more educational activity with nothing special to offer, or others even disliked it maybe because of the difficulties they faced when using this new tool.

Statement 12 (…pleased me a lot, especially when I was exploring and sightseeing). Once again the sample showed that the students tended to have neutral feelings towards the chance they had to explore the content of the virtual world. Nevertheless, most of the students enjoyed that part of the in-world interaction. While students were exploring the virtual world, they also had the chance to see their classmates' creations, use them, and get new ideas. Cross-studying the responses derived from this statement with the one from statement 11, we can understand that for some students using virtual objects existing in the virtual world might be more pleasant than creating their own artefacts from scratch.

Statement 13 (…pleased me a lot, especially when I was using the virtual objects I created). According to the students' answers, using their own artefacts can be a pleasant activity. However, when cross-studying the responses in this statement with those in statement 11, a question is posed: Why students enjoyed using their own virtual artefacts but did not enjoy creating them? The speculation that students were struggling with the technology and, thus, building was a painful and time-consuming procedure can be made.

Statement 14 (…pleased me a lot, especially when I was using others' virtual objects). Since it was a group project and in order to show that they were actually a part of that group, students had, by default, to at least use their classmates' objects in order to work on and complete their assignment. However, using them does not necessarily means that it can offer any kind of pleasure. That can explain, to some extent, the high amount of neutral or even negative responses the participants gave. On the other hand, there were many students who found the whole process pleasant, as it allowed them to get ideas that could have helped them to develop or further enhance their own artefacts.

Statement 21 (…made me more open and positive to collaborations). It seems that collaboration is enhanced through the use of the virtual world. Given that students had to complete a collaborative project working in groups with task division, the fact that most of them felt inspired to work harmonically with their teammates is really encouraging. However, the high counts of neutral and negative responses raise concerns regarding the ways collaboration can be aided through the use of a virtual world as a learning tool.

Statement 22 (…made me learn what other users already knew). Participants' replies to this and the following statement form a very clear view of peer-tutoring in virtual worlds. When students are interacting in a virtual world, they learn what their fellow-students already know, usually subconsciously and without being directly taught, while sharing their experiences and working together for a common goal.

Statement 23 (…made me teach other users things I knew). Most of the students were keen to provide support to others, initially related to the use of the virtual world regarding its tools and capabilities, and then more focused on their assignment. Considering statement 22 along with this statement, it can be postulated that the use of the virtual world had a positive effect on peer-tutoring and social learning.

Statement 24 (…was interesting since I had the opportunity to chat with others about our projects). An interesting form of interaction for most of the participants was talking about, commenting on, and exchanging ideas about their projects. It seems that the use of a virtual world encourages the use of this form of communication. Nevertheless, this kind of interaction had not been as interesting as for the rest of them. The fact that several students thought of it as not particularly interesting or not interesting at all can be attributed to the fact that they conceived it as nothing more than part of their project routine.

Statement 28 (…pleased me a lot, especially when collaborating with others for a common goal). Managing or working together with others to achieve common goals is always a tough process, taking into consideration the diverse personalities that people, and, by extension, students have. However, the high percentages of positive replies indicate that the use of the virtual world seemed to have a positive effect on that, helping students to overcome their difficulties and making them feel more confident. Nevertheless, there were several students who felt uncomfortable in the virtual world for several reasons, some of which have already been mentioned, and this had a negative impact on their collaboration with others. Therefore, it is very important to determine the factors that increase student collaboration and those who decrease it.

Statement 29 (…pleased me a lot, especially when we were laughing with our mistakes). Most of the students seemed to enjoy working in-world even when the results of their work had not been the expected ones. Building and scripting can be a very interesting form of in-world interaction for students, as already noticed through the responses in statement 7. On top of that, when students have the chance to share the results of their work, even the most uncommon, unexpected, and funny ones, with their class and team mates in a virtual space where 3D representations are the key element, even their mistakes can prove to be pleasant and enjoyable.

Statement 30 (…pleased me a lot, especially when we were having breaks from our work). Taking into consideration the data logs, it was revealed that several times students spent considerable time in-world wandering, chatting, and modifying their avatars. However, there were several students who kept a neutral position or even a negative one. Since this virtual world was introduced in the context of a university assignment, many students faced it as a medium to complete their assignment and not as a game-like environment. In addition, there were several students who either did not have spare time to spend in-world or could not find anything interesting enough for them to do other than complete their assignment.

IV. Reflection of the Survey Data

The data collected through this survey greatly validate our taxonomy. Even though student opinion about several aspects of the use of a virtual world on education is confirmed and enhanced, a number of other aspects is altered. This alteration can be attributed not only to students' different personalities, but also to the difference in the learning material, the learning approach, the design of the learning activity, and the difference in the ways the virtual world was used, as well as the purposes it was used for.

The general outcome, comparing the means of each couple of statements and the mean of each single statement, is that the impact that student-to-world interaction has on student feelings towards the use of a virtual world is slightly more positive than that of student-to-student interaction. Nevertheless, both kinds of interaction seem to enhance student engagement with learning activities, but this needs to be further investigated.

A. *In-world interaction both with the world and among students*

Both kinds of interaction that students performed in-world had equally positive results in their engagement with the learning material and in the educational activities. As students stated, both interacting with the content of the virtual world and with their classmates made them have a sense of presence in the virtual world mostly because these kinds of interaction made them spontaneously engage with the activities and focus on their in-world tasks. Besides, in-world student-to-student interaction and student-to-world interaction were rated as equally responsible factors that affect students' willingness to participate in the practical sessions. On top of that, all the complex network of interactions that students performed in-world allowed them to experience the learning material, and as a result their learning outcomes were enhanced.

B. *In-world interaction with the content of the world*

Participants named the student-to-world interaction as a particularly worthwhile reason to use a virtual world. This interaction was described as the main reason for both the learning material and the practical sessions to become more attractive for students. Students stated that building, scripting, exploring, sightseeing and interacting with the content of the virtual world using 3D objects were some of

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their in-world actions that made the learning process pleasant for them. In addition to that, the fact that all student-to-world interaction was synchronous, and the fact that students could receive immediate feedback from the content of the world upon their actions was conducive to students' real-time awareness of the results of their work and actions, in general. That feature was characterised by students as particularly interesting, since it gave students the feeling of a "living" world that responded to their actions.

C. In-world Interaction with fellow-students

The use of a virtual world as a tool in the practical sessions was deemed as particularly beneficial by the participants not only because of the student-to-world interaction they had the opportunity to perform, but because of the in-world student-to-student interaction, as well. The fact that students not only became open and positive to collaborations, but also enjoyed their collaborations in the virtual world is underlined. These kinds of interaction and collaboration encouraged peer-tutoring and peer-assisted learning, since participants mentioned that they both taught their classmates and were taught by them in the context of their in-world collaborations. Moreover, students stated that the fact that they had the chance to talk in-world with their classmates about their projects made the whole process more interesting for them. Students also evaluated as particularly helpful the fact that they could have immediate feedback on the course of their projects from their fellow-students. Even in cases when the results of their work had not been the expected ones, students still enjoyed the whole process, since their mistakes could be observed as funny reactions on the 3D representations. Finally, it seemed that having the chance to use the virtual world not only for educational reasons but also to spend some leisure time, made students enjoy the use of the virtual world and engage with it and with the project. However, the extent to which activities that are irrelevant to the educational project itself are conducive to student immersion in the virtual world and, by extension, conducive to the engagement within the project, is still to be investigated.

V. Limitations of the Study

At this point we should note the limitations of this study and the factors that have potentially influenced the results, even though these influences were intended to be kept to a minimum. The participants of the survey were students of the University of Bedfordshire, which is where all the authors of this paper work. Despite the fact that the questionnaires were completely anonymous and participants were ensured that their participation in the survey would have absolutely no consequence on their academic progression, some of them were potentially forced by some biases to answer in certain ways, which could not have been avoided by the authors

VI. Conclusions

The findings derived from this study validated our taxonomy and confirmed our initial hypothesis that both kinds of interaction have the potential to affect student engagement. The interaction that occurred between the students and the virtual world was shown to be more intense compared to the one that occurred among the students. However, student-to-student interaction was also affected by the one that occurred between the students and the world indirectly. Our hypothesis is enhanced compared to our previous one since it identified a need for careful planning of the educational activities, taking into consideration the wide and complex network of interactions that can be developed in order to achieve engagement. However, further research is deemed necessary in order to shed light on the design principles which educators should take into account when creating learning activities that involve the use of a virtual world with an aim to engage their student with their learning material.

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Gamification of Higher Education by the Example of Computer Games Course

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***Abstract* - Use of game elements in course design is one example of gamification. The course of *Computer Games* was selected as a basis for gamification because game-like approach can support the understanding of the course content. A case study was conducted to find out how students perceive game-like course. The course of *Computer Games* was organized like a game. At the end of the course, feedback was collected. Although most of the game elements were well accepted by the students, it did not lead to deep immersion.**

Keywords – Gamification; Game elements; Computer Games.

I. INTRODUCTION

Video gaming is one of the most important entertainment industries after the movies [1] and its importance is growing. According to Gartner Inc. the game industry turnover for the year 2013 was 93 billion dollars, for the 2015 the revenue is estimated to be 111 billion dollars [2]. Universities feel increased need to provide curriculums and courses related to computer games. Teaching computer game design and development provides different possibilities to combine technology, pedagogy, art and business [3]. One possible approach among others is gamification [4]. This method is not new and is frequently used in marketing and business conditions [5]. Education is one field where game elements have been increasingly used lately [4]. In most cases the gamification is implemented for increasing the engagement among students [6]. In the course of *Computer Games*, gamification can be used also for delivering content – study elements are integrated to the course management [7]. What are those game elements and how can they be used for organizing the work in the course of *Computer Games*? How students are accepting game mechanics in non-game environment? To answer these questions a course *Computer Games* was organized as a game. Later, a survey was conducted among students to find out how well different game elements were implemented.

Research design is based on case study. In the 2nd section, the literature review is provided, game elements are specified and research questions are stated. In the 3rd section, the case – course of *Computer Games* is introduced. In the 4th section, research methods are described. In the 5th section, findings are presented.

II. GAME ELEMENTS

Gamification is the use of game elements and game-like thinking in non-gaming environment [4]. Examples of gamification vary from the single game-like learning activity [4] to the entire course that is designed like a game [7]. Experience points, scoreboards and awards are the most frequently used game elements in gamification but games provide much richer list of elements. To find out what game elements can be used for gamified course it is important to be clear what "game" is.

"Game is a activity of play in the pretended reality where participants try to achieve challenging goal by acting in accordance with rules" [8]. By this definition game does not have to be a competition. Some authors distinguish games from the simulations saying that game is always a competition against something or somebody. Game does not have to be purely entertaining. For example, educational games have a serious goal. Some serious games are not even fun (e.g., medical simulators).

There are different ways how to classify game elements. For example, Werbach and Cevin [9] structure game elements in three levels: components, mechanics and dynamics. In this article the game elements are structured by the main game aspects mentioned in the previous definition.

A. Challenging Goals

Course Goals can be seen as game goals. Every assignment has goals and they can be seen as game challenges [4]. Combining learning goals with game goals is not only related with gamification. This is a starting point for any approach related with game based learning [10].

B. Play

Interactive activities are needed for achieving the goals and completing the challenges. Course activities can be designed as game activities. For example, easiest way to implement interactive activity is to use quiz instead of test [7]. Researchers have found that gamified activities have better results in practical assignments [11].

Feedback – To provide enjoyable playing experience the games should provide instant and rich feedback [8]. Unfortunately this is not always so in the education field. Teachers do not have enough time to provide qualitative and fast feedback to all students. The easiest way to provide fast feedback during the course is to organize interactive activities in the classroom or to design game-like virtual learning environment (VLE) that provides automated feedback for typical activities. Studies have shown that positive feedback stimulates students learning [12].

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Collaboration is one form of interactivity. When majority of the games are based on competition, the collaboration mode is used in party based interaction modes or in role playing games [8]. In both cases, collaboration is achieved through teamwork. Game collaboration models can be used for improving teamwork in learning conditions [13] and in workplace [14].

Competition – Not all games have competition (e.g., simulations) and not all players like to compete with each other. Still it is seen as one of the key fun factors in games [8]. Competition is not commonly used in education. Compering students by the results is even seen as a bad instructional design method (sometimes forbidden by the law). Still the easiest way to implement gamification in the classroom is to use a scoreboard. Also, learning activities can be designed as competitions or fights. For example, debate between two students or teams can be seen as fight. Some instructional designers use graphical game elements for avoiding dissemination of personal learning data but still implementing friendly competition between students [15].

C. *Rules*

Game core mechanics are usually complex set of different objects and relationships [8]. They declare how players and game environment interact with each other. One part of the core mechanics is the conditions for the progression. How player can earn or lose points, how the game is divided into levels and what are the pass or fail conditions. This can be easily implemented in education. For example, grades are experience points (XP), XP's form the score and players are listed on the scoreboard [7].

Levels can be treated differently in games [8]. Usually, levels are different parts of the game world and assignments. Levels in the course can be seen as lessons or learning units. Levels can also refer to the rating of the player based on her score. In this case levels can be seen as a final grades for the course. Levels can be related with the difficulty of the game. In this case levels can describe different versions of the same assignment – suitable for personalized learning. The easiest way to integrate levels is to bind them with score and grades [7].

Balance – For providing enjoyable playing experience, game elements must be in balance [8]. In game-like course it is mostly related with scoring system – how many points for certain activity it is possible to get and how the student progress on the scoreboard. Balanced scoring system solely does not guarantee the balanced user experience. The playing activities and the learning content should also be in balance [16]. In the gamified course, there is a risk that too much effort is put in the play and important information is not achieved [17]. Also, the difficulty of the learning activities should be increasing during the course. Assignments should be balanced in the level where the learner is kept away from boredom or anxiousness – in the zone of flow [18].

Luck or randomness is one part of game mechanics. Some games are heavily based on risk and luck (e.g., gambling). Usually, players do not want to be affected by randomness [4]. They prefer to believe that their achievements are based on their own skills. Luck can be integrated to the course by rolling the dice for selecting the student who has to make a presentation [7].

Risk – Games are entertaining because they provide safe environment for taking risks. Usually, players fail with missions several times before they achieve the goal. Unfortunately this is not acceptable behaviour in educational assignments. Failures are usually punished with negative grades. Taking the final exam more than twice is not tolerated. While in computer games it is normal to have several attempts before defeating the big boss. Risk is a game element that is most difficult to integrate with the course design. Some researchers have shown how using risk simulators will decrease the risky behaviour in real life, for example, in traffic [19]

D. *Pretended Reality*

Game world is an imaginary place – magic circle where players go during the game play [8]. Usually, it is created with the help of the story and graphical elements but not always. Sometimes game world is only a virtual space in players' head. Creating this kind of imaginary place in the classroom is quite complicated. One possibility to achieve this is to design VLE as a game world. One example of building the game world is to use the map of local area for students' data collection and presentation activities [20].

Characters are avatars and non-player characters (NPC) [8]. When implementation of NPC's requires environment similar to the computer game [21], the avatar design can be integrated with creating the student's profile in the course VLE [7]. This avatar is used as a character during the entire course. Students can pretend that they are somebody else (e.g., talented game designer). It can increase the immersion to the course [22].

Game aesthetics – Modern computer games have rich graphics. It is complicated to design educational course in the same level of details as commercial videogames have, but it's realistic to design VLE as a game world or use game like icons for illustrating the course materials. One example is to use a virtual tree as a graphical element for representing the students' progress [15].

Story – Games don't have to be based on story. For example, for puzzle games only the rules are important. Some games (e.g., adventure games) are heavily story based [8]. Stories are also used in education. To build the entire course as a story is a complicated task. One method to do this is to implement the journey of a hero [23]. It can be integrated with avatar design in the beginning of the course, with the character growth during the course and self-assessment at the end of the course.

Immersion – When goals are clear and activities are organized in engaging way the participants loose the sense of time and they stop worrying about themselves. This kind of immersion is typical for computer games. [24].

Some of those items are very similar to educational elements. They can be implemented simply by changing the name of course elements. For example, Grades can be called as XP's, assignments can be called as challenges or missions etc. Some elements are not so easy to integrate with the

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course or lesson. For example, using game aesthetics in course design requires a lot of time. Some of the elements can be integrated directly; some aspects can be achieved through others (e.g., immersion). Implementation of game elements in education is growing trend but it is not widely studied how those game elements are accepted by the learners. The objective of this article is to answer this question.

III. The Case Course

To find out how game elements can be used in education the *Computer Games* course was designed as a game. The selection of the case was made based on convenience – the author of this article simply had to teach this course. This course is part of the Cross Media bachelor curriculum but the admission was open to all students. 35 students enrolled to the course and 23 (passing ratio 66%) of them completed it with positive result. 1 student didn't achieved the positive end result and 11 students disappeared during the first two weeks of the course. Classes took place in the autumn 2013. Learning was conducted with the method of blended learning. It consisted of 12 face-to-face meetings (4 hour sessions per every week) and online learning assignments. Course virtual learning environment was based on Elgg Social Networking platform [25] and was used for study management, sharing learning materials, submitting home assignments and running online discussions (see Figure 1).

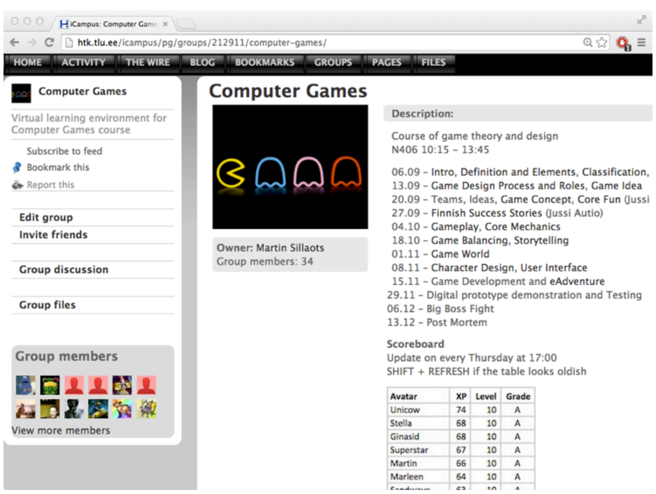

Figure 1. Gomputer Games ELGG based VLE starting page.

The objective of the course was to provide an overall understanding of game research and theory, design and implementation. The main focus lied on the game design [26]. The content of the course was based on the book "Fundamentals of game design" [8]. Learning activities were inspired by the book "Multiplayer Classroom" [7]. Course was organized like a game. The following game elements were implemented: Goals, Avatar, XP's, Scoreboard, Levels, Luck, Collaboration, Competition and Feedback. The goal of gamification was to achieve deeper immersion among students. Elements like game world, visual elements and story were left out from the course design because it was too time consuming to integrate them with the learning activities.

Game vocabulary was used instead of pedagogical terms. For example, students were called as players, teacher was a game master, assignments were missions, exam was a big boss fight, grades were levels etc. Most of the assignments were based on teamwork. Students formed teams and designed a new game from the idea to prototype. Every step in this process was treated as stand alone group assignment. Every assignment had three sub-activities:

- Creating and uploading an artefact (document or drawing or prototype),
- Randomly selected groups or students presented the artefact in the class,
- Asking and answering questions from opposing teams.

Most of the activities involved cooperation in the teams and competition between teams and provided immediate oral feedback to the students and written feedback in the VLE with maximum 1-week delay.

Course started with introducing the learning goals. First assignment was to design a personal avatar. Students were encouraged to use nicknames that are related with the course content. They were also asked to design an icon for the avatar and write character background story. The main objective for avatar design was to generate safe names that can be used on the scoreboard and not to violate the personal data protection law.

Next assignment was related with analysing and introducing student's favourite digital game. Students had to write a short paper about one game and to describe its genre, gameplay and other elements. Third assignment was selecting a role for the game design team based on student's background. Based on roles heterogeneous teams were formed with the help of TeamUp (see Figure 2). This tool enables forming groups automatically based on students' preferences.

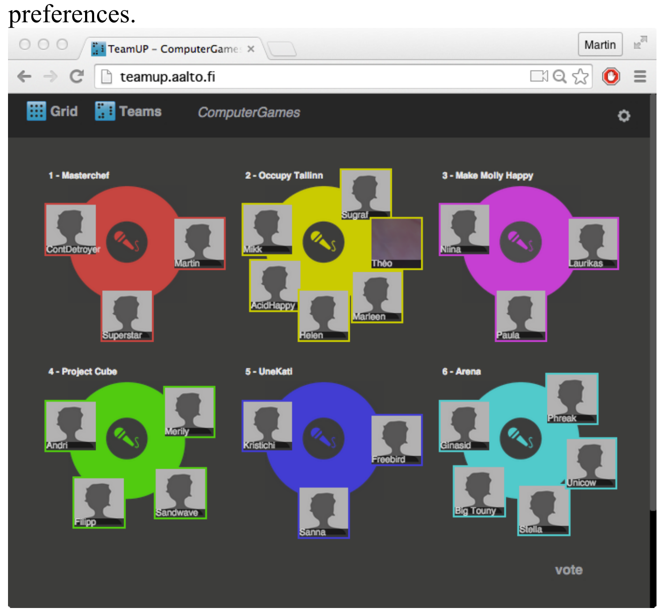

Figure 2. Forming teams with TeamUp.

Forth assignment was providing an idea for the new computer game. Every student introduced their ideas in front of their team. Voting was made inside the group and the selected idea was introduced to the rest of the class. The owners of the selected ideas earned some extra points. After that the rest of the activities were conducted in teamwork. The aspect of chance was reduced during the team activities because it affected only the order of presentations.

Next, students were asked to compose a document describing the specification of the new game. It included design of the game challenges and activities (gameplay), defining core mechanics of the game (rules), writing a story for the game, sketching the graphical items for the game world (backgrounds, characters, objects), composing paper prototypes and implementing digital prototype. For digital prototype development the eAdventure platform was used. eAdventure does not require programming skills [27].

The course ended with the final exam (Big Boss Fight) where teams introduced their game specifications and demonstrated digital prototypes. Visitors from game industry were invited to listen students' presentations and ask questions. After the exam students were asked to conduct self-evaluation. They had a chance to adjust the amount of points that were collected during the teamwork.

Every activity generated certain amount of experience points (XP). Based on XP's students were listed on the scoreboard. Game levels were based on scores and later they were converted into grades. Course included several bonus activities and possibilities to earn extra XP's like testing and evaluating different game projects and providing links to additional learning materials.

IV. METHODOLOGY

Observation diary, online questionnaire and group interview were used for data collection. Teacher of the course made notes after every class. In the end of the course, face-to-face group interview and online survey was organized to collect feedback from students. All together 27 questions were asked (see Table 2). The questions were expressed in the form of a Likert scale, with a free text field for additional comments. 15 students (63%) out of 24 answered the questionnaire.

The interval scale with four values (see Table 1) was used for the answers. The neutral answer was left out intentionally to force students to take clearer standpoints. Descriptive statistics was used for data analysis. Arithmetical averages and standard deviations were calculated for every question and for the group of questions (game element).

TABLE I. SCALES FOR THE QUESTIONS AND RESULTS

Options	Value	Min	Max
Yes	4	3.26	4.00
Rather yes	3	2.51	3.25
Rather no	2	1.76	2.50
No	1	1.00	1.75

Later average results were tied with text-based explanations (see Table 1). The range of possible results from 1 to 4 was divided in to four equal segments. When the average score belongs to the range from 4 to 3.26 it means that this game element was successfully implemented and accepted by the students (Yes). If the aggregated result falls in to the range from 3.25 to 2.51 this game element was partly successful (Rather yes). If the result is between 2.5 and 1.76 the game element was not successfully implemented (Rather no). 1.75 to 1 is a bigger failure (No).

During the data analysis quantitative results were enriched with qualitative data collected with the help of open questions from the online questionnaire, with notes from the observation dairy and comments provided during the group interview.

TABLE II. SURVEY RESULTS PER QUESTIONS AND GAME ELEMENTS

Game Elements and Questions	M	SD
Goals	**3.47**	
1. Objectives were clear during the entire course	3.47	0.74
Avatar	**2.30**	
2. Design of a personal avatar was good for the immersion to the course	3.07	0.96
3. Avatar influenced my behaviour on that course	1.53	0.92
Scoreboard and XP	**3.42**	
4. Scoreboard generated the sense of competition	3.53	0.64
5. Scoreboard motivated me to achieve more	3.53	0.64
6. Provided XP's were in balance with the effort needed	3.20	0.56
Luck	**3.23**	
7. Points that I earned depended on luck [inverted scale, yes = 1]	3.13	0.64
8. Points that I earned depended on my knowledge and contribution	3.33	0.49
Collaboration	**2.98**	
9. I felt cooperation between the group members	3.13	0.92
10. Course supported communication between students	3.13	0.74
11. Teamwork was smooth	2.73	1.10
12. Forming teams was justified	3.13	0.99
13. The way how the teams were formed, was suitable	2.73	1.16
14. Presentation of the teamwork results was engaging	3.20	0.94
15 Thanks to the teamwork it was possible to earn points without contribution [inverted scale, yes = 1]	2.77	1.01
Competition	**3.10**	
16. I felt competition between the students	2.67	1.05
4. Scoreboard generated the sense of competition (repeated)	3.53	0.64
Feedback	**3.58**	
17. Feedback to the learning activities was fast enough	3.80	0.41
18. Feedback was rich enough	3.40	0.51
19. The virtual learning environment was easy to use	3.67	0.72
20. I had clear overview about my progress during the entire course	3.47	0.74
Big Boss	**3.87**	
21. Big Boss Fight was a suitable format for the final exam	3.80	0.41
22. Inviting external experts to the Big Boss fight made the challenge more engaging	3.93	0.26
Immersion	**2.55**	
23. Learning activities were engaging	3.20	0.56
24. During the learning activities I forgot about my everyday troubles	2.13	0.64
25. During the learning activities I felt that time is passing faster than usually	2.33	0.90
26. During the learning activities the concern about self disappeared	2.53	0.92
27. During the learning activities I felt emotional connection with the other students	2.53	0.92
Total	**3.09**	

I. RESULTS

In general, the implementation of selected game elements was partly successful. The total rating for the case is 3.09 – rather yes, although the immersion was achieved in lower level (2.55 – rather yes, but close to the average).

A. Goals

Game and course goals are not so different from each other. Based on the total result (3.47 - yes) it seams that the course goals were clearly understood by the students.

B. Avatar

The use of avatar was not causing stronger immersion into the course (total result 2.30 - rather no). Students agreed, that creating an avatar helps them to immerse with the course in some level (average result for the question 3.07 - rather yes) but it did not change their behaviour during the course (average result 1.53 - no). In positive comments, they said it was fun to design a new personality and it also created some humorous situations during the course (e.g., teacher trying to call students with their avatar names). In negative comments they mention that this was not creating additional value to the course. Some felt it to be silly or even embarrassing.

C. Scoreboard

Replacing traditional grades with XP's, levels and a scoreboard was well accepted by the students (total result 3.42 -yes). Students agreed that XP's were in balance with the effort needed for completing the assignments (3.20 - rather yes), scoreboard generated strong sense of competition (3.53 - yes) and motivated them to achieve more (3.53 - yes). Students provided only positive comments like: "We like games and competition" or "It was fun to over score your friends."

D. Luck

Students were satisfied with the level of randomness (total result 3.23 - rather yes). They did not feel that points depended on luck (3.13 – rather no – inversed scale) and they had a feeling that points are related with their knowledge and contribution (3.33 - yes).

E. Collaboration

Although most of the assignments were executed in teamwork, the collaboration was moderate (total result 2.98 - rather yes). In general, students said that the work in teams was rather justified (3.13 - rather yes) but they were not very satisfied with the method how teams were formed (2.73 - rather yes). Students found that this was the main reason why teamwork was not smooth enough (2.73 - rather yes). In positive comments, some students justified this grouping method because it provided equal chances to everybody. Other suggested to form teams based on game ideas, then all team members are interested in the outcomes. According to students' evaluation they did not abuse the teamwork for doing nothing (2.77 - rather no - inversed scale). But, it seams that some of the students were not honest while answering this question. One of the student said: "Maybe students think they are simply smart when they are letting others to do their work, not realizing that the others DO realize that they are abused. The work still needs to be done and someone has to do it."

Students agreed that the design of the course supported collaboration (3.13 - rather yes) and communication (3.13 - rather yes) among them. One mentioned that communication took place mostly inside the teams. She wanted to feel stronger connection with other teams as well. Some students commented that it was difficult to get the group together for team assignments.

Students agreed that teamwork presentations were engaging (3.20 - rather yes). In negative comments they said that more time for preparation was needed (one week was not enough).

F. Competition

Students felt moderate competition during this course (total result 3.10 - rather yes). Because most of the work was organized in teams, the competition between individual students was low (2.67 - rather yes). Students rather appreciated that the format of the game was mostly based on collaboration and not on competition. They did not feel a need for additional competition elements (e.g., quizzes). Only game element that created the sense of competition was the scoreboard (3.53 - yes).

G. Feedback

Students gave high ratings to the quality of feedback during the course (total result 3.58 - yes). For them the feedback was fast (3.80 - yes) and rich (3.40 - yes) enough. The Elgg based VLE was easy to use (3.67 - yes) and thanks to the scoreboard they had always clear overview of their progress (3.47 - yes). In positive comments, they mentioned that personal feedback presented for every group after the team presentations was good enough. Only negative comment was related with the fact that students have to use too many different VLE's (Moodle, Blogs, etc.).

H. Big Boss

Course ended with the exam (big boss). It did not demand a lot of extra work if all course assignments were delivered on time and with sufficient quality but it required some presentation skills and courage. Students were very satisfied with the format of final examination (3.80 yes). Also, the invitation of external experts was very well justified (3.93 - yes) total rating 3.87 - yes. Students gave high value to the questions and comments provided by the experts. The format of the final exam created a serious and challenging atmosphere. Some suggested to organize "small boss" before the big boss to make better presentations. It is true that training how to make good presentations was missing.

I. Immersion

Although most of the game elements were well accepted by the students (except avatar), the immersion to the course was weak (total score 2.55 - rather yes). In general, they found learning activities engaging (3.20 - rather yes) but it did not lead to forgetting everyday troubles (2.13 - rather no). It did not cause the time to pass faster (2.33 - rather no). Loosing the concern about self (2.53 rather yes) and feeling emotional connection with other students (2.53 rather yes) was achieved in low level. The biggest obstacle for the immersion from the students' point of view was the method how teams were formed (teams first ideas later). One student suggested that the reason was the scoring system – when points are given to teams as whole, individuals in the team stop contributing. She recommended to giving points to the teams but letting team managers decide how to distribute them. Some were not satisfied with the duration of the class. They claimed to have a short attention span and 4 hours is too much time to keep focus on the same topic. Finally, the physical environment of the course was not supporting the immersion. Classes took place in a cinema hall. It was nice environment but too big room with too comfortable chairs. This caused the student`s attention drifting away during the presentations and was not supporting the work in teams at all.

II. Discussion and Conclusion

The goal of this article was to find out how to implement game elements in course settings and how students accept them. The game elements like clear goals, scoreboard, luck, feedback and big boss fight were perceived well by the students. To some extent, those findings are similar to previously conducted survey results. For example, different rewarding mechanics e.g., scoreboard, is the most commonly used elements in gamification [4]. The element that got the highest approval from the students was the big boss fight - final exam in the format of presentation in front of experts from the game industry. It is worth to mention that students were also satisfied with the level of luck used during this course. Implementation of randomness was successful thanks to the fact that it was used for smaller learning activities. Users usually prefer to feel that their achievements are based on their skills not on luck [8].

Game elements like collaboration and competition were implemented partly successfully. In general, students agreed that course of game design should be based on teamwork and not based so much on competition but they were not satisfied with the method how the teams were formed. Forming teams on a voluntary basis around the game ideas should be preferred instead of randomly generated groups and finding ideas inside the teams. Because the interaction mode for this course was mostly based on collaboration, the game elements supporting competition can be reorganized. Although scoreboard seemed to be engaging for students it can be replaced with some less competition based rewarding system e.g., badges. Some mechanics should be provided to reduce possibilities to earn points without actual contribution to the teamwork. One method is to provide certain amount of points for the teamwork and team members have to decide how to share them. If the points are shared in equal level, the personal score for every team member is automatically reduced by one point. Another method is to allow sacking group members who do not contribute at all.

Game element "avatar" was not successfully integrated with the course. It was only implemented for creating user profile and using anonymous names in the scoreboard. To give more value to the course, avatar can be integrated with the story of the course or journey of the character development.

For conclusion, the immersion among students was recognized but unfortunately not in very deep level. Mostly it was caused by the fact how the teams were formed – there was no strong emotional connection between team members and between the students and the game idea. Also, the way, how the learning was organized, had an effect. For example, too much time was spent on traditional presentations. Students did not feel the need for stronger gamification in learning activities but they agreed that more innovative approach like flipped classroom [28] (listening lectures at home and doing assignments in the classroom) can be useful. Also, the physical classroom conditions had a negative effect on immersion. It would be worth of trying to design a game world for the course with the help of game aesthetics and interactive story. Creation of imaginary virtual place should have a positive effect on deeper immersion.

For broader conclusions, additional research should be made. For example, how similar gamification approach can be implemented in other subjects and courses. Also, the level of immersion can be measured more exactly with the help of the flow model [29].

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|Ae|: an e-Learning Environment with Multimodal Interaction

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***Abstract*— e-Learning Virtual Environments or Learning Content Management Systems provide tools to support teaching and learning activities by using the infrastructure of the Web to provide its functionality to users. Available on the Web, these environments are susceptible to access by a variety of devices and modalities such as touch and pen, two modalities not available on desktop computers, so the e-learning environments need to support different modes of interaction. Designing a tailored user interface for each device is not a trivial task and results in a high number of code lines that must be maintained, so we propose to apply multimodal interaction in the Ae e-learning environment to build an e-learning environment with multimodal interaction: the |Ae|.**

Keywords- Multimodal Interaction; Usability; Information Systems; e-Learning Environment.

I. Introduction

e-Learning Environments or Learning Management Systems (LMS) provide tools to support teaching and learning activities by using the infrastructure of the Web to provide its functionality to users. Their user interfaces were designed to have good usability using a desktop computer with keyboard and mouse as input devices and a high-resolution medium-size display as output device. By using the Web as a means of access, these environments are susceptible to access by a variety of devices and a variety of modalities such as touch and pen, two modalities not available on desktop computers and so not considered in their design time. Shneiderman [1] describe that "The new computing technologies would include wall-sized displays, palmtop appliances, and tiny jewel-like fingertip computers that change your sensory experiences and ways of thinking". Kugler [2], supported by reports from Gartner Group, describes one of the big challenges for the Information Technology and Communication (ICT) field in the next 25 years are non-tactile and natural interfaces, and automatic translation of speech. This challenge, coupled with the tendency to change the mouse gradually for emerging alternative interfaces for working with facial recognition, motion and gestures brings new challenges to Human-Computer Interaction (HCI).

Designing a tailored user interface for each device is not a trivial task and results in a high number of code lines that must be maintained. Therefore, our group proposes to apply multimodal interaction in an e-learning environment to allow users use the many modalities that the new devices can support instead of developing one user interface for each type of device. In this paper, we present the advances to produce a web-based multimodal interaction e-learning environment, the |Ae|. Our research goal is studying how the desktop hardware shaped the on-line courses and how multimodality can improve the teaching and learning activities.

Section II presents a literature review about multimodality and e-learning environment. Section III presents the adopted methodology and analysis of our findings, and Section IV presents our conclusions and future works.

II. Literature Review

‘Modality’ is the term used to define a mode in which a user´s input or system´s output are expressed. Nigay and Coutaz [3] define modality as an interaction method that an agent can use to reach a goal; a modality can be specified in general terms as “speech” or in more specific terms such as “using microphones”. Several modalities have become research topics in recent decades; among them, we can mention the voice, handwriting recognition, touch, and gestures. Bernsen [4] says that there are no two equal modalities; each of them has its own strengths and weakness.

Bernsen [4] defined systems that use the same mode for input and output as unimodal systems, and multimodal interaction system as a system that uses at least two different modes for input or output. According to Bangalore and Johnston [5], multimodal interfaces enable the user´s input and system´s output to be expressed in the way or in the ways they are better adjusted, given a task, user´s preferences, and physical and social environment characteristics where the interaction is happening. Multimodality can aim to an increase the usability, accessibility, convenience, and flexibility of an application [6]. To Bernsen [4] the main concern about multimodality is to create something new, because “when modalities are combined, we obtain new and emerging properties of representations that could not be considered individually by the modalities”.

Fadel [7] says, “significant increases in learning can be accomplished through the informed use of visual and verbal multimodal learning”. Alseid and Rigas [8] say, “multimodal metaphors may help to alleviate some of the difficulties that e-learning users often encounter”, focusing their studies on usability and learning of e-learning tools. In this research, the authors study the efficiency, effectiveness, and user satisfaction for the e-learning process evaluating two e-learning interfaces version: one interface with text and graphs (visual channel) and another one with sound, facial expressions, text and graphs (auditory and visual channel).

However, the used input device was a mouse (just one modality) on a desktop computer, and the researches did not study the flexibility of devices.

Sankey, Birch, and Gardiner [9] studied multimodal learning environments that allow instructional elements to be presented in more than one sensory mode (visual, aural, written). In this case, just the output multimodality was studied. Despite the many investigations about how multimodality on content and on interaction impacts positively on learning process, no e-learning environment system with input and output multimodality was found in the literature. Online systems that support e-Learning through the Web are called e-learning environment systems or Virtual Learning Environments (VLE) or Learning Management Systems (LMS). An e-learning environment system is an application that uses the Web infrastructure to support teaching and learning activities, designed to support a variety of users and learning contexts. This environment is composed of tools that allow users to create content, communicate with other users, and manage the virtual space, e.g., chat, forums, portfolios, and repositories. Examples of e-Learning environments are Moodle [10], SAKAI [11], and Ae [12].

III. Methodology and Analysis

We adopted the Ae learning environment to develop our work. This environment is developed by the TIDIA-Ae Project (TIDIA-Ae is the acronym for "Tecnologia da Informação para o Desenvolvimento da Internet Avançada – Aprendizado Eletrônico", in English "Information Technology for Development of Advanced Internet – Electronic Learning"). This project was initiated by FAPESP (the State of São Paulo Research Foundation) with the main goal of developing an e-Learning environment that can explore the potential of Advanced Internet and can provide support to different educational context needs. We chose this learning environment due to our experience in its development and the layered component-based software architecture [13] with specific layer for the user interface.

We started our work with a literature review and investigation of the interaction problems that occur when accessing e-learning environments with modalities that have not been considered in the design process, e.g., accessing the learning environment with touchscreen devices [14]. We noticed that some usability problems happen and need to be corrected so users have a better interaction experience using a touchscreen device. One example of identified usability problem occurs when users have to choose a tool in the Ae environment browsing with a touchscreen device like a tablet or smartphone. Because the touched area is usually larger than the area pointed at by a mouse click, the users might have a problem triggering a certain tool; they might select something that is outside the desired selection. This problem is known as the fat finger problem [15]. Due to the several modalities available nowadays and our expertise, we are focusing our research on touch, pen, and gesture modalities.

After the investigation about usability problems, we developed a tool that takes the benefits of pen input modalities and multi-touch: the InkBlog [16], a tool to handwrite or to sketch posts in pen-based devices by adding features to manipulate electronic ink into a blog tool. Figure 1 shows a handwrite resolution using a smartphone with pen-sensitive screen where the user use the recursion tree technique to demonstrate the complexity time of an algorithmic.

We noticed that the system architecture must change to include components to receive data from new modalities and to treat the multimodality, so we proposed an architecture for e-learning environments with multimodal interaction [17]. Besides the client-server architecture model, a Web application can adopt another architecture model to define and structure the client or server components. Usually the e-learning environments have functionalities to manage data about courses and users, so it is necessary to have components for course management, user management, user authentication, and session management. We considered too the W3C Multimodal Architecture [18], Web-Accessible Multimodal Interfaces architecture [19], and the architecture of multimodal systems [6] to define our architecture. So components to treat the multimodality have been added to the environment (input recognizers, fusion and fission machines, output synthesizers and others). In this in-progress research, we are codifying these components related with the multimodal interaction and their connection with the e-learning environment components, to perform tests and study the impact of multimodality over the learning activities. The first implemented component was to treat electronic ink; this component was developed using part of the InkBlog code.

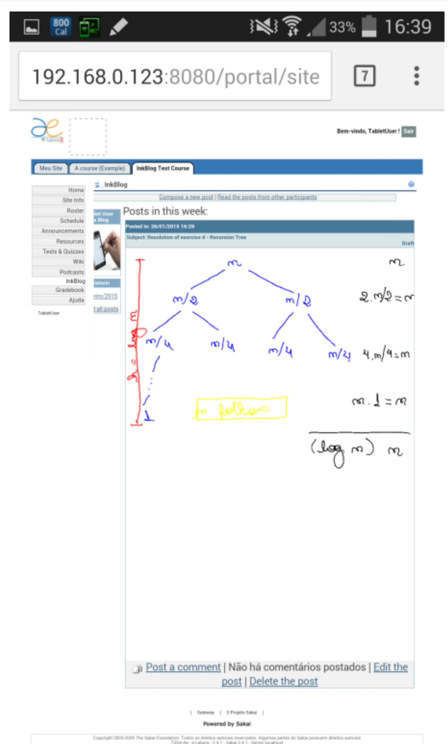

Figure 1. Using InkBlog to handwrite a post using a stylus in a smartphone with pen-sensitive screen and Android version 4.4.2.

After user tests, we developed a second version of the InkBlog tool adding some features to improve the InkBlog to allow users to write messages in touchscreen devices. This changing generated another component that treats input data from touch interactions.

About the identified usability problems due to the modality change, we are applying Responsive Web Design techniques and investigating its limitations. We are facing the following problems: send input data from more than one modality due limitations of Web architecture and actual browsers implementation; dispose available fusion and fission machines on a Web architecture; develop a framework to build easily tools for the environment with multimodal interaction; determine which course characteristics influence a modality and its adoption.

We believe that the modalities (mouse, keyboard, and high-resolution medium-sized screen) shaped the activities done in the environment. Embracing new modalities can delivery other benefit: support a large number of educational contexts. Gay *et al*. [20] suggest that the introduction of wireless computing resources in learning environments can potentially affect the development, maintenance, and transformation of learning communities. We believe that the same can be said about multimodality and when the e-learning environments are employed.

IV. CONCLUSION

Multimodal systems are present in the HCI literature to allow users to interact with more than one mode, supporting multimodality. We believe that multimodal interaction can be a solution for the necessity to allow the environment to be accessed by a variety of modalities, so we are developing an e-learning environment with multimodal interaction called |Ae|. In this paper, we described how we are developing this e-learning environment. We noticed that the impact of multimodality can go besides enabling access for various peripherals interaction and may emerge new functionalities that support the production of content that were difficult before, or impossible, in the environments. We perceived the needs in changing the architecture to treat multimodality and in the user interface to get a better usability in devices with modalities not considered in the design process. Supporting new modalities allows having new tools in the environments, perhaps affecting the learning activities. We want to analyze these on future works.

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