Giovanni Vincenti
Alberto Bucciero
Markus Helfert
Matthias Glowatz (Eds.)

LNICST 180

E-Learning, E-Education, and Online Training

Third International Conference, eLEOT 2016
Dublin, Ireland, August 31 – September 2, 2016
Revised Selected Papers

ICST
Springer

Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering 180

More information about this series at http://www.springer.com/series/8197

Giovanni Vincenti · Alberto Bucciero
Markus Helfert · Matthias Glowatz (Eds.)

E-Learning, E-Education, and Online Training

Third International Conference, eLEOT 2016
Dublin, Ireland, August 31 – September 2, 2016
Revised Selected Papers

Springer

Editors
Giovanni Vincenti
University of Baltimore
Baltimore, MD
USA

Alberto Bucciero
Italian National Research Council
Rome
Italy

Markus Helfert
Dublin City University
Dublin
Ireland

Matthias Glowatz
University College Dublin
Dublin
Ireland

ISSN 1867-8211 ISSN 1867-822X (electronic)
Lecture Notes of the Institute for Computer Sciences, Social Informatics
and Telecommunications Engineering
ISBN 978-3-319-49624-5 ISBN 978-3-319-49625-2 (eBook)
DOI 10.1007/978-3-319-49625-2

Library of Congress Control Number: 2016958836

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

We are proud to present the proceedings of eLEOT 2016, the Third International Conference on e-Learning, e-Education and Online Training! eLEOT 2016 was held from August 31 to September 2 at University College Dublin, in the beautiful city of Dublin, Ireland.

The main theme for this year's eLEOT conference was "Engaging the Students." We received 35 submissions, which resulted in 25 papers being presented and the conference. This year's edition also featured a workshop that focused on education, video games, and virtual reality. One key feature of eLEOT was the Demo Session, where our presenters showcase their projects and let other participants "test drive" their projects. We are also proud supporters of students, who present their work alongside our more seasoned presenters. Finally, we also featured a series of online presentations for all those who were not able to join us in person.

Kevin O'Rourke offered the keynote address to eLEOT 2016. He is currently on secondment to Ireland's National Forum for the Enhancement of Teaching and Learning where he is leading a review of infrastructure for digital learning across Ireland's higher-education sector. When he is not working in the national leagues, he directs eLearning Support and Development with the Dublin Institute of Technology's Learning, Teaching and Technology Centre. We were also honored to feature Stefano Santo Sabato as our Tech-Talk speaker once again. He is the founder and CTO of MediaSoft, S.r.l., one of Italy's premier private endeavors in bridging the gap between industry and academia in the area of distance education. The brilliant work that Stefano and his group produce daily was showcased in part during his presentation.

All of this would not have been possible without the Technical Program Committee, chaired by Alberto Bucciero. He successfully assisted 54 exceptional members of the committee who powered this conference from four different continents, representing both academia and industry. The Organizing Committee is grateful to each member of the Technical Program Committee, and I am grateful to each member of the Organizing Committee for their tireless support. This year's conference was made possible by the professional and tireless work of Matt Glowatz, Markus Helfert, Marco Zappatore, Aleksas Mamkaitis, and John O'Connor. I would like to also thank the European Alliance for Innovation (EAI) as our primary sponsor. The enduring support of Sinziana, Jana, Ivana, and Lenka has been invaluable and essential for the organization of this year's event. And dulcis in fundo (the best for last) I would like to thank all the presenters, who are the true protagonists of eLEOT 2016.

October 2016 Giovanni Vincenti

Organization

Steering Committee

Imrich Chlamtac	Create-Net and University of Trento, Trento, Italy
Giovanni Vincenti	University of Baltimore, Baltimore, MD, USA

Organizing Committee

Giovanni Vincenti	University of Baltimore, Baltimore, MD, USA
Alberto Bucciero	Italian National Research Council (CNR), Rome, Italy
Markus Helfert	Dublin City University, Dublin, Ireland
Marco Zappatore	University of Salento, Lecce, Italy
Matt Glowatz	University College Dublin, Dublin, Ireland
John O’Connor	Dublin Institute of Technology, Dublin, Ireland
Lenka Koczová	EAI, European Alliance for Innovation, Bratislava, Slovak Republic

Contents

General Track

Online Track

Student Track

General Track

A Social Metric Approach to E-Learning Evaluation in Education

Adriana Caione, Anna Lisa Guido, Roberto Paiano,
Andrea Pandurino(✉), and Stefania Pasanisi

Department of Engineering for Innovation,
Via Per Monteroni, 73100 Lecce, Italy
{adriana.caione,annalisa.guido,roberto.paiano,
andrea.pandurino,stefania.pasanisi}@unisalento.it

Abstract. The use of e-learning in education is an ever-increasing practice. E-learning could generate effective learning for education. There are several factors affecting the creation of successful e-learning for education as well as several criteria possibly applied to evaluate the effectiveness. The "traditional" way (questionnaire, interview, information system analysis) to measure effectiveness is not enough in e-learning measure of effectiveness because part of the information, that coming from social networks, will be lost. This paper, after identifying the Critical Success Factors (CSFs) of a synchronous e-learning system, and identifying the Key Performance Indicators (KPIs), proposes an approach for evaluation based on the analysis of information derived from social aspects. The paper proposes a set of CSFs and KPIs to study the students' perception and highlights how to measure the KPIs using social software information.

Keywords: E-learning · Critical success factors · Key performance indicators · Information extraction · Sentiment analysis · Social media

1 Introduction

With the advance of information and communication technologies, e-learning has spread like a new modern educational paradigm.

One problem in the e-learning scenario is defining a useful method to evaluate an e-learning course. In effect, compared to the traditional teaching systems, in e-learning systems there are other aspects related to the use of technology and multimedia systems. An e-learning approach becomes sustainable when the use of computers in particular, and ICT in general, it can provide real added value to teaching, added value that could not be achieved with traditional tools and approaches. One of the major problem of distance learning compared to traditional training is the apparent lack of teacher who becomes a matter to be assessed for the effectiveness of e-learning systems.

The evaluation of education systems can be seen as a process in which one tries to indicate whether the learning experiences with educational software are effective [1]. It is very difficult to define good e-learning: a definition of good e-learning is in [2], where authors affirm that e-learning is "good" if it provides the right people with the right skills at a reasonable cost in a timely manner.

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 3–11, 2017.
DOI: 10.1007/978-3-319-49625-2_1

It is possible to evaluate an e-learning course using the "traditional" approach based on information systems evaluation and other systems (e.g., questionnaires or tests). This approach, very useful to evaluate a business process in a company, may not to be sufficient in the e-learning field. With the advent of web 2.0 people express their opinion using typical web 2.0 tools, such as social networks and wiki. In [3] a survey and an analysis of the use of social software in education is proposed. The paper summarizes the characteristics and the existing problems of the educational application of various social software: the authors identify 438 articles as samples of the content analysis (Chine Journal FullText Database 2003–2008), which use blogs (335 items), wikis (51), social software (21), podcasts (20), and instant messaging (11) in education. Application areas include matters of most concern in teaching and professional development of the teacher, then knowledge management, web-based learning and other fields.

It is clear that a "simple" evaluation of e-learning courses using a traditional approach is not enough and the necessity to use data collected from the "social tools" (blog, wiki and so on) should be explored. In order to develop a systematic approach to the use of data derived from social software for e-learning evaluation, it is appropriate to adopt the Critical Success Factor (CSF) /Key Performance Indicator (KPI) analysis and apply it to this new source of data.

In this paper, we deepen the work described in [4] in which the authors describe a first step towards the evaluation of e-learning projects based on the learners' discussions on social web pages.

Our idea is based on the identification of the CSFs and the KPIs in an education course scenario of synchronous e-learning. We define the social metrics for measuring the KPIs assessed with this social approach.

The use of a social approach is important as it allows us to capture the real perception that the student has with respect to an e-learning course: through a blog the student expresses his or her thoughts spontaneously. Spontaneity is difficult to catch with the classical methods. For example, the questionnaires are one way of gathering information from an e-learning system, but there are some problems with their usage, such as reluctance to answer questions, as well as guessing and the answer being time consuming.

In this paper we propose also an idea to automatically measure the defined KPIs through the analysis of the information extracted from the learners' opinions posted on some social web pages related to an e-learning course. To this end, it is possible to use the software platform, the architecture of which is described in [4], after an upgrade and a customization of the platform itself for the e-learning scenario. This software platform has already been used, with remarkable results, in different agrifood contexts (e.g., wine, olive oil). For the purpose of this work, the KPI evaluation is facilitated by a new introduced feature of the software platform that is, the ability to identify any positive, negative or neutral level of sentiment expressed by the learners in their discussions.

Section 2 describes the related work regarding the approaches and the assessment methodologies defined in the literature. Section 3 illustrates the methodology we propose and Sect. 4 illustrates an idea to measure the defined KPIs using a software platform for relevant information extraction and sentiment analysis. Finally, in Sect. 5, we draw some conclusions and discuss future work.

2 Related Work

The works discussed in this paper are related to three main aspects analysed for this paper: the study of Critical Success Factors in the e-learning systems; the study of Key Performance Indicators in the e-learning systems and the study of Sentiment Analysis, which is a very important aspect to understand the students' perception.

Critical Success Factors (CSFs) in e-Learning Systems. The concept of CSFs was defined in [5] as "those things that must be done if a company is to be successful". The method of CSFs, developed by Rockart (1979), is a simple and inexpensive but successful method for choosing, generally, priority information. The CSFs can be defined, according to Rockart, as those few crucial areas where the company has to perfectly work to succeed in business. The CSFs are, therefore, areas of excellence [7]. It is possible to apply the idea of CSFs to the e-learning area.

In our previous work [4] we have widely described the concept of CSFs in e-learning systems. Since that work, we have further investigated CSFs in e-learning, looking to the more recent literature, with the aim to identify CSFs for the evaluation of e-learning systems and the KPIs to measure such factors.

In [8], the authors show that online courses are defined as having at least 80 % of the course content delivered online, typically with little or no face-to-face learning (e.g., course management system (CMS), video conferences).

In [9], e-learning CSFs within a university environment have been grouped into four categories: (1) Information Technology (IT) (2) instructor (IT competency; teaching style; attitude and mindset); (3) student; (4) university support. In [10] are summarized the four key factors affecting the successful creation of an e-learning model for higher education: (1) human deliberation, which could be considered as "the processes undertaken by people which referred as people"; (2) instructional design, which is the practice of maximizing the effectiveness, efficiency and appeal of instruction and other learning experiences; (3) development of technology; (4) social delivery, which includes some items for measuring the success of e-learning, such as student participation, course content, course structure, financial support, cultural support, learning content and language support.

For the evaluation of these factors there were four major criteria applied to evaluate the performance of any operation. These are: (a) cost efficiency – one important part of the e-learning value was the sum of an ability to save money and how much benefit is generated to the business; (b) quality – there are four levels of quality, including reaction, learning, performance, and results; (c) service – in terms of easy accessibility and the quality of access; (d) speed – how quickly an e-learning initiative is up and running, how quickly the e-learning initiative reaches everyone who needs the content, and how fast the e-learning initiative can be altered due to a change in the business or the need to distribute new or revised information.

Key Performance Indicators (KPIs) in e-Learning Systems. KPIs are a set of indicators that measure the efficiency performance, level of service and quality of business processes [7]. The KPI approach is a flexible and popular approach to conducting performance measurement in organizations. KPIs can be used to assess almost any aspect of work performance, whether financial or non-financial, depending on the individual organization's design. KPIs give a clear picture for each individual in an organization, what is important for them and what they need to do [11].

In [12] are identified the following KPIs for e-learning: (1) effectiveness – the contribution of e-learning (object/program) to the degree of goal reaching; (2) costs (including project costs); (3) satisfaction – e-learning satisfaction (ELS), reaction and satisfaction; (4) effects on business processes; (5) cost–benefit ratio; (6) efficiency – tracking economic effort regarding the e-learning program; (7) material to stimulate lively and interactive learning processes; (8) project progress; (9) learning outcome. In [13] are defined the KPIs for e-learning systems, among which are: employee development, cost-benefit, performance improvement, knowledge gained, trainer performance, courseware performance, environment satisfaction.

Sentiment Analysis. In unstructured document analysis, the sentiment represents the attitude expressed towards something (e.g., a product, a person). It can be positive, negative or neutral and it requires highly complex algorithms in order to be computed by software systems. Research in the field of Sentiment Analysis, currently, shows a new emphasis, as demonstrated by the numerous works published in the last decade. To name but a few, in [14], the authors presented an overview of the techniques used for opinion and attitude detection within text documents. In [15] the authors focused on reviews of films. They ran experiments in Opinion Mining using Machine Learning techniques. In [16], the authors give the basis for the classification of text documents. Even space-time is an important factor in the process of Opinion Mining. In [17], the authors attempt to determine the political orientation of the users [18], through the analysis of the user opinion expressed by Tweets. They used supervised learning algorithms associated with the detection of emoticons.

In e-learning, Sentiment Analysis could be useful in terms of understanding the learners' perception about an e-learning course. The limitation of this technique is that it works well with text in English but not with text written in other languages.

3 Definition of the E-Learning CSFs and KPIs to Understand Student Perceptions

According to the studies reviewed in the 'related work' section, the e-learning CSFs can be grouped into five categories described in Step 1 of the methodology below. For the identification of KPIs in an e-learning education course scenario, we refer to the literature and, in addition, to a simplified approach to the identification of KPIs that is proposed through the use of the indicator triangle method [7]. The method proceeds by identifying the "Resources Committed" in the system, the volumes of input and output, and the KPIs subdivided in three categories: service, quality and efficiency. After defining the KPIs, we select the KPIs that can be measured with social metrics and we define the social metrics for measuring those KPIs. As we show in Fig. 1, we propose as metrics for KPI measuring some examples of keywords, which map the information extracted by our system. The keywords are labelled in the following categories: neutral, positive and negative for identify the sentiment or the mood of users' comments.

Some KPIs are evaluable through statistical parameters extractable by blog. In Fig. 1 the column "type metric" identifies three type of measure: Classic Metric (CM), Social Metric (SM), Statistical Parameters (SP) for each KPI. Below, the steps for the identification of CSFs and KPIs for an e-learning system.

KPIs	Type Metric	Keywords or measure for social metrics
SERVICE		
KPI 1: ease of service accessibility		
a. access time	CM	
b. number of click/link	CM	
QUALITY		
KPI 2: quality of service accessibility		
a. user friendly interface	SM	*Neutral:* Interface, GUI. *Positive:* user-friendly, intuitive, ease to use, well designed. *Negative:* bad designed, complicated,difficult.
b. web 2.0 technology	CM	
c. use of secure protocols	CM	
d. cross-platform capability	CM	
KPI 3: Use of multimedia services		
a. use of audio and video plug-ins	CM	
b. use of videoconferencing	CM	
c. use of blog or forum for sharing and comparing	CM	
KPI 4: Quality of education		
a. dropout rate	SP	time analysis of user comments and counting of user comments for each user
b. student academic grades	CM	
c. improves speed of acquiring new knowledge and skill	SM	*Neutral:* knowledge, skill. *Positive:* new,quickly, improev. *Negative:* worsen, slowly.
d. improved learning efficiency	SM	*Neutral:* learning,efficiency, ability. *Positive:* improve, increase, enhance. *Negative:* worsen, reduce , decrease.
e. student/teacher ratio	CM	
f. number of requests for additional courses	CM	
g. course content currency (courses up-to-date)	SM	*Neutral:* course, content. *Positive:* uptodate. *Negative:* outdate.
h. learning tracks are clearly defined	SM	*Neutral*: learning tracks. *Positive:* clearly,comprehensibly,plainly, with clarity. *Negative:* undefined,unspecified, unexplained, unclear, imprecise, inexact, indefinite, vague.
i. presence of detailed syllabus and prerequisites for all courses	SM	*Neutral:* syllabus, prerequisites. *Positive:* well defined, comprehensibly, detaleid, plainly. *Negative:* undefined, unspecified, unexplained, unclear, imprecise, inexact, indefinite, vague.
j. availability and quality of electronic reference library	SM	*Neutral:* electronic library. *Positive*: availability, high quality, best quality, good quality, better quality, top quality. *Negative:* low quality, unavailable, not available.
EFFICIENCY		
Teacher:		
KPI 5: Promotes student learning	SM	*Neutral:* learning, teacher, student. *Positive:* promotes, encourage, assist, aid, help, contribute to, stimulate, work for; *Negative*: not stimulate, not aid, not encourage.
KPI 6: Uses rigorous instructional strategies (e.g. modeling, demonstrating, think-alouds, etc.)	SM	*Neutral:* instructional strategies. *Positive*: rigorous, accurate, new, good, top. *Negative*: bad, inaccurate.
KPI 7: level of technical competence	SM	*Neutral:* level-technical competence. *Positive:* competent, high level, best level, good level, top level, expert. *Negative:* low level, bad level, incompetent.
Student:		
KPI 8: level of student satisfaction	SM	*Neutral:* student, satisfaction, level. *Positive:* very satisfied, enthusiast. *Negative* :less satisfied, unsatisfied.
KPI 9: how many person in total have taken advantage of the e-learning offer?	SP	Counting user positive comments on specific KPIs
KPI 10: courses keep learner's attention	SM	*Neutral:* learner, student, attention. *Positive:* high attention. *Negative:* low attention.
KPI 11: level of interactivity and feedback	SM	*Neutral:* level, interactivity, feedback. *Positive:* high level, best level, good level, top level. *Negative:* low level, bad level.
KPI 12: level of collaboration and motivation to study	SM	*Neutral:* level-collaboration-motivation. *Positive:*high level, best level, good level, top level. *Negative:low level, bad level.*
KPI 13: level of technical competence	SM	*Neutral:* level, technical competence. *Positive:* competent,high level, best level, good level, top level, expert. *Negative:* low level, bad level, incompetent.
Technology Infrastructure:		
KPI 14: ease of course navigation	SM	*Neutral:* course navigation. *Positive:* ease, effortless, simple, uncomplicated, straightforward, fluent. *Negative:* difficult, arduous, laborious.
KPI 15: ease of course accessibility	SM	*Neutral:* course accessibility. *Positive:* ease, effortless, simple, uncomplicated, straightforward, fluent. *Negative:* difficult, arduous, laborious.
KPI 16: ease of course avalaibility	SM	*Neutral:* course avalaibility. *Positive:* ease, effortless, simple, uncomplicated, straightforward, fluent. *Negative:* difficult, arduous, laborious.

Fig. 1. KPIs and social metrics

Step 1: Identification of the areas of CSFs and analysis of the CSF elements: The e-learning CSFs can be grouped in the following categories:

Information Technology. Technology plays important roles in delivering learning outcomes. The efficient and effective use of Information Technology in delivering e-learning based components of a course is of critical importance to the success and student acceptance of e-learning. IT tools include network bandwidth, network security, network accessibility, Internet availability, Cross-platform capability, Web 2.0 software, audio and video plug-ins, videoconferencing, course management systems, and user interface.

Human Factor. In [19] is explained that the key main factor effecting to create e-learning model for higher education was human factor in terms of technical competency, e-learning mindset and level of collaboration of both instructor and student. In addition, the characteristics of Instructor and Student are defined: technical competence; teaching style; interaction in class. Reference [6] suggested that instructors should adopt interactive teaching style, encourage student-student interaction. It is so important that instructors have good control over IT and is capable of performing basic troubleshooting tasks. The Students' characteristics includes technical competence, student readiness to move online, student participation to study, perception of content and system, collaboration and interaction, motivation.

Instructional Design. In [10] Instructional Design is described as the practice of maximizing the effectiveness, efficiency and appeal of instruction and other learning experiences. It includes the following elements: clarify of objectives, content quality, learning strategies, psychology of learning [8]. Well-designed and selected courses content and learning material facilitate meaningful educational experiences that are essential for implementation of online learning materials.

Cost Effectiveness. One important part of the e-learning value was the sum of an ability to save money (enhance skill and knowledge, improve job performance, and impact results) [10]. Cost Problems include budget to invest in the course, long-term sustainability, necessity of institutions to reduce costs.

Course Evaluation. The effective assessment of e-learning is to evaluate and measure benefits resulting from e-learning implementation. Evaluation process must cover all aspects the online course, to ensure that e-learning systems achieve the objectives of the course. There were four levels of quality, included reaction (typical end-of-course evaluation or rating sheet); learning (evaluation simply as tracking strategy), performance (determination of the effectiveness) and results (often couched in a demand to prove that e-learning works and works better than others) [10].

Step 2: Identification of KPIs: Following the indicator triangle method [7] we identify the resources involved in an e-learning system: Teachers, Students and Technological Infrastructure. The input volumes are the contents to be dispensed while output volumes are the knowledge acquired by students. In Fig. 1, we classify the KPIs in service, quality and efficiency.

Step 3: Selection of KPIs that can be measured with a social metrics: Starting from the set of KPIs identified, we select those that can be assessed through a social metric using the system that we have developed. This analysis is shown in the Fig. 1.

Step 4: Definition of social metrics for measuring KPIs: In Fig. 1 we define the social metric for the KPIs that can be assessed with a social metric approach. To define the social metric we have proceeded in this way: for every KPI measurable with social metric we have analyzed the words that make up the indicator, researching the possible keywords that can be used in a human dialogue to qualify (in positive or negative) the aspects that this indicator describes. We have researched the possible synonyms of the keywords identified to try to have an exhaustive list of words that can be used in spoken language.

The keywords are then labeled in the following categories: neutral, positive and negative to identify the sentiment or the mood of users' comments in the blog.

4 How to Measure the Defined KPIs

In order to measure, with the social metric, the KPIs defined in the previous section, our idea is to analyse the learners' posts published on the social web pages related to an e-learning education course. To achieve this goal, we will use the software platform described in [4]. This platform has been improved through the use of the new version of the third-party AlchemyAPI (www.alchemyapi.com) APIs. This upgrade has led to a far clearer output in terms of significant extracted keywords beyond the ability to compute the level of the sentiment, that is the connotation positive, negative or neutral of each extracted keyword.

To evaluate the sentiment level, AlchemyAPI incorporates both linguistic and statistical analysis techniques. The first one uses a grammatical approach to understand how words combine into phrases, and how phrases combine into sentences. This technique works well with formal texts. The statistical analysis uses a mathematical approach and it is well suited with user-generated content. The combination of these techniques provides a greater accuracy in the sentiment evaluation of the information extracted from the social media.

In order to employ the software platform in the analysis of the learners' perception of an e-learning course, the platform itself must be adapted to the e-learning context. To do that an ontology will be designed in order to model the e-learning domain. This means that it will contain the previously defined e-learning CSFs (information technology, human factor, etc.), KPIs (user friendly interface, improved learning efficiency, etc.) and keywords for social metric (user-friendly, intuitive, efficiency, decrease, etc.). So, the final ontology not only will describe the domain but it will permit the measurement of the KPIs through the analysis of the information retrieved from the learners' opinions posted on the social web pages. To be more precise, the output of the software platform is a tag cloud in which the extracted keywords are represented with different font sizes proportional to the number of occurrences in the text along with different colours that suggest the sentiment level (green for positive sentiment and red for negative one). In addition to this representation, a table form is useful to show the user detailed information about a keyword selected from the tag cloud. They are the keyword number of occurrence in the text, the keyword sentiment level, the social web pages in which the selected keyword appears with the indication of the other keywords found in the same web pages. Furthermore, those keywords will be automatically mapped, if possible, with those contained in the e-learning ontology. In this way it would be possible to characterize the social metric of the KPIs and, as a consequence, to better understand what learners say about an e-learning education course.

5 Conclusions and Future Works

In the e-learning scenario, it is a good practice to define a method for the evaluation of the effectiveness of an e-learning project along with the achievement of the goals in order to better understand the learners' point of view.

In this paper we propose an approach for the evaluation of an e-learning project in the education based on social metrics. It consists of the identification of the CSFs and the KPIs for an e-learning project and the definition of the social metrics in order to measure those KPIs to which a social approach can be applied.

The paper also proposes an approach that seen the employ, the customization with the design and the development of an e-learning ontology along with the upgrade, in terms of APIs, of the system platform described in [4] which is useful in implementing the idea; in effect it can analyse and extract relevant keywords from the users' experiences posted on social web pages and can compute the sentiment level of each retrieved information. These keywords will be then mapped, in the e-learning ontology, with those defined and associated with the relative KPI social metric in order to characterize the KPIs from a quantitative (number of occurrences in text) and qualitative (sentiment level computed) point of view. As a result, the proposed approach could support the e-learning domain expert in identifying the strengths and the weaknesses of e-learning projects. As future developments, we will work on a real use case in the education field: for the evaluation of the approach, it was considered a group of students (about eighty students) of the "Information Systems" course of the Master degree in Business Administration of Faculty of Economics. The students use a social platform available on the intranet of the University in order to insert comments about the course. Then we will analyse these statements to evaluate the proposed approach. We will analyse the goodness of the KPIs we have defined, the software platform developed and we will provide qualitative considerations about the KPIs themselves.

References

1. Kelly, G.: A collaborative process for evaluating new educational technologies. Campus-Wide Inf. Syst. **25**(2), 105–113 (2008)
2. Dust, B.: The eLearning Guild's Online Forums – Elearning Metrics That Work (2007). http://www.elearningguild.com/olf/olfarchives/index.cfm?id=356&action=viewonly
3. Haiyan, Z., Huanjing, W.: Survey and analysis of the use of social software in education. In: 2010 International Conference on E-Health Networking Digital Ecosystems and Technologies (2010)
4. Paiano R., Caione A., Guido A.L., Pandurino A., Pasanisi S.: E-learning project assessment: A new approach through the analysis of learners' posts on social media. EAI Endorsed Transactions on e-Learning (in press)
5. Freund, Y.P.: Critical success factors. Plann. Rev. **16**(4), 20–23 (1988)
6. Volery, T., Lord, D.: Critical success factors in online education. Int. J. Educ. Manage. **14** (5), 216–223 (2000)
7. Bracchi, G., Francalanci, C., Motta, G.: Sistemi informativi aziendali in rete. McGraw-Hill, Milano (2001)

8. Cheawjindakarn, B., Suwannatthachote, P., Theeraroungchaisri, A.: Critical success factors for online distance learning in higher education: A review of the literature. Creative Educ. **3** (08), 61 (2013)
9. Slim, H.M.: E-learning critical success factors: an exploratory investigation of student perceptions. Int. J. Technol. Mark. **2**(2), 157–182 (2007)
10. Prougestaporn, P., Visansakon, T., Saowapakpongchai, K.: Key success factors and evaluation criterias of e-learning websites for higher education. Int. J. Inf. Educ. Technol. **5** (3), 233 (2015)
11. Slizyte, A., Bakanauskiene, I.: Designing performance measurement system in organization. Organizacijø Vadyba: Sisteminiai Tyrimai, pp 135–148 (2007)
12. Hilgarth, B.: E-Learning success in action! From case study research to the creation of the cybernetic e-learning management model. e-Learning 2004, 1–2 (2009)
13. The eLearning Guild's Online Forums – Strategies for Measuring the Value of e-Learning (2005). http://www.elearningguild.com/handouts/378_h1.pdf
14. Ravi, K., Ravi, V.: A survey on opinion mining and sentiment analysis: tasks, approaches and applications. Knowl.-Based Syst. **89**, 14–46 (2015)
15. Pang, B., Lee, L., Vaithyanathan, S.: Thumbs up?: sentiment classification using machine learning techniques. In: Proceedings of the ACL-02 Conference on Empirical Methods in Natural Language Processing, vol. 10, pp. 79–86. Association for Computational Linguistics (2002)
16. Liu, B.: Sentiment analysis and subjectivity. Handb. Nat. Lang. Process. **2**, 627–666 (2010)
17. Maynard, D., Funk, A.: Automatic detection of political opinions in tweets. In: García-Castro, R., Fensel, D., Antoniou, G. (eds.) ESWC 2011. LNCS, vol. 7117, pp. 88–99. Springer, Heidelberg (2012). doi:10.1007/978-3-642-25953-1_8
18. Go, A., Bhayani, R., Huang, L.: Twitter sentiment classification using distant supervision. CS224 N Project Report, Stanford, pp. 1–12 (2009)
19. Soong, M.B., Chan, H.C., Chua, B.C., Loh, K.F.: Critical success factors for on-line course resources. Comput. Educ. **36**(2), 101–120 (2001)

A Technique for Applying RLCP-Compatible Labs on Open edX Platform

E.A. Efimchik(✉), D.A. Ivaniushin, D.S. Kopylov, and A.V. Lyamin

ITMO University, Kronverkskiy pr. 49, Saint Petersburg 197101, Russia
{efimichick, d.ivanyushin, dima}@cde.ifmo.ru,
lyamin@mail.ifmo.ru

Abstract. The paper describes an approach of implementing interaction between Open edX platform and AcademicNT LMS that is used as an external assessment tool. AcademicNT provides Open edX with additional features, such as support of RLCP-Compatible Labs. Features of RLCP-Compatible Labs and an example of such lab are given. Structure of courses in Open edX platform and corresponding structure of AcademicNT supportive course are described, as well as interaction scheme. Described approach allowed reusing content of AcademicNT in courses on Open edX platform, in particular National Platform of Open Education of Russian Federation (openedu.ru) and ITMOcourses (courses.ifmo.ru). This paper may be of interest to those who is going to develop project based on Open edX or course compatible with this platform.

Keywords: MOOC · Interactive practical exercise · Virtual laboratory · RLCP-Compatible labs · National Platform of Open Education of Russian Federation · Open edX

1 Introduction

Massive Open Online Courses (MOOCs) are trending in both e-learning and traditional learning nowadays. Approaches being a base of MOOC s are used in traditional learning for blended education, which allows engaging students and increasing their learning outcomes.

The most popular open education platforms are Coursera, edX, Khan Academy and Udacity. The majority of courses published on edX platform created by MIT and Harvard University is related to technics. In June, 2013 the platform's source code was published on Github and everyone got an opportunity to deploy one's own edX platform instance and create his own courses. Being open-sources the platform was named Open edX.

New updates for the platform are being published regularly, despite its development is held in private. In October 2014, the first named release Aspen was announced. By spring 2016 there are four named stable releases already. Moving to named releases development model tells that edX is highly interested in the successful future of the platform.

Named releases allow community to use latest and stable the platforms codebase. The Open edX platform is complex system, which uses such technologies as: Python,

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 12–18, 2017.
DOI: 10.1007/978-3-319-49625-2_2

Django, Mako, Sass, Javascript, CoffeeScript, JQuery, Underscore, Celery, RabbitMQ, MongoDB, MySQL, Ansible, Paver. The platform has formed big and active community of developers, which the platform developers stay in touch with. Some of third-party developed features are merged into the original codebase and become publically available. Those features can be UI-improvements, new content types, and others.

ITMO University has wide experience in applying IT to education process [2–4], and has been developing its own learning management system AcademicNT which is used to support education process of on-campus students. This LMS can also be connected to other systems. Its key feature is support of variety of pedagogical tests, lecture papers, virtual laboratories, and other content types.

ITMO University has been working on MOOCs since 2012 using experience of creating AcademicNT courses. ITMO University had need of new technologic platform to publish courses besides just content. Oped edX became such platform as soon as being released. Not all the features ITMO University needed were implemented in Open edX platform at first, so the university jumped into development of new features, and some of them are course catalogue, UI improvements, connection with ITMO authentication provider, and others.

AcademicNT has a lot of content, so there was no need in creating new items of some kind, for example, tests, while creating courses for Open edX, as those ones in AcademicNT could be used in Open edX. The issue of connecting AcademicNT and Open edX was stated and latter solved. It also stores RLCP-compatible virtual labs, which are unique elements that can be used in course content.

ITMO University was not the only one in Russia, who started to use Open edX for MOOCs. National Platform of Open Education (NPOED) – association of 8 leading universities in Russia, was created in 2015 to combine efforts to develop MOOC-platform and create new courses. The platform required to include such modules as learning management system (LMS), content management system (CMS), single sign on authentication provider, billing system, catalogue system, individual education tracks, analytics system. As for LMS and CMS, the Open edX was taken as a base system, but the rest of required components were developed from scratch.

2 RLCP-Compatible Labs as Assessment Tools for Online Courses

Using practical assignments in MOOCs, and especially assessing them, usually requires great efforts. RLCP-Compatible Labs is one of the tools for that. RLCP-compatible labs provide such features as automated variant generation and solution evaluation, which all allows easy scaling usage of these labs.

RLCP-compatible labs [5] are used in online courses for forming and measuring skills of solving algorithmic tasks, which require appliance of well-known algorithms with strictly defined steps.

Algorithmic tasks allow checking solutions step by step, splitting student's solution into pieces, and comparing each piece with the ones made with the reference algorithm. This makes possible to point out a step, where student made a mistake, and give a feedback message with corresponding grade. Using such tasks requires control over variants and theirs difficulties. This issue is solved by special algorithms of creating predefined difficulty level variants. As an example let's consider virtual lab created for course "Linear Circuits" (Fig. 1), where student have to perform modeling of transient process in electrical circuit and take measures of an oscillograph. As student change switches states or oscillograph control elements, these parameters are sent to virtual lab server with use of Calculate method, and new Y-coordinates for the oscillograph curve are given back. As student finds out correct parameters (as he supposes), student writes them down in the corresponding fields in virtual stand and presses "Check" button. These parameters are sent as solution to virtual lab server and the solution is evaluated via Check method, and the grade is assigned.

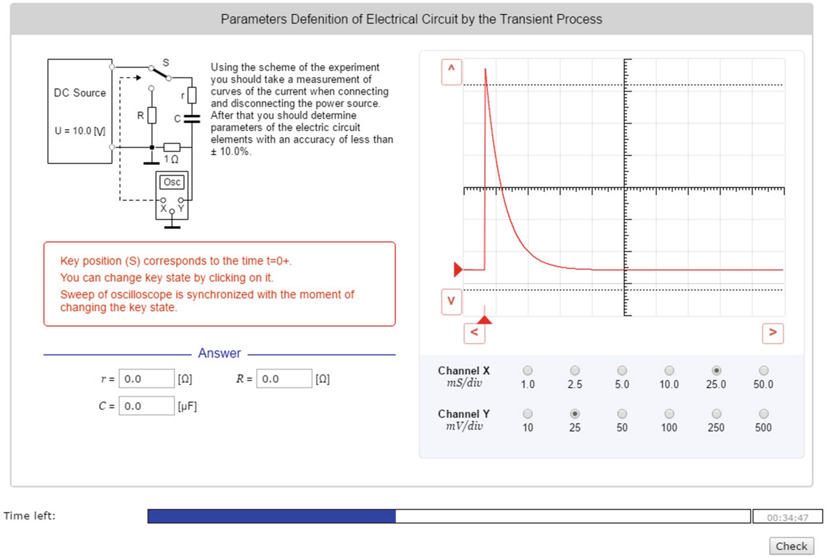


Fig. 1. Example of virtual lab stand

RLCP-compatible Lab consists of two independent modules: virtual stand and RLCP-server. The virtual stand is responsible for visualizing the variant data and providing tools for compose and editing mediate solutions [6, 7]. RLCP-server supports interactions via RLCP-protocol and provides responses on several types of requests: creating new variant, performing intermediate calculations, and evaluating solution. To perform secure interaction, these two modules have no information on each other, and exchange messages via special environment, which controls over the students' task solving process. There are more details on the workflow in future papers.

3 AcademicNT as External Assessment Tool for Open edX

RLCP-compatible labs require special environment to be run in to provide such features as automated variant generation and step-by-step student solution evaluation, as such environment provide event system to perform these actions. Neither Open edX nor all platforms based on it, such as NPOED and ITMOcourses, have no embedded RLCP-compatible labs control environment, so all RLCP-compatible labs used in online courses are hosted in AcademicNT, which support those requirements and can be used as external service for carrying out assessment evaluation. Further a way of implementing an interconnection between AcademicNT and Open edX platform to use RLCP-compatible labs using seamless session is described.

AcademicNT stores data in XML-based format named AcademicRM. Virtual stands are described by LabTool element, which stores stand's display name, URIs to lab's data files. Element Frame describes task and consists of task display name, its description, pointer to virtual stand and date required to form lab's variant. Frame elements are attached to Script elements. Script element also contains display name and description of lab, rules of forming total grade for lab. To grant a student access to the test script, Course element should be created with tree structure of Elements. Each course's Element has a Script element assigned. The Course element stores data on students' earned grades. To link course's Element and Script element a Unit element should be created, which is matched to Open edX Component element.

Course content is represented with four levels in Open edX: section, subsection, unit and component. Each week students gain access to new content. Each week is represented by Section level. Type of content, for example, video lectures, or virtual labs, is represented by Subsection. Each Unit in user interface is a single page with piece of content. To add content on this page a Component should be used. Figure 2 shows structure described above.

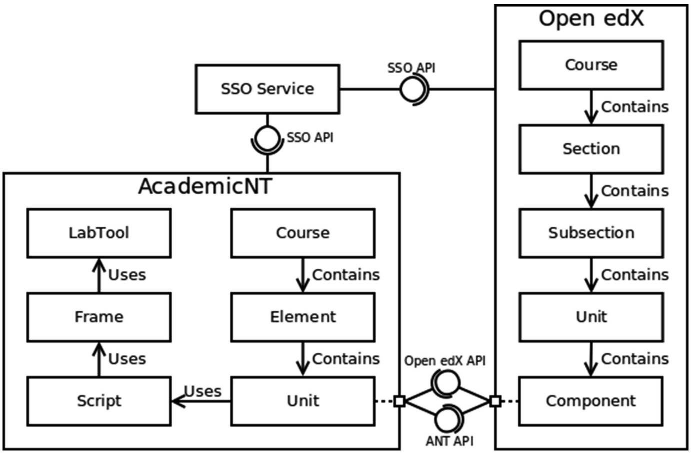


Fig. 2. AcademicNT and Open edX course structures

4 Open edX and AcademicNT Interaction

General interaction scheme (Fig. 3) includes such elements as Student, AcademicNT, Open edX and Single-sign-on (SSO) service.

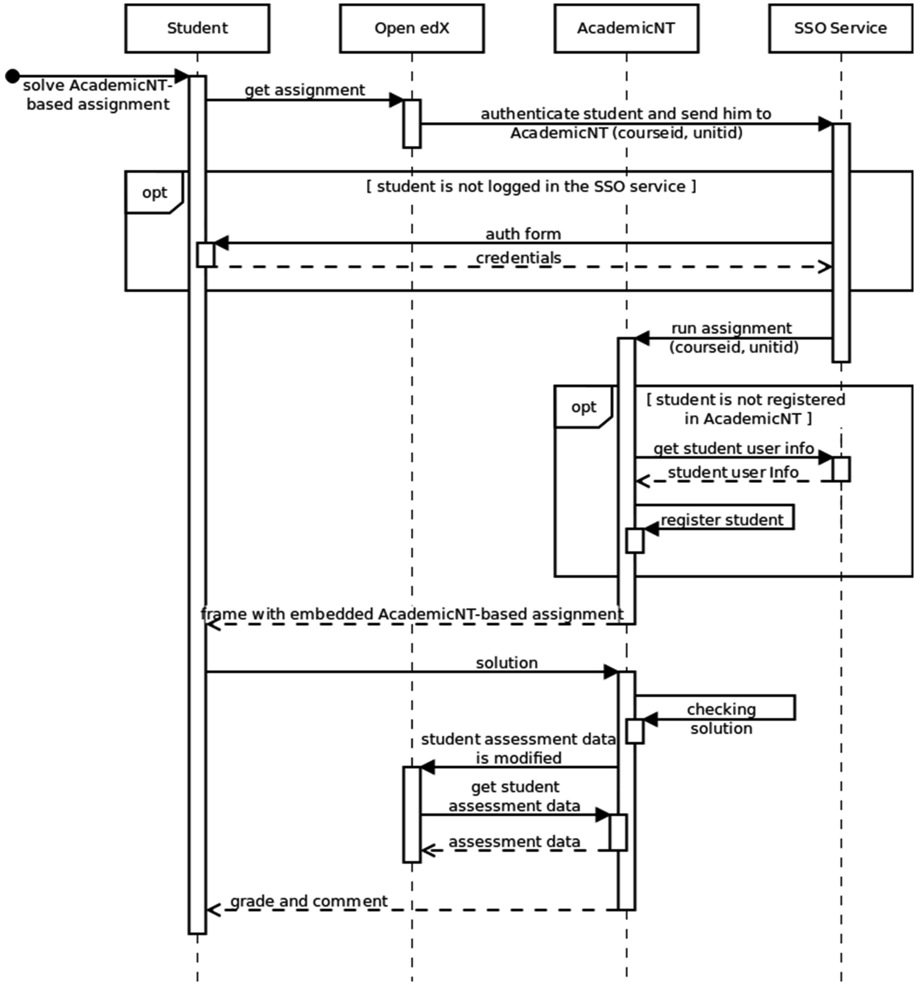


Fig. 3. Interaction scheme

The interconnection process starts when a student decides to solve AcademicNT-based assignment. He opens an Open edX page in a web-browser to get an assignment, which can be either a test or an RLCP-compatible virtual laboratory. The Open edX platform finds out, which exact assignment was requested, using course_id and unit_id parameters, and redirects student to corresponding page in AcademicNT. Open edX performs the redirect via SSO Service using SSO Service api to make sure of student identity. SSO Service may perform additional checks on the user identity, for example, and request student credentials once more if needed. In case of successful login SSO Service redirects student to the page of AcademicNT containing assignment requested.

Before rendering an assignment page AcademicNT determines whether current user exists in database. In case of user related data absence, AcademicNT performs an additional request to SSO Service obtaining missing data and creates an account for current user. Later this account will be used for this particular student. A frame containing the assignment will be shown after all the checks passed.

When student finishes the assignment, his solution is transmitted to AcademicNT, which validates and evaluates it. After that a report containing feedback message and resulting grade is shown. At the same time AcademicNT notifies Open edX that student's assessment data has been modified, and Open edX performs counter request to obtain full report containing all user attempts to build own grade report.

AcademicNT provide necessary API for all interconnection phases including such methods as getCourseUnit to provide student with page of AcademicNT-based assignment, getCourseAttempts that returns records on students' progress, getCourseInfo to get course metadata.

Open edX platform provides an interface named XBlock to include different kinds of materials in a course, for example, video lectures and surveys.

XBlock interface is a part of python package authored by edX. The key feature on this interface that its implementation is responsibility of course's author, so they may perform any action possible, for example conditional surveys or modelling, which all depends on course's designers and developers.

An XBlock was developed for the technique proposed to maintain interconnection between Open edX platform and AcademicNT.

More to say correctly implemented XBlock may be used in any implementation or instance of Open edX platform. So NPOED and ITMO courses share the same XBlock implementations.

5 Conclusion

A technique proposed in this paper allows to organize interaction between Open edX and AcademicNT. It provides project based on Open edX with test, virtual labs and other materials stored in AcademicNT, which cannot be used natively, as they provide much more features than Open edX may support now. These materials are used in 7 courses published on NPOED and ITMOcourses.

The technique may be used for interconnection of Open edX and other existing services of testing and assessment. This allows reusing existing materials, and making the principle of cooperation with existing courses as the main idea, but not the challenge.

Taking into account that Open edX platform is open sourced, the experience described in this paper may be useful for institutions creating and using open online courses.

References

1. Lisitsyna, L., Lyamin, A.: Approach development of effective e-Learning courses. Front. Artif. Intell. Appl. **262**, 732–738 (2014)
2. Lyamin, A.V., Vashenkov, O.E.: Virtual environment and instruments for student olympiad on cybernetics. In: Proceedings of 8th IFAC Symposium on Advances in Control Education, Kumamoto, Japan (2009)
3. Belashenkova, N.N., Cherepovskaya, E.N., Lyamin, A.V., Skshidlevsky, A.A.: Protection methods of assessment procedures used in e-Learning. In: 13th International Conference on Emerging eLearning Technologies and Applications, pp. 27–32 (2015)
4. Kopylov, D.S., Fedoreeva, M.K., Lyamin, A.V.: Game-based approach for retaining student's knowledge and learning outcomes. In: 2015 9th International Conference on Application of Information and Communication Technologies (AICT2015), pp. 609–613 (2015)
5. Lyamin, A.V., Efimchik, E.A.: RLCP-Compatible virtual laboratories. In: International Conference on E-Learning and E-Technologies in Education, pp. 59–64 (2012)
6. Efimchik, E.A., Chezhin, M.S., Lyamin, A.V., Rusak, A.V.: Using automaton model to determine the complexity of algorithmic problems for virtual laboratories. In: Proceeding of 9th International Conference on Application of Information and Communication Technologies, pp. 541–545 (2015)
7. Chezhin, M.S., Efimchik, E.A., Lyamin, A.V.: Automation of variant preparation and solving estimation of algorithmic tasks for virtual laboratories based on automata model. In: Vincenti, G., Bucciero, A., Vaz de Carvalho, C. (eds.) eLEOT 2015. LNICSSITE, vol. 160, pp. 35–43. Springer, Heidelberg (2016). doi:10.1007/978-3-319-28883-3_5

Active Learning and ICT in Upper Secondary School: A Possible Answer to Early School Leaving

Silvia Panzavolta(✉) and Chiara Laici

INDIRE, Innovation Department,
Via Michelangelo Buonarroti, 10, 50122 Florence, Italy
{s.panzavolta, c.laici}@indire.it

Abstract. The paper outlines the first phase of a three-year research activity on active learning in the core curriculum subject, intended as a possible solution to student disengagement in secondary schools. The paper presents the problem the research intend to attack - school failure, school unsuccess, student disengagement and early school leaving - and describes the context of the research, its originality, and the remedial measures put in place by the research team and policy makers. Among those, Continuing Professional Development (CPD) of teachers and structural measures to involve several stakeholders, including students. Then, the research design is given and the research tools presented, showing what dimensions are investigated. Finally, it provides some preliminary results as for one of the four qualitative case studies being carried out and future research perspectives.

Keywords: Student engagement · Core curriculum subjects · Upper secondary school · Early School Leaving (ESL) · CPD

1 Introduction

As mentioned in the 2013 European Commission Report on Early School Leaving [1], "Early school leaving (ESL) is a multi-faceted and complex problem caused by a cumulative process of disengagement. It is a result of personal, social, economic, education or family-related reasons. Schools play an important role in addressing ESL but they cannot and should not work in isolation. Comprehensive approaches that focus on the root causes of ESL are required to reduce ESL. Reducing ESL can help towards the integration of young people into the labour market, and contribute to breaking the cycle of deprivation that leads to the social exclusion of too many young people". The Europe 2020 strategy [2] sets out a target of reducing school drop-out rates to less than 10%, asking a big effort to all Member States that are afflicted by this problem.

This article has been developed jointly by authors. Silvia Panzavolta wrote the Sects. 1, 2, 4.1 and 4.3. Chiara Laici wrote the Sects. 3, 4.2, 4.3 and 5

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 19–27, 2017.
DOI: 10.1007/978-3-319-49625-2_3

Given this scenario, the Italian Government issued a Law [3] addressing the problem of ESL, and created the so-called "Technical and Vocational Poles" as a possible solution. In fact, Technical and Vocational Poles, as imagined by the Government and described in the mentioned Law, represent an organizational model potentially capable of reconnecting VET schools – the most afflicted by drop-out rates – to their community and production districts and of fostering a systemic approach to employability, by networking schools, companies, vocational training agencies and universities (as suggested by the European Commission in the mentioned Report, this is a "comprehensive approach"). These Poles could be able to represent a solution to the ESL since they put together different stakeholders (companies, regional VET systems, schools) and can offer specific VET courses and opportunities (apprenticeship, dual system, VET regional courses, alternating training, etc.) answering the different needs of at-risk students.

In Tuscany, drop-out rates are heavy, reaching 16,3% - far away from the threshold set out by the European Commission for 2020. Moreover, the NEET[1] population is growing, making the ELS phenomenon ever more serious. That's why an early and systemic intervention is crucial, so that each student can be offered various VET opportunities, designed according to the specificities of the community and of the labour market where s/he lives and studies. The Tuscan Region started this new organization of the VET system in 2013, setting out a specific Decree [4] so that Poles could be constituted from then onwards[2]. In Tuscany 25 Poles have been created, covering 5 main production sectors (agriculture, tourism, fashion, mechanics, navigation), among which 8 were identified [5] to be the object of an experimentation on 5 main areas (school and vocational guidance; active learning in the core curriculum subjects; additional VET courses; alternating training; dual system), considered as crucial to reduce ESL and school failure. INDIRE has been chosen by the Tuscan Region, together with other Institutions, to support the Poles in their innovation and experimentation processes, in particular on active learning in core curriculum subjects and alternating training.

2 The CPD Project on Active Learning

The CPD project on active learning "La didattica laboratoriale nei Poli Tecnico-Professionali" has been designed by INDIRE according to a specific definition which is in relation to a different model of schooling, where lectures are replaced by student-centred activities, so-called "lab activities".

According to several researchers [6–10], even though ESL is a complex problem where many causes occur, schools play an important role, especially when student engagement is concerned. Active learning means putting in place different strategies

[1] NEET = Not in Education, Employment or Training.

[2] In order for a Pole to be formally created, there must be at least: two Technical or Vocational schools, at least two companies and one institute delivering post-secondary non-tertiary courses (ISCED 4). These institutions must sign a formal agreement where medium-term objectives (for 3 years), a governance organization and committees are identified.

able to: engage students in tasks oriented to projects or product construction; solicit different learning styles and preferences; develop competences and soft skills; include informal and non-formal learning of students, also by strengthening networking with different stakeholders outside the schools; differentiate and customize learning opportunities according to students' profiles and attitudes; adjust time and place of learning according to needs and requests from students; make it possible for teachers to teach with problem-solving and interdisciplinary approaches; use authentic tasks and innovative assessment practices; develop creativity and research-oriented competences.

The coaching model is based on the tutorship between expert schools - so-called "tutor" schools - and trainee schools and it is derived by the "Avanguardie Educative" Movement model [11]. Both face-to-face and virtual classrooms are in place to scaffold the piloting of schools as for the innovative methodologies proposed. The project [12] lifespan is one school year (September 2015–June 2016).

3 The Research Design on Active Learning

In order to answer learning needs of young students that use daily ICT as a communication, learning and creative knowledge construction tool [13], it is important to change the lecture-based model of schooling, with its desks in line, and rethink the school settings to make them more flexible and open, as socio-constructivist theories advocate. According to the social theory of learning [14], a classroom should be intended as a learning community where the teacher guides, engages, and interests his/her students, thus making it possible peer education and peer tutoring to be promoted. In such flexible learning situations, learning by doing, discovery learning, cooperative learning and reflective learning - where the teacher is a coach and not a lecturer - are promoted [15]. ICT should be considered as enablers for transforming learning environments, promote knowledge co-construction, allow personalization of outcomes and strategies and scaffold the acquisition of curriculum cultural and symbolic clues [16–18]. ICTs act on different levels - cognitive, communicative, expressive, creative and socio-relational levels - since they allow the manipulation of objects (i.e. simulation, 3D visualization), student authorship [15], student-student and teacher-student collaboration and active participation.

The present research activity, as highlighted above, considers active learning with ICT as a possible answer to engage at risk students and it is aimed at investigated its efficacy and effectiveness, especially in core curriculum subjects.

The three-year research activities, after a preliminary phase of literature review, will be deployed into two phases: the first one (school year 2015–2016) will insist on a local and regional dimension whilst the second one (school year 2016–2017) will take into account a wider dimension (national and international). During the first phase, 4 schools are taken into account and 4 case studies being carried out, one for each core curriculum subject (*maths, sciences, language education, foreign languages*). Case studies have been selected by using a stratified random sampling method, the strata being the production sectors, four in total in Tuscany, or: mechanics, navigation, tourism-agriculture and fashion. The second phase will take into account inspirational cases where the "lab-approach" is in place, in order to derive innovative practices that can be exported to other contexts and scaled-up. Research activities investigate specific dimensions that literature correlates [19, 20] with disengagement and ESL such as student motivation, school well-being, teacher performance, classroom climate, school organization. Each dimension is observed before and after INDIRE CPD course on active learning takes place[3]. The tools selected by the research team are the following ones: standardized tests; observations in the classrooms; student Portfolios; video-observations by the teachers, focus groups with the students; interviews with subject teachers and head teachers; content analysis on online environments and teachers' documentation.

4 Preliminary Results: A Case Study on English Language Teaching and Learning

As for this case study, one of the 4 foreseen in the first year, we would like to stress some results as for: standardized tests [21]; observation in classroom; student Portfolio; video-observation. Some information on the composition of the classroom is useful to have a clearer understanding of the educational context. The students attend the second year of a technical navigation school, located in Leghorn, which is a rather historical school of the harbour city. There are 22 students, 18 boys and 4 girls, among whom there are 3 Special Education Needs (SEN) students[4] and 2 failed students. Few technologies are available in the classroom (one IWB, not properly working). Wifi is available only for teachers.

4.1 Standardized Tests

AMOS standardized tests provide teachers, psycho-pedagogists, and school psychologists with tools for the assessment of study skills, cognitive styles and emotional and motivational aspects of learning, thus allowing a deep understanding of student strengths and weaknesses and suggesting remedial activities to be put in place to scaffold them. The specific tests that were administered during the pre-CPD phase in the classroom, in December 2015, are the following ones. *QSS*: questionnaire on study strategies, subdivided into 3 dimensions (a. efficacy - the student beliefs as for the efficacy of possible strategies that an ideal student can use; b. use - relating to the actual use the student does of those strategies; c. coherence - measuring the gap between the strategies considered as ideally useful and those actually employed by him/her). *QC*: questionnaire on the student personal beliefs and confidence as for his/her intelligence and personality, his/her learning goals (mastery versus performance goals) and his/her

[3] From now onwards, in the text we will refer to the 2 moments as pre-CDP and post-CPD.

[4] Definitions of SEN students vary widely across countries as they are specific to each country's legislation. In Italy SEN students are made up of three main group: disabled student, student with learning disorder (i.e. dyslexia), students with socio-cultural disadvantages (Ministry of Education Note NO.8 issued on March 6th 2013).

self-efficacy perception in facing study activities. *QAS*: the questionnaire aims at assessing the student self-regulation skills (identifying three dimensions: a. organization - capacity to plan the quantity of material to be studied in due time; b. personal processing - capacity to process the content in order to understand and remember it; and c. self-evaluation - capacity to predict the results of one's own performances, to realize the degree of achievement and detect possible weak points in one's own study strategies), his/her knowledge of possible strategies and sensibleness in using them according to the situation and to personal characteristics. *QSC*: questionnaire on student cognitive styles. Cognitive style is intended as the student's preference in the use of specific strategies. The test discerns among two styles: global - when the person prefers to have a global picture of a content - and analytic - when the person looks at details and specific topics. *QAR*: questionnaire on anxiety and resilience, measuring both the degree of arousal - physical and psychological - when facing a threat or an obstacle and the ability of the student to face difficulties and unsuccess.

Some results of the standardized tests are rather interesting, some are in line with our expectations. As for the QSS, it turned out that the class is generally poor in identifying effective study strategies, even though they show an adequate use of the strategies they considered as most relevant. As for QC, the majority of the students has a flexible conception of their personality and intelligence and, as we expected, they have more performance goals than mastery goals. As for QAS, surprisingly the class has in general good self-regulation strategies, even though the metacognitive sensibleness is generally low. As for QSC, the majority of the class has a global and visual cognitive style, as turned out to be in the portfolios as well. Finally, as for QAR, the class has in general a good degree of resilience and the peak of arousal is mainly on mastery goals.

4.2 Observation in Classroom

The pre-CPD observation was done in December 2015. Before visiting the classroom, the researchers informed the teacher on the observation protocol. The observation was carried out by two researchers, who stayed in the classroom during one-hour lesson without interacting with the students and the teacher. They used an observation grid presenting several sections: general context information; organization of space and time of the lessons; student work organization (group work, individual work, etc.); classroom climate (social, emotional and relational aspects); teacher role; ICT use (roles, attitudes, etc.). Each researcher noted his/her personal notes and afterwards produced a narrative observation report, referring to the sections above. The two reports were then sent to the teacher for comment integration. In May 2016 the post-CPD observation will take place.

On the observation day, 19 out of 22 students were present, among whom one is a SEN student (his SEN teacher was in class) and two have learning disorders. The setting was traditionally arranged, with the whiteboard, the teacher desk and the student desks set in line. The setting remained unchanged during the lesson; the teacher, instead, went around, presenting herself more as a facilitator than a "knowledge broadcaster". However, the rhythm of the lesson was totally guided by the teacher, asking students, involving them in the discussion and providing feedback and examples. It was an interactive lesson on grammar and vocabulary, following a flexible storyboard, with some conversation in English. Interactions were always between one single student and the teacher. The classroom seemed to be quiet and well behaving, but only little engaged. Students seemed to be tired, shy, unemotional. They only participated a little bit more when some familiar content was considered (i.e. their smartphones). The role of the teacher, as said above, was that of facilitating and scaffolding students, trying to involve them and to interest them, even by joking of playing with words. An IWB was present but no ICT were used during the lesson. Based on the observation, researchers found a class with low motivation, little engaged, even though good and trustful relationships exist among students and with the teacher.

4.3 Student Portfolio

The student portfolio, divided into four sections, is a tool designed to help students become aware of their learning strategies and study method. It can be used as a mean for sharing one own's progress in one or more areas taken into account [22]. The student portfolio is an online tool to allow students reflect on their competencies, guide them in their decision making process and develop their metacognition, considering its multidimensional meaning: attitudes, skills and behaviours [23]. The style of the portfolio is informal, comprising both open and multiple choice questions - some of them even using visual hints such as comics - and asking students to upload their material (note-taking, pictures, etc.). Students were asked to fill in the four sections during the whole school year, in particular, Sects. 1 and 2 in the pre-CPD phase and Sects. 3 and 4 in the post-CPD phase. Section 1 - filled in by November 2015 - dealt with study habits and preferences, self-esteem and learning needs. Section 2 was to be filled in after a usual - very likely traditional - lesson, in order to gather the student's emotions towards that lesson, his/her thoughts on the teaching process, the lesson weaknesses and strengths and, finally, his/her suggestions to improve it. Section 3 should be filled in after an active lesson has been experienced (it could be from March onwards) according to the same schema as in Sect. 2. Finally, Sect. 4 aims at summing up the whole year experience and metacognition process and bringing to conclusions and perspectives.

Between November 2015 and January 2016, Sects. 1 and 2 were filled in by 19 out of the 22 students of the classroom. This paragraph looks in particular to some of the answers provided by the students to the question "How I learn" and the one asking them to provide a definition of what they mean by "active learning". Students report that *they learn better* if they are actively involved in the learning process (i.e. by repeating, personally processing or making exercises and practical work) and that *they are facilitated* by the mediation of a classmate. They also like getting some feedback by the teacher and they prefer their work being constantly checked. They also report *working better* if the tasks are clear, thus suggesting a crucial point: a well-designed and performed lesson. They say *they remember more* if they write on their notebook what they do during the lesson. When they are asked *to do some exercises*, they prefer to have concrete examples, to read/listen to rules and study them beforehand. As for their definition of “active learning”, they generally relate it with the process of applying knowledge. Some think of “active learning” as something happening in the lab, a physical place that is generally designed for applying knowledge and linked with the workplace.

4.4 Video-Observation

Teachers were also given a specific protocol of video-observation, called EVIDENT (Evidence-based VIDeo Enquiry iN Teaching) [24], implying the video recording of a typical lecture (of at least 45 min), the self-analysis against a specific Self-Assessment Grid, the visual representation of his/her scoring through a Radar and a reflection process through a specific format (Self-analysis and Improvement Report). The protocol is based on the DASI dynamic model [25] and on Hattie’s work [26].

The investigated dimensions are presented the following ones. *Organisation and structure of the lecture*: structuring of the lecture in terms of methodological-teaching components, form of message, relations with contents already dealt with, and with phenomena linked to the student’s personal life. Description provided by the teacher on the reasons why a certain content is learnt. *Problematization*: behaviour of the teacher aimed at the problematization of contents, posing questions, answering students’ doubts and favouring/promoting discussion on a new content. *Examples and application*: opportunities in terms of: modelling (the teacher provides behavioural models, cognitive, emotional and relational strategies that the students can follow and copy); application (the teacher foresees exercises, experiments, etc., ensuring the processing of new contents in an active way, by students). *Time management*: management of the activities, avoiding waste of time by the teacher and organizing the school-time at best, as well as the time for studying at home. *Learning environment*: the class is perceived as a learning environment, profitable in terms of learning and socialization. *Assessment and metacognition*: presence of assessment, self-assessment elements, peer-evaluation and description/sharing of associated criteria. Attention to metacognitive aspects.

The results of the analysis made by the English teacher confirm what was observed by the researchers during the observation visit. The strongest aspects are “Organization and structure of the lecture” (10/10) and “Problematization” (10/10): in fact, the lecture was highly teacher-led, with the teacher asking questions to students and guiding the progress of the work. The teacher makes an extensive use of “Problematization” (10/10). This is coherent with what we observed, since the teacher asked the students to apply grammar, to compose sentences and to propose examples for vocabulary or grammar rules. Another strong dimension is “Assessment and metacognition” (10/10). What we observed showed that the teacher pays attention to provide an immediate feedback to students, even though we could not see in that lecture an innovative use of assessment practices (peer evaluation, rubrics, etc.). It can be that in the lesson she observed, those aspects were covered. The only very weak point is the dimension “Management of time” (4/10) intended as the actions that the teacher puts in place in order to manage the activities, avoid waste of time, and organize the school-time at best, as well as the time for studying at home. The rhythm of the lesson we observed was little bit slow, with some students talking with each other or not paying attention because the engagement was not stable. Another dimension to be improved is "The classroom as a learning environment" (8/10), in particular for the area of the ICT use and for differentiation, since the lesson was generally delivered as if all students had the same needs, styles and preferences.

5 Conclusions and Research Perspectives

From these first analysis results on the English case study – which has of course some limitations due to the stage of the analysis – we can say that the students consider collaboration and self-paced learning as equally important, even though from the observation we carried out collaborative work should be better developed, since the lesson was mainly based on teacher-led activities and individual work. A strong point in the lesson structure is the constant feedback that the teacher gives to the students - which they appreciate and considered as a crucial point - even though some aspects should be improved, or: an explicit and clear presentation of lesson time, objectives and roles; a constant engagement of students in concrete tasks and activities; personalization strategies in order to meet the different cognitive styles (mainly global and visual type, as emerge from standardized tests and portfolios). Since the class climate and relationships among students and with the teacher are very good, and that the majority of the students has a flexible conception of their personality and intelligence and good self-regulation skills, we hope that the CPD course will empower the learning community. Given the little emotional arousal observed and the low motivation demonstrated, we suppose that, by using more engaging methods and combining them with ICT - which is the core of the CPD offer - students will show more participation and engagement. This will be our research focus in the final part of the first-year case studies (May 2016). The other 3 case studies are being carried out and analyzed and research activities will continue in the school year 2016–2017, focusing on national and international level.

The DigCompOrg international framework [27] for educational organization innovation, will also be considered as a tool for supporting teachers and head teachers in innovating teaching/learning practices, school leadership/governance, and networking.

Acknowledgments. The authors wish to thank Carlo Beni, data analysis responsible, for his precious contribution.

References

1. European Commission: Reducing early school leaving: key messages and policy support, Brussels, p. 4 (2013)
2. European Commission: Taking stock of the Europe 2020 strategy for smart, sustainable and inclusive growth, Brussels (2014)
3. Law-Decree no. 5, 02 September 2012
4. Decree of the Tuscan region no. DD 4782/2013

5. Decree of the Tuscan region no. DGR 420/2014
6. Frabboni, F.: Il laboratorio. Roma-Bari, Laterza (2004)
7. Frabboni, F.: Il laboratorio per imparare ad imparare. Tecnodid, Napoli (2005)
8. Dewey, J.: Esperienza e Educazione. La Nuova Italia, Firenze (1984)
9. Nigris, E., Negri, S.C., Zuccoli, F.: Esperienza e didattica: le metodologie attive. Carocci, Roma (2007)
10. McKenzie, W.: Intelligenze multiple e tecnologie per la didattica. Erikson, Trento (2005)
11. Laici, C., Mosa, E., Orlandini, L., Panzavolta, S.: "Avanguardie educative": a cultural movement for the educational and organizational transformation of the Italian school. In: Conference Proceedings "The Future of Education". Libreriauniversitaria.it Edizioni (2015)
12. La didattica laboratoriale nei Poli Tecnico-Professionali. http://www.indire.it/progetto/didattica-laboratoriale-poli-tecnico-professionali/
13. Ito, M., Baumer, S., Bittanti, M., Boyd, D., Cody, R., Herr-Stephenson, B., Horst, H.A., Lange, P.G., Mahendran, D., Martínez, K.Z., Pascoe, C.J., Perkel, D., Robinson, L., Sims, C., Tripp, L.: Hanging Out, Messing Around, and Geeking Out: Kids Living and Learning with New Media. The MIT Press, Cambridge (2010)
14. Fabbri, L., Melacarne, C.: Apprendere a scuola Metodologie attive di sviluppo e dispositivi riflessivi. Franco Angeli, Milano (2015)
15. Rivoltella, P.C.: Fare didattica con gli EAS. La Scuola, Brescia (2013)
16. Falcinelli, F.: Le tecnologie dell'educazione. In: Rivoltella, P.C., Rossi, P.G. (eds.) L'agire didattico. Manuale per l'insegnante. La Scuola, Brescia (2012)
17. Rossi, P.G.: Tecnologie e costruzione di mondi. Post-costruttivismo, linguaggi e ambienti di apprendimento. Armando, Roma (2009)
18. Jonassen, D.H., Howland, J., Marra, R.M., Crismond, D.: Meaningful Learning with Technology, 3rd edn. Merrill/Prentice Hall. Columbus, OH (2008)
19. Lamb, S., Markussen, E., Teese, R., Sanberg, N., Polesel, J. (eds.): School Dropout and Completion: International Comparative Studies in Theory and Policy. Springer, Netherlands (2011)
20. Boscolo, P.: La fatica e il piacere di imparare. UTET, Torino (2012)
21. De Beni, R., Moè, A., Cornoldi, C., Meneghetti, C., Fabris, M., Zamperlin, C., De Min Tona, G: Test AMOS. Abilità e motivazione allo studio: prove di valutazione e orientamento per la scuola secondaria di secondo grado e l'università. Erickson, Trento (2014)
22. Varisco, B.M.: Portfolio. Valutare gli apprendimenti e le competenze. Carocci, Roma (2004)
23. Rossi, P.G., Giannandrea, L.: Che cos'è l'e-portfolio. Carocci, Roma (2006)
24. Mosa, E., Panzavolta, S., Storai, F.: What feedback for teachers? A pilot for the teacher as a reflective practitioner. IAFOR, ECE (2015)
25. Creemers, B.P.M., Kyriakides, L.: Using educational effectiveness research to improve the quality of teaching practice. In: Day, C. (ed.) The Routledge International Handbook of Teacher and School Development. Routledge, London (2012)
26. Hattie, J.A.C.: Visible Learning: A Synthesis of over 800 Meta-analyses Relating to Achievement. Routledge, London-New York (2009)
27. Kampylis, P., Punie, Y., Devine, J.: Promoting effective digital-age learning - a European framework for digitally-competent educational organisations (2015). doi:10.2791/54070

An Approach to Development of Practical Exercises of MOOCs Based on Standard Design Forms and Technologies

L.S. Lisitsyna and E.A. Efimchik(✉)

ITMO University, Kronverkskiy pr. 49, Saint Petersburg 197101, Russia
lisizina@mail.ifmo.ru, efimchick@cde.ifmo.ru

Abstract. The paper describes an approach to the development of interactive practical exercises of the MOOCs on the basis of the standard design forms and technologies and the results of its application in the MOOC "Methods and algorithms of graph theory", first run of which took place in 2015 on a National Platform of Open Education of the Russian Federation. The features and examples of standard design forms of applied practical exercises are given. The results of the application of the course, which confirms the efficiency of the proposed approach, are provided. Analysis of records of assignments in this course points to a tendency of reduction of time spent on exercises throughout the course. It was found that the reduction of time spent on exercise is significantly affected by situational awareness training that provided by the using of standard technologies and design forms to develop interactive practical exercises.

Keywords: MOOC · Interactive practical exercise · Situation awareness training · Virtual laboratory · RLCP-compatible labs · Graph theory · National platform of open education of Russian Federation

1 Introduction

Experimental studies on development and application of Situation Awareness Trainings (SAT) for students of first and second academic years were conducted at the ITMO University in 2014–2015. These studies confirmed that after training sessions students have shown not only the growth of the main indicators of cognitive functions (attention, speed of thinking, etc.) but also increase of e-learning results (score for online exams for a number of disciplines) [1, 2].

These studies were preceded by studies of the positive experience of SAT application in training for pilots, air traffic controllers, etc. that aimed improvement of skill of interaction with complex computer systems in a dynamically changing environment [3]. In the process of training students had to deal with a variety of rapidly changing user interfaces. Changes of tasks, scales, tips should be detected as fast as possible. This ability is also necessary for students in Massive Open Online Courses (MOOC): they have to perform a variety of practical exercises and take tests and online exams while under stress because of the time limit.

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 28–35, 2017.
DOI: 10.1007/978-3-319-49625-2_4

Interactive practical exercises are essential elements of any MOOC. In contrast to the polls that are taken after each video lecture to check the ability to apply knowledge gained, practical exercises may not use technology of tests. Their implementation requires technologies that allow to shape and control skills of solving typical problems of the application domain of the course. Usually complexity of common problems and methods of their solution in the course gradually increases that imposes additional requirements for the technology of the implementation of practical exercises. Firstly, these technologies should use uniform tools for implementation of all variety of practical exercises of the course (forms of task representation and composition of solution, user interfaces, navigation, reference, etc.). Such approach would include the SAT elements for the shaping of transferable skills that allow students to focus all cognitive resources on the application domain of the practical exercise and, thus, reduce the time required to perform each new practical exercise in the MOOC.

This article discusses an approach to this problem based on technology of RLCP-Compatible virtual laboratories, which is used in the development of practical exercises of the course “Methods and algorithms of graph theory” (authored by professor of the ITMO University Lisitsyna L.S., in Russian). The course is being applied on the National Platform of Open Education of Russian Federation since 2015. The article presents the results of practical application of the course, confirming the efficiency of the approach described.

2 Practical Exercises of the Course «Methods and Algorithms of Graph Theory»

This course is studied for 10 weeks, and the total labor intensity of the course - 3 credit units. Expected learning outcomes [3] in this course are LO1 – an ability to show a basic knowledge of mathematics (graph theory); LO2 – an ability to practice effective methods and algorithms for solving typical problems on graphs. The course is an educational module of discipline “Discrete Mathematics” which is a part of the basic educational programs for bachelors of the universities of Russian Federation [9].

Theoretical training includes not only number of video lectures and polls, but also relevant interactive demonstrations which includes a description of the algorithm (method of solving the corresponding problems on graphs) and an example of its usage in practice. Practical exercises (Table 1) are important interactive elements of the course. They help to shape and assess skills of learning outcomes. Each student has a fixed number of attempts to pass each practical exercise. Assessment result of learning outcomes is described with help of a 100-point scale. 70 points can be earned for the practical exercises and 30 points can be earned for the online exam, which is held online on the 10th week of the course. The threshold of passing for both practical exercises and online exam is - 60% of maximum possible points [9].

Practical exercises are based on technology of RLCP-Compatible virtual labs. This technology was designed in ITMO University in order to organize processes involving virtual labs. It allows to perform most of operations in fully automated mode and easily adapt to large amount of students which is helpful in MOOCs [5]. Each RLCP-Compatible virtual laboratory consists of virtual stand and RLCP-server.

Table 1. Practical exercises of the course

#	Typical graph problem	Algorithm	Max score
1	Search shortest route	Lee algorithm	5
2	Search route with minimal weight	Bellman-Ford algorithm	6.5
3	Search for Hamilton loops	Roberts-Flores algorithm	6.5
4	Search for minimum spanning tree	Prim algorithm	6.5
5	Search for minimum spanning tree	Kruskal algorithm	6.5
6	Search for largest empty subgraphs	Magu-Weismann algorithm	6.5
7	Minimum vertex coloring of graph	Method based on Magu-Weisman algorithm	6.5
8	Minimum vertex coloring of graph	Greedy heuristic algorithm	6.5
9	Search perfect matching in a bipartite graph	Hungarian algorithm	6.5
10	Detecting of isomorphism of two graphs	Algorithm based on ISD method	6.,5
11	Graph planarization	Gamma-algorithm	6.5
		TOTAL	70

Virtual stand is a tool, which is used by a student to get details of the given task and to compose a solution including all intermediate results. That solution is checked by RLCP-server. RLCP-server is a special TCP-server that provides the interface for RLCP (Remote Laboratory Control Protocol). RLCP-server is also responsible for the composing task variants and performing special intermediate calculations that must be held in safe environment. These two modules are not aware of each other and interact through a special control environment, which automatically manages each session of task solving. Such structure provides protection against unauthorized access. Because of lack of such environment in the National Platform of Open Education, virtual laboratories are deployed on the base of LMS AcademicNT of the ITMO University [6], which performs as an external assessment service. The interaction of the systems is implemented at a level that provides seamless sessions and registration of the achieved results in both systems.

Virtual labs of the course are aimed to shape and evaluate skills of solving typical tasks using known algorithms, that requires rigid action sequences and logical methods. On the one hand, this type of task requires variability of the tasks in conjunction with strict control of the complexity of variants. To solve this problem each virtual lab uses special algorithm to compose variants of specified class of complexity [7, 8]. On the other hand, this type of tasks allows to check the all intermediate results of the solution comparing it to solution provided by the reference algorithm. This allows to detect exact stage of the solution at which student made a mistake and provide him useful comment about it.

3 Standard Design Solutions in Practical Exercises of the Course

Following standard design solutions were developed to shape transferable skills of usage of RLCP-Compatible virtual labs for practical exercises of the course.

The standard form of the task frame with embedded virtual stand (Fig. 1). At the top of the frame, a general description of the task and description of the variant are arranged. Then embedded virtual stand goes. Information about time passed and time left is located below virtual stand as well as a button to finish the task solving.

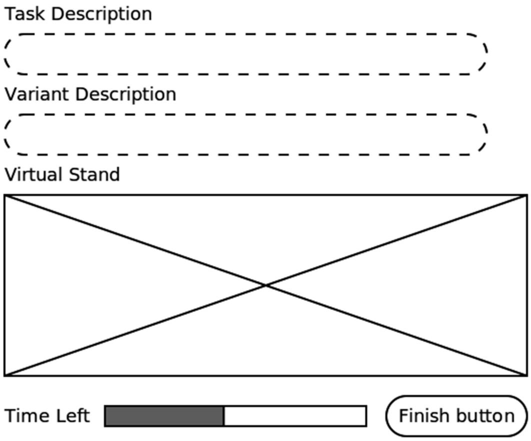


Fig. 1. The standard form of the task frame

Next standard form is a virtual stand for composing of solution (Fig. 2). There is a header with the name of the laboratory and help button at the top of the virtual stand. Under the heading on the left side an area of variant details is located, which usually contains an interactive graph. To the right of it – an area of solution composing where students specifies intermediate data of solutions.

This area usually contains tables that should be filled manually or by interaction with the interactive elements of the graph, for example, to specify a set of vertices and edges student just clicks on them on the image of the graph after selecting the desired row or cell of the table or the input field. The solution may consist of several steps, navigation between which is performed by the standard buttons “Next step” and “Prev step”. The student specify the final answer for the given task in an area at the bottom of the stand.

The third standard form is a virtual stand for composing solution for tasks having a variable number of steps (Fig. 3). Sometimes the main part of the solution includes a series of identical steps, the amount of which depends on the complexity of the variant of task. In general, one or more initial steps precede that series. So, a special tool is embedded between the area of initial steps and the area of the final answer to manage

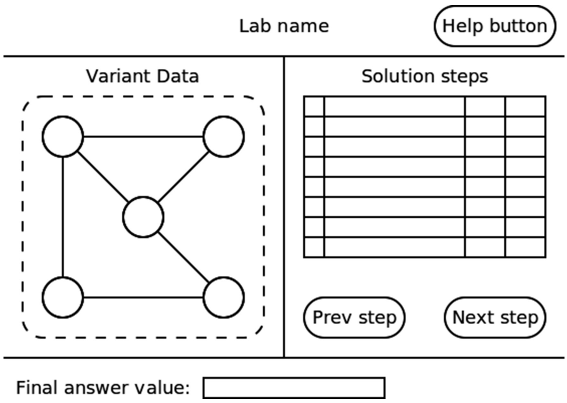


Fig. 2. The standard form of a virtual stand for composing of solution

the list of serial steps. The student can add new steps to the end of the list or remove steps from the end of the list. Typically, the area of the main part of the solution equipped with its own scroll bar that allows student not to lose sight of the variant data and the area of the final answer.

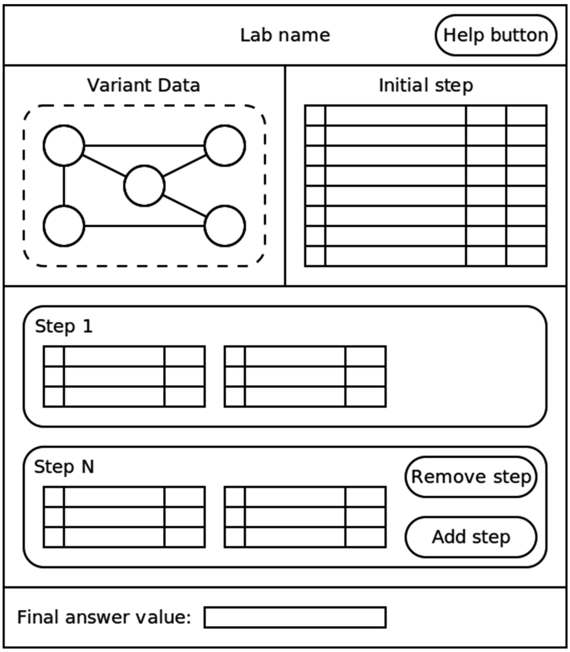


Fig. 3. The standard form of a virtual stand for composing of solution for tasks having a variable number of steps

All virtual stands are decorated in the same style; all control elements of different virtual stands have similar appearance and method of interaction. The course provides a special video lecture to explain how to use practical exercises: how to work with interactive pictures of graphs, where one can get help on input, how to navigate between the solution steps, how to edit the resulting solution, how to complete solution and get a report with the evaluation results. During the course these skills are shaped by practicing due to each new exercise requires that students use them over and over again, thus reducing the time required to solve the next task.

4 Considerations on Results of the Application of the Course

For the first run of the course «Methods and algorithms of graph theory» on the National Platform of Open Education of the Russian Federation in 2015 there were 2605 students who registered to the course, but only 239 students started to perform practical exercises (9.2% of participants). Table 2 describes their evaluation results. Students who scored 60 points (39.3% of all active students) received certificates. Each forth active student gained certificate with honors (90 points or more), while 4.2% of active students scored the 100. For each exercise student had maximum of five

Table 2. Processed data on the time spent on practical exercises

#	Related algorithm	Amount of processed records	Average time, sec. (a)	Average time in the first half of attempts, sec. (f)	Average time in the second half of attempts, sec. (s)	Reduction of time to complete exercise, % p = (f − s)/a
1	Lee algorithm	173	307,7	386,5	246,4	42,2
2	Bellman-Ford algorithm	110	1103,1	1338,4	890,9	37,4
3	Roberts-Flores algorithm	130	861,1	1057,5	720,0	34,2
4	Prim algorithm	60	837,5	894,6	804,1	9,6
5	Kruskal algorithm	45	696,0	795,3	605,5	25,6
6	Magu-Weismann algorithm	95	1770,5	1920,7	1627,9	15,2
7	Method based on Magu-Weisman algorithm	62	1609,5	1734,2	1489,6	13,2
8	Greedy heuristic algorithm	74	521,1	588,7	438,3	25,6
9	Hungarian algorithm	77	762,3	837,9	714,8	16,9
10	Algorithm based on ISD method	56	1489,7	1698,1	1339,4	17,9
11	Gamma-algorithm	79	371,0	436,7	341,6	17,2

attempts, including attempts to improve the previous score and 96% of students in average coped with the task and 85.4% of students in average gained maximum score, which demonstrates the efficiency of application of interactive practical exercises in the course [9].

We next consider the results of the time spent on practical exercises in the course. All records of performed exercises were processed to collect statistics with the exception of those that were interrupted by students (student opened a task, but decided to quit the assignment). There were 311 of "student-exercise" pairs that were selected by condition that student used to perform the exercise at least 2 times. It resulted to 1656 processed records for 152 students. All attempts were split into two parts (the first and the second half of the trials). "Average time" value is actually counted as average value of average time to complete the exercise per student.

The data in Table 2 shows that the reduction of the time of re-assignments decreases during the first weeks of exercise, and then set in a certain range. Main point of interest is a persistent tendency of reduction of time to complete an exercise, despite the increasing complexity of theoretical material for their implementation. Reduction (p) of execution time of each practical exercise based on two factors:

$$p = p_1 + p_2,$$

where p_1 – reduction by transferable skills of usage of RLCP-Compatible virtual labs in practical exercises (SAT); p_2 – reduction by training of solving problems on graphs using the corresponding method (algorithm).

It is obvious that the proportion of $p1$ will gradually decrease during the course, and the proportion of $p2$ in general depends on the complexity of the relevant method. This, for example, leads to a huge reduction of time for practical exercise #4 (Prim's algorithm is simple to understand).

Thus, the analysis of the dynamics of reduction of time to complete practical exercises confirms our hypothesis that the use of the standard design forms and technologies for interactive practical exercises in the MOOC improves performance of the course (high scores, reduction of time to complete exercises).

5 Conclusions

Thus, the approach to develop of practical exercises for MOOCs that is based on the standard design forms improves performance of the course. This is confirmed by the results of the application of the MOOC "Methods and algorithms of graph theory" in 2015 on a National Platform of Open Education of the Russian Federation, in which all 11 practical exercises were implemented on the basis of technology of RLCP-Compatible virtual laboratories. Almost all active students have coped with the these exercises, and 85.4% students to have reached the maximum score for exercises despite of fixed number of attempts (up to 5). Perhaps the most important result of this study is confirmation that throughout the course there is a tendency to reduce the time required to complete practical exercises, despite the increasing complexity of the theoretical material. It was found that the SAT makes a significant contribution to the reduction of time to complete practical. Therefore, developers of MOOCs should use standard design forms and technologies for interactive practical exercises to improve the efficiency of their courses.

Acknowledgment. This paper is supported by Government of Russian Federation (grant 074-U01).

References

1. Lisitsyna, L.S., Lyamin, A.V., Martynikhin, I.A., Cherepovskaya, E.N.: Situation awareness training in e-Learning. In: Uskov, V.L., Howlett, R.J., Jain, L.C. (eds.) Smart Education and Smart e-Learning. SIST, vol. 41, pp. 273–283. Springer, Heidelberg (2015). doi:10.1007/978-3-319-19875-0_25
2. Lisitsyna, L.S., Lyamin, A.V., Martynikhin, I.A., Cherepovskaya, E.N.: Cognitive trainings can improve intercommunication with e-Learning system. In: 6th IEEE International Conference Series on Cognitive Infocommunications, pp. 39–44, IEEE Catalog Number CFP1526R-USB, ISBN 978-1-4673-8128-4 (2015)
3. Endsley, M.R., Robertson, M.M.: Training for situation awareness in individuals and teams. In: Endsley, M.R., Garland, D.J. (eds.) Situation Awareness Analysis and Measurement. LEA, Mahwah (2000)
4. Lisitsyna, L., Lyamin, A.: Approach to development of effective e-Learning courses. Front. Artif. Intell. Appl. **262**, 732–738 (2014)
5. Lyamin, A.V., Efimchik, E.A.: RLCP-compatible virtual laboratories. In: International Conference on e-Learning and e-Technologies in Education, pp. 59–64 (2012)
6. Kopylov, D.S., Fedoreeva, M.K., Lyamin, A.V.: Game-based approach for retaining student's knowledge and learning outcomes. In: Application of Information and Communication Technologies, pp. 609–613 (2015)
7. Efimchik, E.A., Chezhin, M.S., Lyamin, A.V., Rusak A.V.: Using automaton model to determine the complexity of algorithmic problems for virtual laboratories. In: Proceeding of 9th International Conference on Application of Information and Communication Technologies, pp. 541–545 (2015)
8. Chezhin, M.S., Efimchik, E.A., Lyamin, A.V.: Automation of variant preparation and solving estimation of algorithmic tasks for virtual laboratories based on automata model. In: Vincenti, G., Bucciero, A., Vaz de Carvalho, C. (eds.) eLEOT 2015. LNICSSITE, vol. 160, pp. 35–43. Springer, Heidelberg (2016). doi:10.1007/978-3-319-28883-3_5
9. Lisitsyna, L., Efimchik, E.: Design and application of MOOC "Methods and algorithms of graph theory" on National platform of open education of Russian Federation. In: Uskov, V.L., Howlett, R.J., Jain, L.C. (eds.) Smart Education and e-Learning 2016. SIST, vol. 59, pp. 145–154. Springer, Heidelberg (2016). doi:10.1007/978-3-319-39690-3_13

Creating Inspiring Learning Environments by Means of Digital Technologies: A Case Study of the Effectiveness of WhatsApp in Music Education

Michele Della Ventura(✉)

Department of Technology, Music Academy "Studio Musica",
Via Andrea Gritti, 25, 31100 Treviso, Italy
dellaventura.michele@tin.it

Abstract. One of the most interesting challenges that many schools are facing today is the introduction of the most recent digital technologies in the learning process. These technologies also turn out to be efficient for the students in terms of motivation. Motivation and the nature of the learning experience are important factors for all students, but particularly for students with dyslexia. This research paper explores the effectiveness of using mobile technologies to support a course titled "Sound Recording" in Music Technology. Specifically, it discusses the effects of WhatsApp mobile learning activities guided by activity theory on students' knowledge management. Results showed that students with dyslexia compensated for their processing deficits by relying on learning strategies and help seeking.

Keywords: Dyslexia · Learning · Motivation · Music education · Social network

1 Introduction

School finds itself operating in a world of communication that has in recent years been deeply changed by Web 2.0 and by the mobile devices, by the cloud and by mobile computing, a world in which technology "migrates" thanks to the mobile devices into our lives becoming a tool and space for the creation and circulation of culture [1, 2].

Starting from the obvious fact that these technologies were not devised and designed to be used in didactics but they actually do contribute to all those informal learning paths that are typical of the current society of knowledge and they may me integrated in the creation and management of the educational environments, the question that must be asked is how to turn them into a learning environment. To generate this transformation we must meditate on how times, spaces, roles and didactic methodologies change so as to promote the centrality of the learning process and make students become the key players: from passive consumers of technologies to responsible authors who, following the teacher's lead, manage to gradually develop an inclination towards research and towards cognitive flexibility.

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 36–45, 2017.
DOI: 10.1007/978-3-319-49625-2_5

It is not the simple introduction of technologies into the classroom that can create innovation in didactics: cultural change is needed in order to go beyond the concept of the classroom being the context within which knowledge is passed on, to the learning environment *intentionally* designed by the teacher, in which students use different technologies in an integrated manner, taking advantage of their potentialities and allowing the students to become protagonists in the knowledge building process [3].

It is in this same context that the teacher also has to deal with another issue, namely the one related to the concept of "classroom" intended as a group of students having heterogeneous learning styles. The presence of dyslexic students imposes on the teacher certain didactic choices that help such students and that also turn out to be useful for **all** the other students (the non-dyslexic ones) in order to make didactic practice more efficient, the study method more conscious and the learning more long lasting and more profound [4].

Yet among these uncertainties there is an element that is still clear and can be easily explained: the importance of motivation in the educational process. It has been already established that technologies contribute to promoting in the student (intended in general, non-dyslexic and dyslexic) the development of behaviors that characterize the affective-motivational ambit [5]: from the traditional technologies, i.e. the digital and telematic ones, to the most recent social technologies, that have the potentialities to become engines able to act positively on the motivation to learn, on the interest, the participation and the commitment.

From the perspective of technologies, the educational scenario had, in these recent years, the chance to receive ever-better-targeted answers, following the diffusion of the tools of the so-called Web 2.0 [6] that witnessed the establishment of the *social network* websites.

This article presents a case study referred to a Music Technologies (MT) teaching project in Senior High Schools specializing in Music. MT is a complex discipline because of the countless technical terms that it deals with: that is why students often experience a feeling of incapacity which leads to disesteem and ultimately to an educational failure.

The main objective of this project was to check on and assess the impact of the use of ICT in the students' learning process: increase the student's motivation in order to see if it corresponds to an improvement of his/her academic results. For this reason it has been decided to introduce the use of WhatsApp in the classroom.

This paper is organized as follows.

Section 2 describes the Social Network. Section 3 describes the tools used for the choice of the Social Network. Section 4 explains the choice of the WhatsApp. Section 5 shows an experimental test that illustrate the effectiveness of the proposed method. Finally, conclusions are drawn in Sect. 6.

2 The Social Network

If the Social Networks may be considered a tool "for and of didactics", the first issue to solve for the teacher is the choice of which Social Network to use in the classroom group: Facebook, Twitter, Instagram or WhatsApp, to mention only the most well known. The common feature of these environments is content sharing [7]. The social networks would, therefore, be characterized by [8]:

(1) uniquely identifiable profiles, made up of content supplied by the user, content supplied by other users and/or data provided at a system level;
(2) publicly structured connections that may be viewed and browsed by others;
(3) features that allow the users to consume, produce and/or interact with flows of content generated by the users that are supplied by the existing connections.

However, every Social Network has an intrinsic feature that distinguishes it from the others: on Facebook you can post photos and videos or see the ones shared by other users, or chat with your friends who have signed up; WhatsApp is a fast and easy alternative to the usual text messages (SMS) to "chat", because it can be used on the cell phone; to post the photos you need to use Instagram.

Certain conditions must be implemented [9, 10] for technologies to be used as a learning resource and not to be "neutralized" by a traditional use that subjects them to a transmissive didactics. First of all, real homework must be proposed to students, that should get them involved in resolving problems, in searching for information or in building artefacts (for instance relationships), thus giving more meaning to the needs of knowledge and of commitment. Technologies must help to open the class towards real interlocutors [11] (be them other students to collaborate with or experts to ask for advice), near or far, of different languages, culture or ages.

3 Choosing the Social Network

The choice of the Social Network as a didactic resource cannot be therefore independent of a careful analysis of the class, intended as a group of heterogeneous students as far as learning, but also personal life styles are concerned.

The research presented in this article refers to a pilot project that analyzes the effects on learning and on teaching brought by the implementation of the Social Network in the classroom lesson. The discipline forming the object of the project is Music Informatics, which belongs to the ambit of Music Technologies. This discipline deals with the analog-to-digital conversion of sound, the tools for the analysis of digital sound, the digital audio formats (lossy and lossless), the Internet and audio streaming.

The main difficulty stemming from it is the large amount of technical/scientific and conceptual terminology.

The choice of the Social Network was done by analyzing the results of an (ex-ante) survey carried out in class. The students were asked to answer the questions in a questionnaire (see example in Table 1), meant to explain the "affective-motivational" relationship everyone of them has with the technologies. Every question offered the possibility to choose an answer, to indicate if it represented a useful or an accessory element in everyday life as a person, and to assign a numeric value (from 0 to 10) representing the importance acknowledged on a personal level (where 0 meant more importance acknowledged for the objective/personal factor and 10 meant more importance given to the affective/social factor).

Table 1. Excerpt from the ex-ante questionnaire.

Question	Useful/Accessory element	Score (0–10)
Use of the internet:		
(1) often		
(2) enough		
(3) seldom		
Use of the internet:		
(1) on the computer		
(2) on the tablet		
(3) on the cell phone		
Use of the internet to:		
(1) consult books		
(2) read newspapers		
(3) video-calls		
(4) other………..		
Have you participated in a discussion forum?		
(1) often		
(2) sometimes		
(3) never		
Have you participated in a chat?		
(1) often		
(2) sometimes		
(3) never		
Have you ever been a part of remote workgroups supported by web technologies?		
(1) YES		
(2) NO		
Do you think you could participate and have good results in:		
(1) talks		
(2) research groups		
(3) open activity groups		
In a workgroup:		
(1) you collaborate equally		
(2) you tend to be the leader		
(3) you prefer to follow the others		
…	…	…

The results were represented diagrammatically (Fig. 1) by a tool called "Virtual Show & Tell" [12] and analyzed to be able to choose the Social Network. The "Virtual Show & Tell" tool consists of a Cartesian diagram that associates the emotional/functional aspect (that is if the answer has a personal or useful value) with the personal/social aspect (that is if the answer has a personal value or is open to many people). The various answers are represented by colored circles the size of which changes based on the percentage of people that gave the same answer and the color of which changes based on the answer representing a useful element (black) or an accessory element (red) in that specific person's everyday life.

Areas containing elements with general common features may be therefore highlighted on the diagram. In our case, for instance, 4 areas may be highlighted:

(1) *Utility*: gathers all the elements needed for complementary functions such as word processing, image editing…
(2) *Needs & Procedures*: groups all the elements referring to personal tastes;
(3) *Devices*: groups all the elements related to the technological equipment being used;
(4) *Communication*: gathers all the elements referring to the information processing, transformation and transmission systems.

From an analysis of these elements you may note how the students' attention was directed towards the affective/social area. Communication in chat and on Social

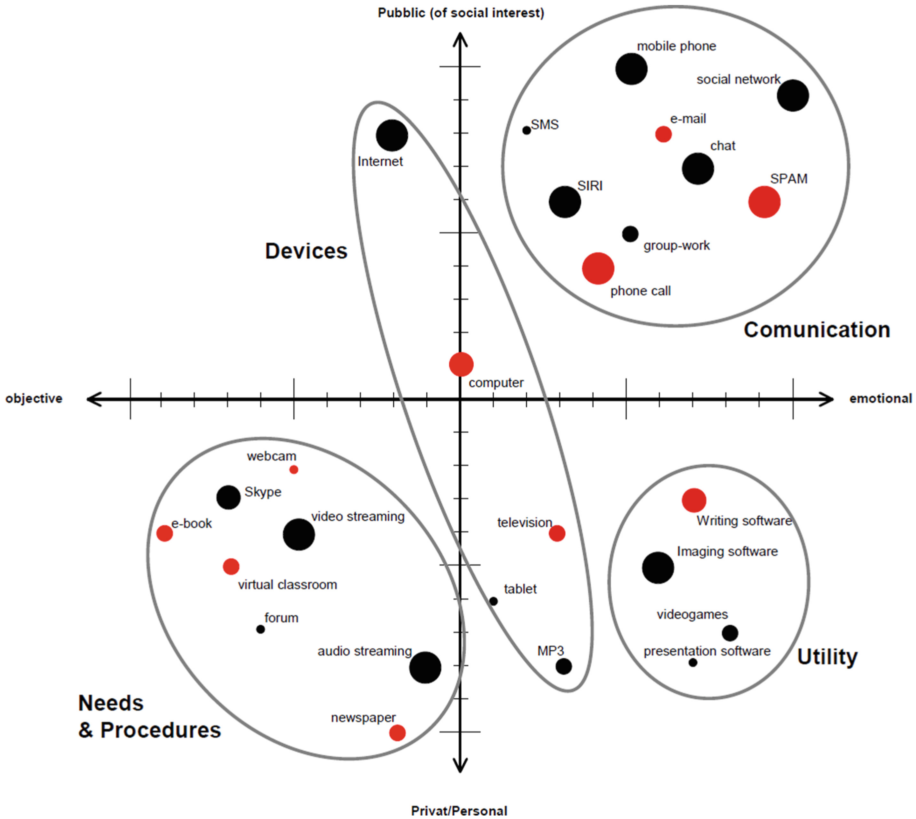


Fig. 1. Diagram representation (Show & Tell) derived from the questionnaire analysis.

Networks (rather than the SMS) prevails, through the use of the cell phone (rather than the computer or the tablet), communicating with “buddies” through voice messages (SIRI) to the detriment of text messages; they use the Web a little to find information (e-books, articles, newspapers…); they use the text processing and graphic software only for strictly personal purposes.

From these considerations and based on the classroom group structure (that included some dyslexic students) the choice was made to use WhatsApp as a work tool.

4 Why WhatsApp?

WhatsApp (from the English phrase “What’s up?” meaning “What’s new?”) is an instant messaging application for smartphones. It allows users to exchange images, videos, and audio or written messages using their Internet connection. WhatsApp has positioned itself as a superior alternative to SMS messaging, which can be very expensive when used in foreign countries due to roaming charges; WhatsApp, in contrast, relies on the active Wi-Fi network.

The general benefits of using WhatsApp instant messaging in the blended mobile lecture are as follows [13–15]:

- WhatsApp instant messaging facilitates online collaboration and cooperation between online students connected from school or home in a blended mobile lecture;
- WhatsApp is a free application that is easy to use;
- Provide online students with the ability to exchange text messages, images, videos, and voice notes to their social network or group and contacts;
- Information and knowledge are easily constructed and shared through WhatsApp instant messaging [16];
- WhatsApp provides students with the ability to create a class publication and thereby publish their work in the group [15, 16];
- Groups connected to WhatsApp instant massaging can share learning objects easily through comments, texting and messaging. Discussions are related to the course content taught 100% in-class;
- Provide students or instructors with the ability to create a group (social network group) that supports the social interactions: members can engage in discussion forums [17, 18];
- WhatsApp provides the ability for students to send messages without limits;
- Students using WhatsApp can message one another through texts, images, videos, and so on.

Last but not least, WhatsApp seems to be useful as a tool for the dyslexic student. The possibility to send and listen to audio messages rather than text messages helps the students who have trouble with reading; the possibility to listen several times to the same message helps them to learn; the possibility to dictate a message (SIRI) rather than write it down also compensates the writing difficulties.

5 Application and Analysis: Research Method

The research presented in this article (see paragraph 3) was conducted for a time period of 4 months (from February 2015 to May 2015) and it engaged the third grade of the Music High School, with a total of 24 students (11 girls and 13 boys) of which 2 affected by dyslexia.

In the first month of work the students participated in the lessons in the classroom listening to the explanations of the teacher and only taking notes: no text or lecture notes were given to them. At the end of the month, an examination was passed in the classroom with an open-ended questions test, identical for non-dyslexic and dyslexic students.

The result supplied important (and at the same time expected) indications so as to be able to continue with the project. In particular, the following data emerged (Fig. 2):

(1) 75% of the students (18 students) answered all the questions (none of the dyslexic students);
(2) 46% of the students (11 students) were able to make connections between different concepts (none of the dyslexic students);
(3) 30% of the students (7 students) reported examples in the answers in support of the explanation (of which 1 dyslexic student).

The indicated parameters do not refer to the correctness of the answers or of the examples.

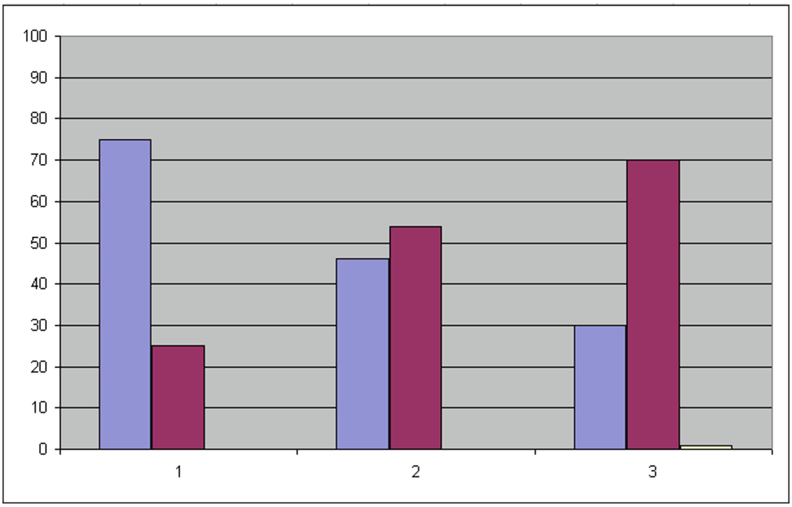


Fig. 2. Results of the first examination

In the following months, two work groups were created, each made up of 12 students, dividing the students who had high academic performances equally between the two groups. The two dyslexic students were inserted each in a different group. The students were allowed to use WhatsApp for personal study.

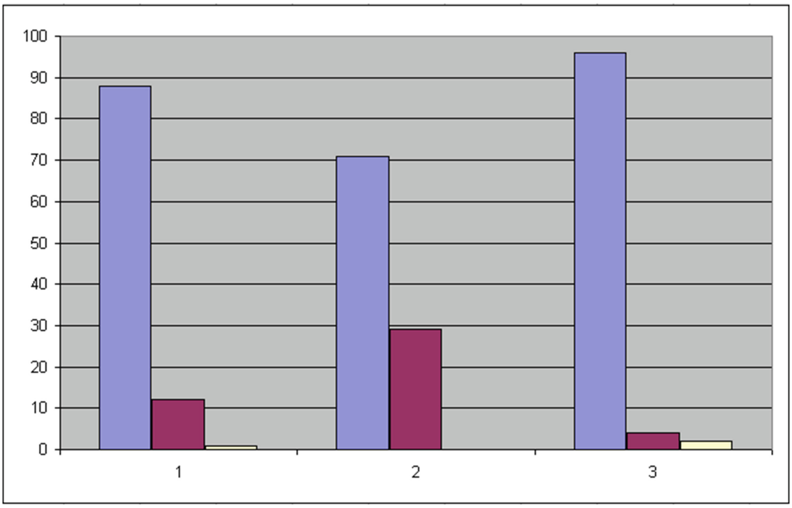


Fig. 3. Results of the second examination

At the end of the project a classroom examination was carried out (assigning everyone the same test), the results of which exceeded the expectations (Fig. 3):

(1) 88% of the students (21 students) answered all the questions (of which 1 dyslexic student);
(2) 71% of the students (17 students) were able to make connections between different concepts (none of the dyslexic students);
(3) 96% of the students (23 students) reported examples in the answers in support of the explanation (of which 2 dyslexic students).

Besides the numeric results that can be read in the diagrams, one of the most important things that emerged refers to the increase of the number of students that answered all the questions and the use of the examples in the same answers: the students used WhatsApp to share the notes, using a simple and precise language in order to meet the needs of the group.

There was a substantial improvement, as far as the two dyslexic students are concerned, to the point of managing to pass the final examination with a mark higher than 60%, considering that it was not (as already mentioned) different from the test of the other colleagues. Their oral presentation improved as well, the dyslexic students managing to formulate discourses full of examples, rather than mere definitions.

The learning improvement also appeared for students who already drew a high profit: the process was positive for them as well, inasmuch as they learned to select the information they found based on the group members (particularly with reference to the dyslexic students).

6 Discussion and Conclusions

This paper has presented an analysis of the results of a research project involving social interaction via WhatsApp. The introduction of WhatApp was truly satisfying: there was a positive and significant impact both on the learning and on the teaching which was subsequently mirrored by the results reached at a didactic level.

It was determined that the technologies must be understood as a complex of artifacts that may boost didactic communication and have an impact on the teaching-learning processes. The new technologies are not, as a matter of fact, the goal, but the means: they allow a facilitation, an enhancement of a process that leads to more significant learning forms and that allows organizing the assimilated knowledge in a stable way and integrating them into what we already know.

The technologies within an *intentional* planning by the teacher may promote the shared knowledge building, the interaction with the information content, but also the customization of the learning paths and strategies and the active and also creative learning of the different disciplines.

References

1. Ferrari, S., Carlomagno, N., Di Tore, P.A., Di Tore, S., Rivoltella, P.C.: How technologies in the classroom are modifying space and time management in teachers' experience? REM V, **2** (2013)
2. Bell, A.: Exploring Web 2.0: Second Generation Interactive Tools, Kindle Edition (2001)
3. Rivoltella, P.C.: Smart Future. Didattica, media digitali e inclusione. Ed. Franco Angeli, Milano (2015)
4. Hatcher, J., Snowling, M.J., Griffiths, Y.M.: Cognitive assessment of dyslexic students in higher education. Br. J. Educ. Psychol. **72**(03), 119–133 (2002)
5. O'Reilly, T.: What is Web 2.0: Design patterns and business models for the next generation of software (2005). http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html
6. Jonassen, D., et al.: Meaningful Learning with Technology. Pearson, Merrill (2007)
7. Boyd, D., Ellison, N.B.: Social network sites: definition, history, and scholarship. J. Comput. Mediated Commun. **13**(1), 210–230 (2007)
8. Ellison, N.B.: Sociality through social network sites. In: Dutton, W.H. (ed.) The Oxford Handbook of Internet Studies, pp. 151–172. Oxford University Press, Oxford (2013)
9. Cesareni, D.: Un linguaggio diverso. Cooperazione Educativa **61**(2), 10–15 (2012)
10. Prensky, M.: H. sapiens digitale: dagli immigrati digitali e nativi digitali alla saggezza digitale. TD - Tecnologie Didattiche **50**, 17–24 (2010)
11. Selwin, N.: I Social Media dell'educazione formale ed informale tra potenzialità e realtà. TD - Tecnologie Didattiche **55**, 4–10 (2012)
12. Giovannella, C., Camusi, A.: Tools for an Augmented Design: quantitative virtual show&tell. Interact. Des. Architecture(s) J. - IxD&A **3–4**, 117–124 (2008)
13. Church, K., de Oliveira, R.: What's up with whatsapp? Comparing mobile instant messaging be-haviors with traditional SMS. In: Proceedings of the 15th International Conference on Human-computer Interaction with Mobile Devices and Services, pp. 352–361. ACM (2013)

14. Cohavi, A.: How did Whatsapp became the strongest social network? (2013). Calcalist. Retrieved http://www.calcalist.co.il/local/articles/0,7340,L-3593840,00.html
15. Cavus, N.: mLearning: An experiment in using SMS to support learning new English language words. Br. J. Educ. Technol. **40**(1), 78–91 (2008)
16. Gutierrez-Colón Plana, M.: Improving learners' reading skills through instant short messages: a sample study using WhatsApp. Proceedings of WorldCALL 2013 - CALL: Sustainability and Computer-Assisted Language Learning. Glasgow (2013)
17. Riyanto, A.: English Language Learning Using 'WhatsApp' Application (2013)
18. (http://akhmadriyantoblog.wordpress.com/2013/07/21/english-language-learning-using-whatsapp-application/)
19. Mphahlel, M.L., Mashamite, M.: The Impact of Short Message Service (SMS) Language on Language Proficiency of Learners and the SMS Dictionaries. A challenge for Educators and Lexicographers. In: Proceedings of the IADIS International Conference Mobile Learning (2005)

Digital Competence and Capability Frameworks in the Context of Learning, Self-Development and HE Pedagogy

David Biggins[1(✉)], Debbie Holley[1], George Evangelinos[2], and Marketa Zezulkova[3]

[1] Bournemouth University, Centre for Excellence in Learning, Talbot Campus, Poole BH12 5BB, UK
{dbiggins,dholley}@bournemouth.ac.uk
[2] Anglia Ruskin University, Faculty of Health Social Care and Education, East Road, Cambridge CB1 1PT, UK
george.evangelinos@anglia.ac.uk
[3] Insitute of Communication Studies & Journalism, Charles University, Smetanovo nab. 6, Prague 110 00, Czech Republic
marketa.zezulkova@fsv.cuni.cz

Abstract. The paper explores and compares digital competence (DigComp) framework, published by EU in 2013 and updated in 2016, with digital capabilities (DigCap) framework introduced within the UK higher and further education context in 2009 and updated in 2015. The similarities found between the updated versions are in the increased focus on data in the context of privacy and overall literacy, as well as in the inclusion of wellbeing into the key areas. The main difference between the digital competence and capabilities frameworks is in the DigComp's neglect of life-long learning and self-development. The paper further discusses the frameworks, their similarities and differences, through a single UK institution case study of a technology enhanced learning toolkit for HE. It then concludes by arguing for a human-centered approach to digital competence and capability frameworks, in which learning, self-development and wellbeing should play a vital role.

Keywords: Competence · Capability · Framework · Toolkit · Learning · Wellbeing

1 Introduction

Despite the number of efforts in promoting and developing digital competence across varying social spheres such as education, health and policy, the study *Measuring Digital Skills across the EU* (2014) found that 47% of the EU population has insufficient digital skills, whilst 23% has none at all, as well as that 39% of the EU workforce has insufficient digital skills with 14% having no digital skills, and lastly 64% of disadvantaged people (aged 55–74, low educated, or unemployed) have an insufficient level of digital skills and 38% have no digital skills at all [1]. The study adds that *information* and *communication* skills are higher than *content creation* and

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 46–53, 2017.
DOI: 10.1007/978-3-319-49625-2_6

problem-solving skills among the EU population. This represents a key challenge for institutions educating young adults who seem technologically competent but at the same time might have a narrow knowledge and set of skills connected to specific platforms (e.g. social networks) and technology (e.g. mobile phones) [2, 3].

It however is not digital competence or capability per se that is important, but instead the inclusive and effective life-long learning and enabling that it embodies. Education of all levels is preoccupied with complex literacy and student's ability to navigate self-learning for continuous development [4]. Digital competence and capability therefore plays, or should play, an essential role in both enhancing immediate, and enabling life-long, learning. Recognising this, EU and distinct local organisations – such as JISC in the UK – have developed and acknowledged a number of digital competence and literacies frameworks for the purpose of encouraging and underpinning various educational and other initiatives. This paper reviews the frameworks, positions them within the HE context and explores their practical implications through a single UK institution case study of a technology enhanced learning toolkit.

2 EU-Commissioned Digital Competence Frameworks

The European Parliament and the Council published recommendations on key competences for lifelong learning that included *digital competence* in 2006, whilst defining *competence* as 'a combination of knowledge, skills and attitudes' and clarifying that *key competences* are those 'which all individuals need for personal fulfilment and development, active citizenship, social inclusion and employment' [5]. This life-long learning reference framework approaches digital competence as a confident, informed, critical, reflective, responsible, ethical, and legal use of *Information Society Technology (IST)* – its tools and complex information – for personal, cultural, social, creative, innovative, and/or professional purposes. EU established here that digital competence penetrates all aspects of life at all stages, but there was no strategic framework in place until *Europe 2020* and its *Digital Agenda* (2010) made of seven pillars with one being 'promoting digital literacy, skills and inclusion' [6].

Following the Agenda, the *Digital Competence* (DigComp) project was commissioned by the EU DG for Education and Culture in 2011, leading to the publishing of the first DigComp framework two years later [7]. The Fig. 1 below summarises the core areas of the digital competence original framework from 2013, as well as its second draft of which the final version is expected to be published in May 2016.

The proposed changes, firstly, put more emphasis on 'digital technologies', and secondly, clarify and extend the safety area. Although the revisions are not yet definitive, safety will probably undergo the most significant changes, reflecting not only the EU's but also the general public's increased concern about personal data protection and overall privacy. The seemingly less significant amendment is the inclusion of 'well-being', but we would argue otherwise. Although the decision might be underpinned mainly by EU health and well-being agenda penetrating a number frameworks developed under distinct strategies (e.g. *EU Youth Strategy* [8]), it returns digital competence to its more complex and varied role in one's life as initially recognised by The European Parliament and the Council in 2006. Moreover,

DigComp framework 2013	DigComp draft framework 2016
1. Information	**1. Information**
Browsing, searching and filtering information	Browsing, searching and filtering information
Evaluation information	Evaluation information
Storing and retrieving information	Storing and retrieving information
2. Communication	**2. Communication**
Interacting through technologies	Interacting through technologies
Sharing information and content	Sharing information and content **through digital technologies**
Engaging in online citizenship	Engaging in **citizenship through digital technologies**
Collaborating through digital channels	Collaborating through digital **technologies**
Netiquette	Netiquette
Managing digital identity	Managing digital identity
3. Content Creation	**3. Content Creation**
Developing content	Developing content
Integrating and re-elaborating	Integrating and re-elaborating **content**
Copyrights and licences	Copyrights and licences
Programming	Programming
4. Safety	**4. Safety**
Protecting devices	Protecting devices
Protecting data	Protecting **personal** data and **privacy**
Protecting health	Protecting health **and well-being**
	Protecting the environment
5. Problem Solving	**5. Problem Solving**
Solving technical problems	Solving technical problems
Identifying needs and technological responses	Identifying needs and technological responses
Innovating and creatively using technology	Creatively using **digital** technology
Identifying digital competence gaps	Identifying digital competence gaps

Fig. 1. Digital competence framework 1.0 and its second updated draft

well-being has also been recently added to the six elements of digital capability [9] developed by *JISC (Joint Information Systems Committee)*, a UK-based non-profit organisation providing frameworks and resources for strategic development of digital literacies within the higher and further education sector. The following section will further discuss the digital capability framework and compare it with DigComp.

3 Digital Capabilities Framework in the UK HE and FE

Beetham and McGill led the JISC's Digital Capabilities (here referred to as DigCap) frameworks project in 2015, within which they reviewed over sixty frameworks and to them relevant websites and publications, while at the same time interviewed dozens experts based in HE and the relevant industry spheres [9]. The research found that there was a high awareness of the original seven elements of digital literacy published by JISC in 2009 [10], which allowed the research participants to provide informed insights and recommendations. They for example suggested that 'different areas visibly overlap' and thus 'described a '*venn diagram*'or '*flower with overlapping petals*'as more appropriate' than the tabular approach used by the previous framework [9] or currently by EU's DigComp. On this ground, a new diagram visualising the updated framework has been developed (see Fig. 2 below).

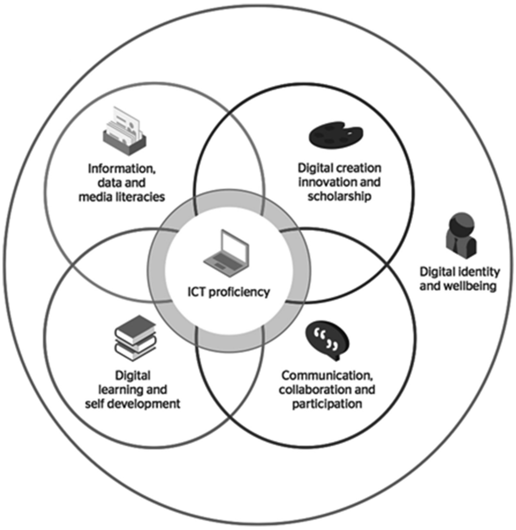


Fig. 2. Digital capabilities framework and its six elements updated in 2015

When comparing the new DigCap framework with the previous seven elements of digital capabilities, the information and media literacies have been brought together and at the same time extended with data literacy. JISC's DigCap and EU's DigComp frameworks therefore agree on the increased importance of 'data'. However, whereas EU focuses on protecting personal data and privacy while leaving 'literacies' to other frameworks (e.g. *Study on Assessment Criteria for Media Literacy Levels* [11]), JISC acknowledges more explicitly their overlap.

DigCap 2009 and 2015 as well as DigComp 2013 and 2016 frameworks all stress the significance of digital creation, innovation, communication, collaboration, participation or engagement, and digital identity. In addition to these and as mentioned earlier, the latest versions of the frameworks both added 'wellbeing'. DigCap justified this, on one hand, by the research finding that ‘digital practices could be a source of stress and concern’ among teachers (e.g. workload) and students (e.g. cyberbullying and time management), and on the other hand, by stating that ‘[e]veryone can suffer if digital technologies are used without attention to human and environmental health, and without considering whether digital practices are fully inclusive and equitable’ [9]. Whereas the first argument is grounded in Beetham and McGill’s primary research, the second is fully consistent with EU Digital Agenda’s aim to build ‘inclusive, equitable and sustainable European information society’ [12] as well as with other EU frameworks (e.g. *Education 2030: Incheon Declaration and Framework for Action towards inclusive and equitable quality education and lifelong learning for all* [13]).

The foremost striking difference between DigComp and DigCap lays in the area of scholarship, learning and self-development. Although one could argue that this is due to DigCap being developed specifically for education sector, it seems equally reasonable for DigComp to include digital learning and self-development, especially since the EU’s concept of digital competence originated in its life-long learning frameworks. Among other JISC’s work, *Learning in a Digital Age* [14] could be of interest to EU’s DigComp as it identified key areas of educational activity where innovation was crucial for lifelong learning to flourish: curriculum design and delivery, assessment, and support for learners.

Additionally, current work is being undertaken with the UK skills sector looking at engaging ‘digital students’, learners undertaking apprenticeships; offenders; learners in the Further Education sector [15]. Patterns are starting to emerge: regarding access to technology, fast Wi-Fi with good connectivity and the availability of a PC, laptop or tablet at the course centre are identified as the most important aspects of access to technology. Thus the UK specific work very much reflects the wider EU picture of complexity with consistent issues around access to technology, contributing to the digital divide. Lifelong learning and self-development remain challenges that society struggles with, best practice shows that we need to engage our stakeholders more widely to meet this challenge. Bournemouth University (BU) is an institution that prides itself on access; all students have the opportunity to undertake a work based placement; thus getting staff to model self-development and lifelong learning and to engage students with a wider digital agenda is essential. The following section will use the case of Bournemouth University to discuss DigComp and DigCap frameworks further.

4 Technology Enhanced Learning and Self-Development: Case of BU Digital Toolkit

BU’s digital toolkit, developed by the Centre for Excellence in Learning (CEL), will serve here as a case study that helps to illustrate abstract ideas through examples of real situations [16]. Case study approach is popular in educational research [17] as it allows to set a phenomenon such digital competence and capability learning within its context [16]; here being higher and further education in the UK, and by extension EU.

The mission of CEL is to make a significant contribution to strategy of fusing education, professional practice and research to enhance student learning experience across the University. A major theme is technology enhanced learning (TEL). This theme harness available technology to develop the competencies and confidence of staff and to engage and enthuse students in their learning. As Heppell (2016) argues, 'one significant impact of new technologies in education has been to give teachers and learners a voice through the many "bottom up" channels' [18]. Although TEL Tools have been in use for many years, their uncoordinated growth meant that many, sometimes duplicate, tools were being used and support was sporadic.

The TEL Toolkit was envisioned as a way of bringing together these disparate resources in one place so that staff, students, partner institutions and the wider academic community would know where to go for publicly accessible TEL information [19]. Support for the Toolkit is provided by Learning Technologists and IT, ensuring it is relevant and contemporary. Students interface with the Toolkit via the practice of lecturers and independently via exploration of the website, experiences that act to raise student expectations of the use of TEL.

An important aspect of the Toolkit is the six learning pedagogies it incorporates. The first four – blended learning, feedback and feedforward, flipped classroom, and assessment – are relevant to EU's educational frameworks and JISC's DigCap, whereas the remaining two – collaboration & co-creation and engagement – are directly aligned with both DigCap and DigComp. For each area, there is an explanation of why the pedagogy is important to teaching and learning, how staff can use the approach and the TEL tools available to develop their practice.

The TEL Toolkit is supported by an online questionnaire that enables staff to self-assess their confidence in tools and their broader digital literacy for the areas Figs. 1 and 2. The rationale for the questionnaire is two fold. First, staff gain a better understanding of their own digital skills and identify areas for self-development through personalised support which links to their well-being. Secondly, CEL uses the information to make informed decisions about how and where to focus resources.

The Toolkit has been in operation for 5 months and has been favourable received by staff. There have been 1,750 sessions to the Toolkit and 8,831 page views. Each week, roughly 40% of access originates from outside the University. Competitions and social media have been used to promote staff interest and engagement. A working group has been created to continue to develop and expand the Toolkit and also to manage the feedback from staff.

The dual forces of technology-capable staff and heightened student expectations are driving TEL developments at BU and together these will enhance the student experience.

5 Discussion and Conclusion

Through comparing the original and updated versions of digital competence and digital capabilities frameworks, the paper discovered parallel changes in the field of data privacy and data literacy as well as in the emphasis on wellbeing, whereas learning and self-development have been for now omitted by the EU's DigComp original and draft frameworks. Using BU's TEL digital toolkit as a case study, the paper illustrated how technological tools and human learning, self-development and wellbeing must go hand in hand, rather than being seen as separate phenomena, when discussing and applying digital competence and capabilities frameworks.

The close relationship between capability and wellbeing is possible to observe, for instance, in Alkire's [20] work that uses Sen's capability framework for the measurement of wellbeing. It can be difficult to establish a benchmark for measurement of digital competence and capabilities as the base level keeps moving up as new tools and skills become available and the levels of expected knowledge keep increasing. Even though Alkire focuses on public policy, there potentially is a space for measuring the effectiveness of an institutional TEL toolkit in a similar way. A research exploring TEL toolkit effectiveness, possibly in the context of wellbeing, is needed here.

A welcomed and positive change is the human-centered approach to digital competence and capability frameworks constructing 'human lives in terms of possibilities rather than deficits' [21] that penetrates a growing volume of recent research and practice in technology enhanced learning. If TEL is such a key area of learning and self-development, the HE and FE institutions should investigate whether it is feasible to make TEL compulsory so that TEL moves from an optional to a mandatory element of unit delivery. As the case study briefly highlighted, the ways in which TEL can rise in importance within an institution is through organisational leadership, a strategy that identifies the importance of TEL, support for staff and an embedding of the TEL philosophy in working practices such as objective setting and feedback gathering. Key to success however lays here in the human-centred approach prioritising staff and students' immediate and lifelong wellbeing rather than the mere use of digital tools.

References

1. European Commission: Measuring Digital Skills across the EU: EU wide indicators of Digital Competence (2014)
2. Evangelinos, G., Holley, D.: A Qualitative exploration of the EU digital competence (DIGCOMP) framework: a case study within healthcare education. In: Vincenti, G., Bucciero, A., Vaz de Carvalho, C. (eds.) E-Learning, E-Education, and Online-Training (ELEOT) First International Conference, Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, pp. 85–92. Cham: Springer International Publishing (2014). doi:10.1007/978-3-319-13293-8
3. Evangelinos, G., Holley, D.: A qualitative exploration of the DIGCOMP digital competence framework: attitudes of students, academics and administrative staff in the health faculty of a UK HEI. EAI Endorsed Trans. e-Learn. **2**(6), e1 (2015). doi:10.4108/el.2.6.e1
4. Zezulkova, M.: Media learning in primary school classroom: Following teachers' beliefs and children's interests. In: Kotilainen, S., and Kupiainen, R. (eds.) Reflections on Media Education Futures, pp. 159–169 (2015)
5. The European Parliament and the Council of the European Union: Recommendation of the European Parliament and of the Council of 18 December 2006 on key competences for lifelong learning (2006)
6. European Commission: Digital Single Market Europe 2020 strategy https://ec.europa.eu/digital-single-market/en/europe-2020-strategy
7. European Commission: DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe (2013)

8. European Commission: Youth Strategy on Health and Wellbeing. http://ec.europa.eu/youth/policy/youth_strategy/health_wellbeing_en.htm
9. Beetham, H.: Revisiting digital capability for 2015 (2015). http://digitalcapability.JISCinvolve.org/wp/2015/06/11/revisiting-digital-capability-for-2015/
10. Beetham, H., McGill, L., Littlejohn, A.: Thriving in the 21st century: Learning Literacies for the Digital Age (LLiDA project) (2009)
11. Celot, P.: Study on Assessment Criteria for Media Literacy Levels (2009). http://ec.europa.eu/culture/library/studies/literacy-criteria-report_en.pdf
12. Mansell, R.: Here comes the revolution – the European Digital Agenda. In: Donders, K., Pauwels, C., Loisen, J. (eds.) The Palgrave Handbook of European Media Policy, pp. 202–217. Palgrave Macmillan, Basingstoke (2014)
13. European Commission: Education 2030: Incheon Declaration and Framework for Action towards inclusive and equitable quality education and lifelong learning for all (2015)
14. JISC: Learning in a Digital Age Extending higher education opportunities for lifelong learning (2011)
15. Pepler, G., Jeans, N.: Summary of Jisc Digital Student Skills Sector study: preliminary review of the Learner Focus Groups (2016)
16. Yin, R.K.: Case Study Research: Design and Methods. Sage. Quin, Thousands Oak (2009)
17. Quinn, R.E.: Building the bridge as you walk on it: a guide for leading change. Jossey-Bass, San Francisco (2004)
18. Heppell, S.: From Digital Literacy to Capability: Critical review (2016)
19. Bournemouth University: The TEL Toolkit. https://www1.bournemouth.ac.uk/about/centre-excellence-learning/tel-toolkit
20. Alkier, S.: The Capability Approach and Well-Being Measurement for Public Policy (2015). http://www.ophi.org.uk/wp-content/uploads/OPHIWP094.pdf
21. McDougall, J., Readman, M., Wilkinson, P.: From Digital Literacy to Digital Capability. http://www.cemp.ac.uk/downloads/From%20Digital%20Literacy%20to%20Capability%20-%20Project%20Report.pdf

Holographic Signing Avatars for Deaf Education

Nicoletta Adamo-Villani(✉) and Saikiran Anasingaraju

Department of Computer Graphics Technology,
Purdue University, 401 N. Grant Street, West Lafayette, IN 47907, USA
{nadamovi, sanasing}@purdue.edu

Abstract. The paper describes the development and initial evaluation of an Augmented Reality (AR) system aimed at improving deaf children's competence in mathematics. The system allows for creating 3D animated avatars that translate from spoken English to Signed English (SE) in real time. The virtual sign language interpreters, displayed as 3D holograms in a mixed reality environment, can be used in the classroom to translate in real time the math lessons delivered by the teacher, at home to facilitate communication between hearing parents and deaf children, and at home or in the lab when children interact with math digital learning materials. An initial formative evaluation with deaf students, parents and educators supports the usability and usefulness of the AR system.

Keywords: Signing avatars · Deaf education · Augmented reality

1 Introduction

This article presents a novel approach to deaf education using holographic AR technology. The approach described in the paper is unique because it: (1) uses advanced technology to improve mathematics skills of K-6 deaf students; (2) provides equal access and opportunities by overcoming known deficiencies in science, technology, engineering and math (STEM) education as reflected in the under-representation of deaf people in fields requiring STEM skills; (3) provides a model for teaching technology in general that can contribute to improving deaf education around the globe. The paper is organized as follows: Sect. 2 discusses challenges in Deaf Education, Sect. 3 presents a brief review of studies on the application of AR in educational settings, and Sect. 4 reports prior research on signing avatars. The system is described in Sect. 5 and the evaluation study and findings are reported in Sect. 6. Conclusion and future work are included in Sect. 7.

2 Challenges of Deaf Education

Various estimates put the number of Deaf and Hard of Hearing people in the United States at 28 million [1]. An estimated half million Americans have severe to profound hearing loss, 8% are children (3–17 years) and 54% are adults 65 years of age or older [2]. Deaf individuals face barriers in school, the workplace, and social venues, which prevent them from equal opportunity for success.

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 54–61, 2017.
DOI: 10.1007/978-3-319-49625-2_7

The Deaf are significantly underrepresented in the fields of science and engineering and historically, it has been difficult for them to gain entry into higher education that leads to STEM careers [3]. There are several factors that contribute to this disparity: (1) significant delay in deaf children's literacy; (2) the difficulty of (hearing) parents to convey in sign language basic mathematical concepts, and the lack of efficient tools for learning sign language mathematics; and (3) the inaccessibility to incidental learning; i.e., exposure to media in which mathematical concepts are practiced and reinforced. Deaf children lack access to many sources of information (e.g., radio, conversations around the dinner table) and their incidental learning suffers. A strong need exists for solutions which allow deaf children to communicate and interact with other people in an environment free of prejudice, stigma, technological barrier, or other obstacles. The project described in the paper contributes to fill this need.

3 Augmented Reality in Education

Several studies have investigated the use of AR in learning environments [4], however the benefits of AR in education are still unclear and further research is needed. Wu et al. [5] suggest that research in this field should aim at discovering the unique characteristics and advantages of AR in education that differentiate this technology from others. One of the goals of the proposed work is to advance knowledge in this direction.

Recently, Diegmann et al. [6] conducted a review of the advantages of AR in educational settings based on 25 publications, and classified the benefits into five groups. Benefits related to "State of Mind" include students' increased motivation, attention, concentration and satisfaction; benefits related to "Teaching Concepts" include increased student-centered learning and improved collaborative learning. Benefits related to "Presentation" include increased information accessibility and increased interactivity. Benefits related to "Learning Type" are improved learning curve and increased creativity; those related to "Content Understanding" include improved development of spatial abilities and improved memory. Bacca et al. [7] analyzed 32 studies on the use of AR in education published between 2003 and 2013 and identified applications, target groups, advantages, limitations, and features. Results from their analysis show that the majority of existing AR applications are in science education, followed by arts and humanities, and engineering, manufacturing and construction; the largest target group is college level students. Major benefits include "learning gains" and "motivation", followed by "increased capacity of innovation" "positive attitudes", "awareness", "anticipation" and "authenticity". Main limitations include "difficulties maintaining superimposed information" and "intrusive technology".

The majority of the studies that were analyzed focused on marker-based AR, as marker-less AR has not been widely used in educational settings yet. The project described in the paper uses the latest advancement in marker-less AR, hence it contributes knowledge in a new area that needs exploration.

4 Signing Avatars

Research findings support the value of signing avatars. The pioneer work in applying computerized animation to sign language was carried out by Vcom3D [8]. Vcom3D SigningAvatar™ accessibility software has demonstrated the benefits of using 3D signing avatars to provide multimedia access and increase English literacy for the Deaf. In 2005, TERC collaborated with Vcom3D on the SigningAvatar®accessibility software and developed a Signing Science Dictionary [9]. Purdue University Animated Sign Language Research Group focuses on development and evaluation of innovative 3D animated interactive tools, e.g. Mathsigner, SMILE [10] and ASL system [11] aimed at improving deaf children's math skills. In the U.S., English to sign language animation translation systems include those by Zhao et al. [12] and continued by Huenerfauth [13] and by Grieve-Smith [14]. In China, researchers have created the Kinect Sign Language Translator, a system that understands signs and converts them to spoken and written language [15].

5 Description of the AR System

The project extends the functionality of the previously developed ASL system (a detailed description of the ASL system can be found in [11]; a demo of the system can be accessed at http://hpcg.purdue.edu/idealab/asl/about.htm). The new AR system takes as input: speech, a rigged 3D character and our current database of animated signs. The system recognizes speech and translates it into English text. The English sentences are interpreted to identify the signs, prosodic markers and prosodic modifiers needed to animate the signing character. The output is accurate and life-like Signed English animation data for the avatar. The signing avatar is displayed as a 3D hologram (Fig. 1-right) and viewed through the AR glasses (Fig. 1-left). The original ASL system was developed in Unity 3D, and assets such as avatar meshes, rigs, and animations were reused. Translation of spoken English was implemented using the Microsoft Speech SDK. A custom Speech Recognition Grammar Specification (SRGS) file for K-6th grade level math preparation was developed to test the holographic AR system.

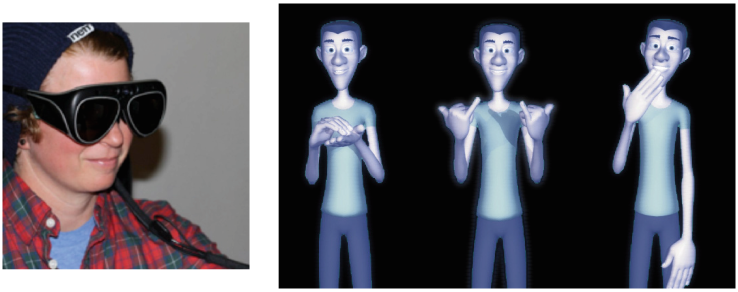


Fig. 1. AR glasses (left); holographic signing avatar (right)

Please note that the system does not translate from speech to animated American Sign Language (ASL). Several considerations currently prevent such an endeavor. While extensive research on the structure of English is available, the study of ASL structure is only recently begun, and there are significant barriers to simple syntax-to-syntax translations. Second, of course, there is the general translation problem related to the semantic domains of words not overlapping in different languages. For example, the English word 'run' can translate into different ASL signs depending on the context: 'run a race', 'run an office', 'run for office'. While lexical sign choice can be guided by our existing algorithms so that the correct sign appears, we cannot yet guarantee that the ASL syntax associated with that sign will come out correctly. Thus, signed English is a viable first step for development of the system.

To date the AR system has been used in the context of math education. The rationale is twofold: (1) as mentioned in Sect. 2, there is a pressing need to improve deaf children's competency in mathematics, and (2) the authors have extensive experience in research and development of K-6 math tools for deaf children [10, 11] and had previously created a database of animated signs for K-6 mathematics.

5.1 Technical Details

The AR system was developed using the Meta 1 developer kit and the Unity 3D game engine. The meta 1 SDK includes 3D see-through glasses, head and hand tracking, cameras and audio input/output. The AR glasses allow users to see the real world with holographic images in it. Deaf children sitting in a classroom see the holographic signing avatars seamlessly integrated with the physical environment (Fig. 2). Students can move around their immediate environment without losing the holograms because the digital eyeglasses offer 360-degree head tracking. So far, the holographic signing avatars have played the role of sign language interpreters (e.g. they translate into SE what the teacher or parent is saying). However, the AR system also allows students to interact with the holograms via simple gestures (for head and hand tracking, the meta1 uses a nine-axis inertia sensor, a magnetic compass, an accelerometer and a gyroscope). This possibility will be explored in future applications.

The meta 1 SDK is powered by the Unity engine. Using Unity as the development platform offered two main advantages: (1) Unity has an optimized graphics pipeline that supports interactive rendering of complex animated 3D meshes and advanced lighting and textures even on computers with limited graphics capabilities. (2) Unity interfaces seamlessly with major 3D animation tools and file formats, and allows for instantaneous import and update of asset files and animations.

6 Initial Evaluation

The objectives of the initial evaluation were to investigate (1) whether the 3D holographic signing avatars are usable by deaf children, and (2) the attitude of deaf children, their parents and teachers toward them. In particular, the formative evaluation focused on usability, willingness to use and perceived usefulness as evaluated by the children,

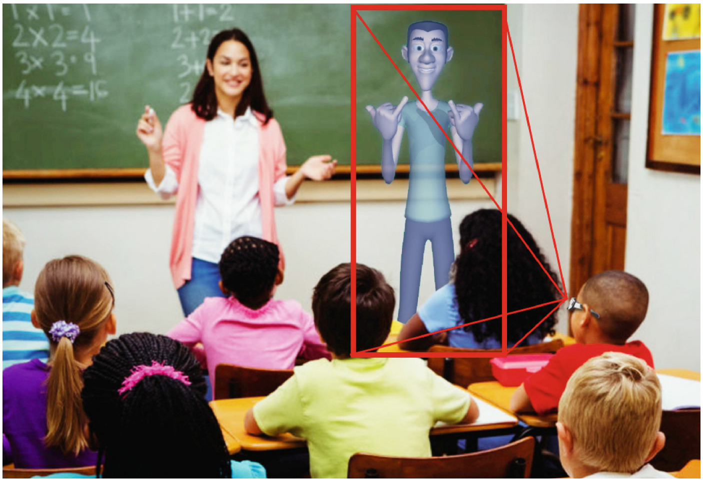


Fig. 2. Holographic 3D signing avatar seamlessly integrated in the classroom environment. The avatar, seen thorough the AR glasses by the child with the red shirt, is translating into SE what the teacher is saying

teachers and parents, and enjoyment measures from the children themselves, following procedures we have previously used to assess other systems [16]. We employed quantitative and qualitative methods of data collection and analysis to examine the usability and functionality to identify weaknesses. Evaluation instruments included:

- Rating/ranking exercises and observation to measure "fun" and usability with the children. The evaluation of "fun" was based on the three dimensions of fun proposed by [17]: expectations (i.e., the component of fun which derives from the difference between the predicted and reported experience), engagement, and endurability (or 'returnance'), i.e., the desire to do again an activity that has been enjoyable. Ranking and rating questions were used primarily to measure endurability and expectations, while observation was used to assess engagement and usability. In general, ranking, rating, and observation have been proven to be more reliable than children's responses to questions on whether they liked something [18]. All ranking and rating questions were designed to be age appropriate: for instance, children rated elements of the system using a scale with 4 smiling/frowning faces (full smile, partial smile, partial frown, full frown), which the authors had used in a previous study with children [16].
- Interviews with teachers and parents regarding their perception of benefits and challenges of using the AR system.

6.1 Subjects and Procedure

Subjects included 5 children (age 7–10; all children were ASL users), 2 hearing parents and 2 K-6 math teachers. The teachers, children and parents were invited to one of the research labs at Purdue University and one of the teachers was asked to deliver a 10 min math lesson. In the first part of the experiment, all children were given a set of AR glasses so they could see the holographic virtual sign language interpreters translating the teacher's lesson in real time. In the second part of the experiment, the parents and the teacher who was not lecturing were given the AR glasses and the teacher was asked to repeat a segment of the math lecture (only 5 AR glasses were available in the lab therefore children, parents and educators could not use the glasses at the same time). In the third part of the experiment, 2 of the children (wearing the AR glasses) sat in front of a computer displaying a digital math lesson, which included text and images. Their parents sat next to them and explained the lesson. The children viewed the holographic signing avatars, which translated what the parents were saying in real time. Upon completion of the three parts of the experiment, the children were asked to answer the rating questions and the evaluator interviewed the parents and teachers.

6.2 Findings

Fun and Usability (Children). The diagram in Fig. 3 summarizes the results of the children's *expectations* by showing the differences (in mean values) between the predicted and reported experience. According to Read et al. [17], this difference is an effective indicator of how enjoyable the experience has been. As mentioned previously, children rated their responses using a scale with sad and happy faces. To calculate the mean values, the happiest face was assigned a value equal to 4 and the saddest face was assigned a value equal to 1. Results show that the children had high expectations but the reported experience surpassed them. The system was perceived more fun and easier to use than expected, and following/completing the lessons with the signing avatars less challenging than expected. Table 1 summarizes the results of the 'Again-Again Table' used to measure 'returnance'. The table reveals that children enjoyed all activities and wanted to do them again.

Observation showed the all children were engaged and attentive. Two children showed discomfort with the glasses and readjusted them on their nose several times. The glasses are designed for adults and their size is too large for children. We are currently researching a solution to this problem, including coupling the glasses with a headband.

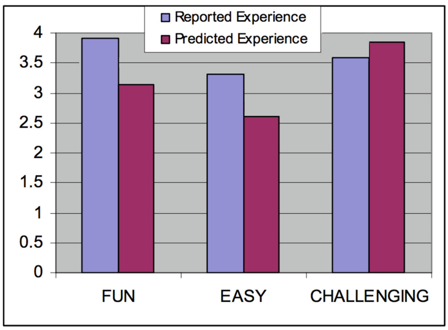


Fig. 3. Diagram showing the differences between the predicted and reported experience

Table 1. Summary of results of the 'Again-Again Table'

Question	Mean value (1–4)
Use the AR glasses again?	3.8
Watch the signing avatars again?	4
Walk toward/around the signing avatars again?	4

Perception of Benefits and Challenges of the AR System (Teachers And Parents). All subjects agreed that the AR system is a useful tool that shows great potential for improving young deaf children accessibility to learning content. Both teachers commented that the signing avatars were "*accurate and fluid*". Two of the subjects expressed some concerns regarding the usability of the glasses and commented: "*two of the children seemed uncomfortable with the glasses, maybe because they are too heavy*". Both teachers said they would like to use the system in their class and both parents were interested in using the system at home when helping the children with the homework, however they were concerned about cost.

7 Discussion and Conclusion

The immediate benefit of this research is to improve access to K-6 math educational materials for deaf children, and therefore improve deaf students' learning of mathematical concepts. In order for the potential of the system to be fully realized, it must move from laboratory development and testing to field-testing and use. Thus, future work will focus on ensuring the successful transition of the system from research laboratory and expert user conditions to an actual education institution for the Deaf (i.e. the Indiana School for the Deaf) where the system is needed and where it is ready to make a potentially considerable impact.

Future work will also focus on extending the system in order to achieve a 2-way communication (speech to signing and signing to speech). Building on research by Chen et al. [15], we plan to use signing data captured with the Kinect motion control camera and translate the gestures into words which can be spoken by the avatar. Initially, sign recognition will be limited to K-6th grade level math vocabulary.

In summary, the work reported in the paper addresses an important research question: can the application of holographic AR improve deaf learning in STEM disciplines and overall communication between hearing and non-hearing members of our society? It also aims to advance what is known about the potential of AR for disability education and for improving the lives of people with disabilities. While our initial objective is to target the educational audience, we believe that facilitating creation of sign language translation is important beyond the education domain. For instance, the holographic 3D signers could be used in many other domains, such as entertainment and social networking to remove current communication barriers.

References

1. United States Census Bureau: Americans with disabilities (2010). Current population report. http://www.census.gov/prod/2012pubs/p70–131.pdf
2. Blanchfield, B.B., Dunbar, J., Feldman, J.J., Gardner, E.N.: The severely to profoundly hearing impaired population in the United States: prevalence and demographics. Bethesda, Project HOPE Center for Health Affairs, MD (A shorter Policy Analysis Brief (Series H, vol. 1, no. 1, October 1999), August 1999
3. Burgstahler, S.: Increasing the representation of people with disabilities in science. J. Inf. Technol. Disabil. **24**(4) (1994)
4. Lee, K.: Augmented reality in education and training. Tech. Trends **56**, 13–21 (2013)
5. Wu, H.K., Lee, S.W.-Y., Chang, H.-Y., Liang, J.-C.: Current status, opportunities and challenges of augmented reality in education. Comput. Educ. **62**, 41–49 (2013). doi:10.1016/j.compedu.2012.10.024
6. Diegmann, P., Schmidt-Kraepelin, M., Eynden, S., and Basten, D.: Benefits of augmented reality in educational environments - a systematic literature review. In: Wirtschaftsinformatik Proceedings 2015. Paper 103 (2015). http://aisel.aisnet.org/wi2015/103
7. Bacca, J., Baldiris, S., Fabregat, R., Graf, S., Kinshuk.: Augmented reality trends in education: a systematic review of research and applications. Educ. Technol. Soc. **17**(4), 133–149 (2014)
8. Vcom3D. http://www.vcom3d.com/
9. Signing Math and Science. http://signsci.terc.edu/
10. Adamo-Villani, N., Wilbur, R.: Two novel technologies for accessible math and science education. IEEE Multimed. Spec. Iss. Accessibility **15**, 38–46 (2008)
11. Hayward, K., Adamo-Villani, N., Lestina, J.: A computer animation system for creating deaf-accessible math and science curriculum materials. In: Proceedings of Eurographics 2010 - Education Papers, Norrkoping, Sweden, May 2010. EG Digital Library (2010)
12. Zhao, L., Kipper, K., Schuler, W., Vogler, C., Badler, N., Palmer, M.: A machine translation system from English to American sign language. In: White, John, S. (ed.) AMTA 2000. LNCS (LNAI), vol. 1934, pp. 54–67. Springer, Heidelberg (2000). doi:10.1007/3-540-39965-8_6
13. Huenerfauth, M.: A multi-path architecture for machine translation of English text into American sign language animation. In: Proceedings of the Student Workshop at the Human Language Technology Conference/North American Chapter of the Association for Computational Linguistics (HLTNAACL) (2004)
14. Grieve-Smith, Angus, B.: SignSynth: a sign language synthesis application using Web3D and perl. In: Wachsmuth, I., Sowa, T. (eds.) GW 2001. LNCS (LNAI), vol. 2298, pp. 134–145. Springer, Heidelberg (2002). doi:10.1007/3-540-47873-6_14
15. Kinect sign language translator expands communication possibilities (2013). http://research.microsoft.com/en-us/collaboration/stories/kinect-sign-language-translator.aspx
16. Adamo-Villani, N., Wright, K.: SMILE: an immersive learning game for deaf and hearing children. In: Proceedings of SIGGRAPH 2007 - Educators, San Diego, 5–10 August 2007. ACM Digital Library (2007)
17. Read, J.C., Macfarlane, S.J., Casey, C.: Endurability, Engagement and Expectations: Measuring Children's Fun. Shaker Publishing, Interaction Design and Children, Eindhoven (2002)
18. Hanna, L., Neapolitan, D., Risden, K.: . Evaluating computer game concepts with children. In: Proceedings of the 2004 Conference on Interaction Design and Children: Building a Community, Maryland, pp. 49–56 (2004)

How to Apply Gamification Techniques to Design a Gaming Environment for Algebra Concepts

Usef Faghihi[1(✉)], Donald Aguilar[2], David Chatman[2], Nicholas Gautier[2], Jeffrey Gholson[2], Justin Gholson[2], Melvin Lipka[2], Robert Dill[2], Philippe Fournier-Viger[3], and Sioui Maldonado-Bouchard[4]

[1] Department of Mathematics and Computer Science, University of Indianapolis, Indianapolis, IN, USA
faghihiu@uindy.edu

[2] Department of Computing and Technology, Cameron University, Lawton, OK, USA
{Daguilar,David.chatman,Nicholas.Gautier,jg924694, jg907547,melvin.lipka}@Cameron.edu, binarybob0010@gmail.com

[3] School of Natural Sciences and Humanities, Harbin Institute of Technology Shenzhen Graduate School, Shenzhen, Guangdong, China
philfv@hitsz.edu.cn

[4] Department of Psychology, McGill University, Montreal, QC, Canada
siouimb@gmail.com

Abstract. Applying game-like mechanics in non-game software is a technique known as gamification. Gaming environments have been used to teach mathematical topics such as addition and division in a fun manner. However, given the difficulty of mathematical concepts, especially at the college level, it is very difficult to make software that can be considered both a video game and a teaching tool. Past game work in mathematics has mainly been the creation of puzzle games for primitive concepts such as addition. Our aim with this work is to show how we can build a type of entertainment software that allows users to learn mathematical concepts through play and investigate whether this type of game can help reduce players stress.

Keywords: Gamification · Artificial intelligence · Tutoring systems · Gamifing mathematics' concepts

1 Introduction

Many people struggle when it comes to learning mathematics [1, 2]. It has been shown that video games equipped with intelligent tutoring system tools can significantly improve learners' performance [4–7]. In a previous paper [4], authors showed that compared to traditional and online tutorials systems, gaming environments can be particularly beneficial for learning mathematics at the college level. However, the

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 62–70, 2017.
DOI: 10.1007/978-3-319-49625-2_8

authors only discussed how the quadratic formula can be implemented as a type of puzzle game. That is, the learners must have some background in college algebra in order to be able to solve puzzle games. Learners who have difficulty with mathematics may not be motivated to complete such puzzle games. Furthermore, the explicit introduction of mathematics into puzzle games might increase the learners' apprehension and anxiety level thus preventing learning [8, 9].

While playing a game and learning, it is imperative that the learner remains motivated. Many psychological methods such as the instructionalist and constructivist methods have been used in Intelligent Tutoring Systems (ITS) to keep students engaged and motivated during training sessions [10, 11]. However, one might ask, what shall we do if you are teaching math and your students aren't into it?

In an educational software, to get learners engaged when it comes to the gamification of a concept, most refer to the use of gamification techniques such as leveling up users in the game, as well as using badges and points: increasing the numerical number of your work. However, given the level of difficulty involved in teaching mathematical concepts, additional gamification concepts should also be used[1]. The first and most important criterion is that the learners feel they are playing a game- not solving a mathematical problem. Furthermore, the aforementioned gamification criteria make sense in learning environments in which learners can identify themselves with the game. This should have the feel of a real entertainment environment once they are immersed. Thus, making users forget about math and have low level stress while playing and learning.

In this paper, we show a system that starts with very primitive concepts such as addition and subtraction, and allows learners to learn difficult concepts such as coefficient in quadratic formula. The key component of this work is making an emergent training session. That is, the learner must feel he/she is playing a real game (not a mathematical puzzle to be solved), and become engaged with the game. Once the player's attention is engaged, mathematical concepts are introduced within the game.

Our claim in this work is that to maintain learners' motivation, the following criteria are essential: (1) the game must have elements of fun; (2) there must be a path to the mastery of game: learners receive hints and are prompted about their progress towards short-term and long-term goals. As opposed to ITS, the hints and demonstrations are presented in two parts, (a) hints and demonstrations about how to play the game, (b) hints and demonstrations about how to solve the mathematics problem; (3) challenges must be integrated into the game; (4) There must be competition and feedback: learners constantly know where they stand and where everyone else stands. A slight difference between gaming environment (GE) and Intelligent Tutoring Systems (ITS) for feedback is that ITS uses messages such as hints to motivate, and confirm learners actions. However, GE uses rewarding strategies such as badges; (5) There must be badges: once a player achieves a goal, it is clearly shown together with the score on the main menu of the application; (6) create challenges that do not have only one solution; and finally, (7) a tutoring system must be integrated within the game to intervene and help learners when necessary [4, 12].

[1] https://www.youtube.com/watch?v=qsl9NjyVpHY.

In this paper, we focus mainly on how to use gamification techniques to make learning math fun. Furthermore, our previous work has shown that even when we have a gaming environment that teaches math concepts in a fun way, the users can still have difficulty interacting with the system. So, our goal in this paper is to propose a way to make an environment that is both fun and easy to interact with, making learning emergent. As a first step, we describe how learners who were asked to solve a mathematical problem after using our mathematics computer game, called Flunky Math Mayhem, and reported lower anxiety about mathematics than learners asked to solve the same problem without having used our game first. We consider this a first piece of evidence that our game provides a learning environment for learning mathematics that promotes motivation and enthusiasm in the learners.

In the following sections, we use ITS tools, gaming technology, and artistic animations to create mathematics lessons with which it is fun to play and learn. We show different techniques which can be used to gamify algebra concepts. That is, from very basic and overlooked elements of daily life, one can make learning mathematics fun. In section two, we discuss the gaming environments that were conceived for learning mathematics. In section three, we describe our system (Flunky Math Mayhem), which is conceived to teach mathematical concepts. We then compare learners anxiety levels who use our system with the learners who did not for a given mathematics problem (see Sect. 4).

2 Related Works

Nowadays, game technology and gamification surround our daily life [13]. Games are created as hobbies for children and adults. Governments use them to encourage people to pay their taxes and use public transportation [14–16].

Many researchers and companies have been working on the learning of math using game technology, namely, Goodwin[2] for middle grade math games. Among others, gaming environments such as Math Playground, are shown to be useful for children learning math skills [17][3,4,5]. However, Math Playground lacks tutoring elements. Some of the aforementioned gaming environments also lack scaffolding for learners or they are not fun at all. Khan Academy (KA)[6] covers mathematics among other topics. Yet although Khan Academy uses elements of ITS (i,e., hints and gamification such as badges), it lacks fun components [2]. Indeed, those training sessions do not use video games and include few or no elements of fun.

Immersiveness is very important in our discussion because it is one of the most important steps that make learners get attracted to the gaming environment. Once

[2] http://www.mangahigh.com/en-us/.

[3] http://www.mathplayground.com/.

[4] http://matematika.hrou.cz/.

[5] http://www.ixl.com/.

[6] https://www.khanacademy.org/.

learners start playing the game, it automatically leads them step by step through the training session to help to achieve designed goals for this session.

When a mathematical concept is gamified, the gaming environment must help learners make associations between the gaming elements, aspects of the non-game activities, *the learners' own goals and the learners' own desires* [18]. To our knowledge, for higher- level mathematical concepts (i.e., quadratic formula such as[7,8,9]), gaming environments have failed to make learning and practicing mathematical concepts fun for students. This is in part because the current ITS lacks the gaming and artistic animation tools that can help designing fun lessons and fun interactions [4]. Therefore, to design and implement the Flunky Math Mayhem environment, we followed the following major steps:

(1) For each specific mathematical concept, we identified corresponding possible solutions and the various ways that the concepts could be taught in fun ways.
(2) For each concept and lesson, we designed gaming environments and elements for real games (i.e., Flunkys Fig. 2). To cover different concepts, we drew from different video games and movies. We also considered the narration of the game. That is, the game played in the first level must be coherent with the games played in the more difficult levels.
(3) For each concept, the lessons and solutions were discussed from an artistic point of view: artistic and real life examples were used to make the lessons' concepts fun.
(4) The psychological component of the lesson: we found real life entities that can be associated with every math concept and lesson.
(5) We integrated the gaming environment and ITS' tools that track users interaction and intervene when needed. For more work please read [4].
(6) We integrated gamification tools such as badges and scoring.

In the next section we describe the Flunky Math Mayhem game.

3 Flunky Math Mayhem[10] Description

Given that this paper focuses on how using gamification techniques can be applied to gamify both simple and upper-level mathematical concepts, in this section, we very briefly mention two different levels of our games: (1) simple addition; (2) first step to solve quadratic formula- identify coefficients such as a, b, c in a quadratic formula. It must be noted that we have implemented other concepts such as subtraction, division, fractions, factoring in a quadratic formula, etc. But for the sake of this paper, we will only explain these two concepts in our Flunky Math Mayhem game.

---

7 http://www.mangahigh.com/.

8 http://www.coolmath.com/.

9 http://www.onlinemathlearning.com/.

10 https://github.com/joseffaghihi/GamificationAlgebraConcepts.

In the following we will explain how we implemented two different levels of our Flunky Math Mayhem.

The main characters of our games are Flunkys, inspired from the Despicable Me movie[11].

Addition: The storyboard for this game is that Flunkys must escape a doomed island and make it on the boat (Fig. 2). In this scenario, Flunkys need to be trained and get ready for this adventure. In the first level (Fig. 1), they are embarking on a quest that will determine the rest of their lives. The Flunkys must train to be one of the few Flunkys that will be allowed on the boat. Only the fit Flunkys can escape the clutches of what is to come:

- Getting flicked off the ladder to climb
- Being faster than the other Flunkys so they won't be left behind

In this scenario, only the strongest can survive. Just like the Flunkys must train, the player must train. This level will test the player and the Flunkys quick wit to be able to quickly solve for x. Importantly, knowing how to solve for x is one of the first steps in knowing how to solve a quadratic equation. For the simple addition level (Fig. 1), while Flunkys run on a treadmill, there are bulleted numbers thrown towards them. Using up-down and left-right arrows, learners must help the Flunky avoid the wrong numbers by tilting to the left or right. However, when the right numbers come (numbers for the equation), the learners must make the Flunky collide with it. When this happens, a firework with noises is released and the learner is rewarded. On the left top part of the screen (Fig. 1) the formula appears. On the right side, the learner's life indicator demonstrates how many lives the learner has left. It must be noted that this environment is firstly created to make players play and avoid numbers. Again, the learners first try to learn how to make Flunkys run faster and tilt to left or right to save them. After a while if users cannot get the right answer the numbers spawning rate will decrease and finally a demonstration will be shown to explain the addition concept before the user can restart the game.

Coefficients in Quadratic formula: To start his level, we have created a boat (Fig. 1. B). Once this level loads, a quadratic formula is shown to the learners. The learner needs to find out coefficients a, b and c in the formula. At this point, Flunkys who were saved from the previous levels, are automatically spawned in the scene and try to go up to the ladders that are laid on the boat. There are two types of Flunkys that try to conquer the boat. The right numbers (good Flunkys) who were saved from previous levels and the wrong numbers (bad Flunkys). Getting bad Flunkys in the boat will make it sink and good Flunkys will not be able to escape from the island. The game encourages players to save the good Flunkys and the boat by flicking off the wrong Flunkys. That is, the player is a hero who tries to save good Flunkys from falling off the boat. Our goal when creating the challenge of the game was for it to be simple to play, in the essence of a popular game at the time called Flappy Bird.

[11] *"A 2010 American 3D computer-animated comedy film from Universal Pictures and Illumination Entertainment that was released on July 9, 2010 in the United States." Wikipedia.*

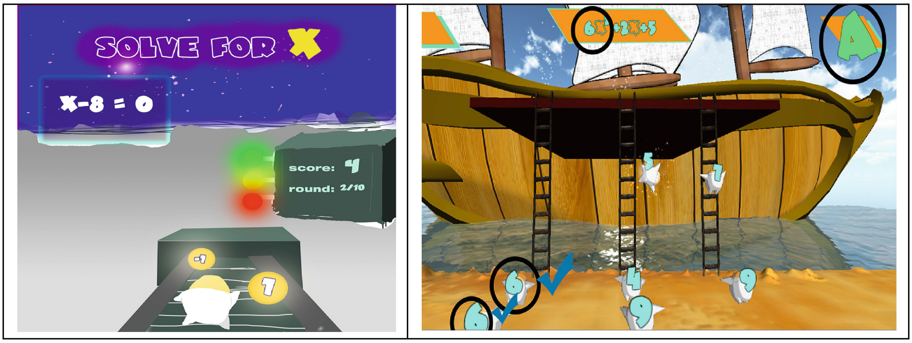


Fig. 1. (A) A Flunky runner on a Treadmill; (B) Finding the coefficients a, b, and c in a quadratic formula. The learner needs to let right numbers get to the boat by clicking on the wrong numbers.

To understand what the learner is doing at each moment, we made a parser for learners' activities. Time for solving problems is very important. Because each problem must be solved in a specific time frame, the timing to solve each problem is decided according to average time learners clicking on the Flunkys. If learners are slow in their first click, the Flunky spawning modules spawn Flunky at a lower speed. As the user improves, the game speeds up.

Finally, if the user misses the correct Flunkys, an animation that explains the quadratic formula automatically appears on the screen to help students understand a, b and c in a quadratic formula (Fig. 2). Thus, based on the learners' performance, the system assigns a score, give hints, presentations, changes some specific fonts, plays an audio file, blinks buttons or levels up the user.

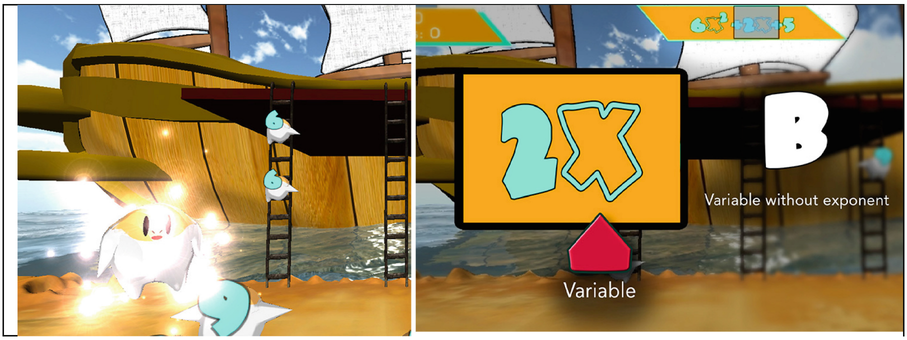


Fig. 2. Left side show the spirit of the Flunky who appears when learners needed help. The right side shows the explanation of coefficients in a quadratic formula.

In Flunky Math Mayhem, a learner can start each level with one or more animations that teach a lesson about, for example, how to use the game (Fig. 3) or the quadratic formula: Learners are free to follow the lesson, which is a fun animation (Fig. 3), or start playing with the game and solve the problems [3, 5–7]. Below, we briefly describe learners' outcome at a quadratic formula question either after playing our game, or not.

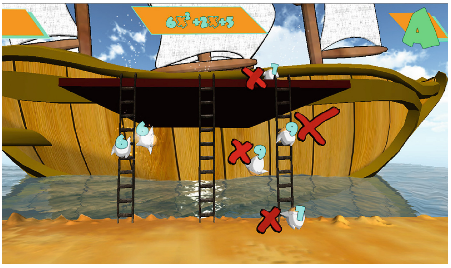


Fig. 3. An animation that show how to play the game.

4 Educational Game Evaluation by Users

Our long-term goal is to reduce the anxiety level of the learners who interact with this education game. As a first step, we asked adults attending a computer science workshop at Cameron University to participate in a pilot test. Fifteen individuals agreed to participate. Participants were randomly divided in two groups. Group A was told that they would have to solve a quadratic formula problem following a 15 min waiting period. Group B was told that they would have to solve a quadratic formula problem after having played our educational game for 15 min.

Following these instructions, we asked all participants to report their anxiety levels using a simple scale of −100, −50, 0, 50 or 100 (−100 extremely anxious to 100 not anxious at all). After completing the mathematical problem, we asked all participants to report anxiety levels again.

As can be seen in Fig. 4, all participants reported anxiety after having been informed that they would have to solve a mathematical problem (pre-test). However, participants who were asked to play our educational game prior to solving the problem reported significantly lower anxiety after having solved the problem. (Post-test; $p < .05$).

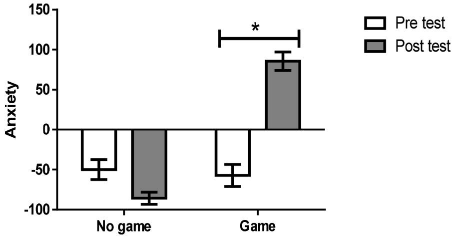


Fig. 4. Anxiety reported prior to mathematical test and after.

5 Conclusion

Video games can use gamification tools to foster learners' confidence when it comes to learning difficult topics such as mathematics [4]. They are also able to present various approaches to solve a given problem. Although many gaming environments exist to teach children mathematics, no such game exists to bond primitive mathematics concept to college-level math. Furthermore, for students who have difficulty with mathematics, even the word *a math gaming environment* may trigger a discouraging feeling in a training session. In this paper, our aim was to bring an environment that is a real game. Learners become engaged with the story board of our game, starting first with basic difficulty levels toward more difficult college algebra such as quadratic formula. Our very first primitive results proof-of-principle results are promising and demonstrate that this idea is worth pursuing. Another future aim would be to test larger sample of participants with our game, comparing anxiety levels and performance of participants who use Flunky Math Mayhem and ITSs' systems such as AutoTuror Lite[12].

Acknowledgements. We wish to thank Sioui Maldonado-Bouchard for her help in revising English in this paper, sharing her neuroscience expertise and the design and implantation of statistical experiments in this work.

References

1. Donovan, M.S., Bransford, J.D.: How Students Learn: History in the Classroom. National Academies Press, Washington, DC (2004)
2. Scarlatos, L.L.: Tangible math. Interact. Technol. Smart Educ. **3**, 293–309 (2006)
3. Bonwell, C.C., Eison, J.A.: Active learning: creating excitement in the classroom, (School of Education and Human Development, George Washington University Washington, DC) (1991)
4. Faghihi, U., Brautigam, A., Jorgenson, K., Martin, D., Brown, A., Measures, E., Maldonado-Bouchard, S.: How gamification applies for educational purpose specially with college algebra. Procedia Comput. Sci. **41**, 182–187 (2014)
5. Melis, E., Siekmann, J.: ACTIVEMATH: an intelligent tutoring system for mathematics. In: Rutkowski, L., Siekmann, J.H., Tadeusiewicz, R., Zadeh, L.A. (eds.) ICAISC 2004. LNCS (LNAI), vol. 3070, pp. 91–101. Springer, Heidelberg (2004). doi:10.1007/978-3-540-24844-6_12
6. Corbett, A.T., Koedinger, K.R., Anderson, J.R.: Intelligent tutoring systems. In: Handbook of Human Computer Interaction, pp. 849–874 (1997)
7. Latham, A.: A conversational intelligent tutoring system to automatically predict learning styles. Comput. Educ. **59**, 95–109 (2012)
8. Plake, B.S., Parker, C.S.: The development and validation of a revised version of the mathematics anxiety rating scale. Educ. Psychol. Measur. **42**, 551–557 (1982)
9. Ma, X.: A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. J. Res. Math. Educ. **30**, 520–540 (1999)

[12] http://www.skoonline.org/home.

10. Insights, M.M.: K–12 Education: Opportunities and Strategies for Ontario Entrepreneurs (2011)
11. Brown, A.L.: Motivation to learn and understand: on taking charge of one's own learning. Cogn. Instr. **5**, 311–321 (1988)
12. Koster, R.: Theory of Fun for Game Design. O'Reilly Media Inc., Sebastopol (2013)
13. McCallum, S.: Gamification and serious games for personalized health. Stud. Health Technol. Inf. **177**, 85–96 (2012)
14. Zichermann, G., Cunningham, C.: Gamification by Design: Implementing Game Mechanics in Web and Mobile Apps. O'Reilly Media Inc., Sebastopol (2011)
15. MacDonald, A.: Can We Change Behaviour and Meet Objectives Through Fun. Policy Horizons Canada, Ottawa (2012)
16. Newsom, G., Dickey, L.: Citizenville: How to Take the Town Square Digital and Reinvent Government. Penguin, New York (2013). https://www.penguin.com
17. Stanislav, V.: Online Problems for Mathematics and Computer Science Education (2013)
18. Nicholson, S.: A user-centered theoretical framework for meaningful gamification. In: Proceedings GLS 8 (2012)

Intelligent Tutoring Systems

Vladimír Bradáč[1(✉)] and Kateřina Kostolányová[2]

[1] Department of Informatics and Computers,
University of Ostrava, 70103 Ostrava, Czech Republic
vladimir.bradac@osu.cz
[2] Department of Information and Communication Technologies,
University of Ostrava, 70103 Ostrava, Czech Republic
katerina.kostolanyova@osu.cz

Abstract. The importance of intelligent tutoring systems has rapidly increased in past decades. There has been an exponential growth in the number of end users that can be addressed as well as in technological development of the environments, which makes it more sophisticated and easily implementable. In the introduction, the paper offers a brief overview of intelligent tutoring systems. It then focuses on two types which have been designed for education of students in the tertiary sector. The systems use elements of adaptivity in order to accommodate to as many users as possible. They serve both as a support of presence lessons and, primarily, as the main educational environment for students in the distance form of studies – e-learning. The systems are described from the point of view of their functionalities and typical features which differentiate them. The authors conclude with an attempt to choose the best features of each system, which would lead to the creation of an even more sophisticated intelligent tutoring system for e-learning.

Keywords: Adaptive systems · e-learning · ITS · Intelligent tutoring systems

1 Introduction

Computer-based learning is very favoured among the users of e-learning, mainly if it concerns languages [1], and as described in paper [2]. Languages can be taught and learnt through e-learning although with limited possibilities and results. Thus, various systems have been developed in order to overcome this insufficiency.

If any discussion about e-learning, adaptive learning and similar issues are to be discussed, recognised researches in this field should also be mentioned in order to define our approach. The most suitable starting point is undoubtedly Brusilovski's work concerning adaptive hypermedia and educational systems [3] and primarily [4]. His approach is the basis for other researchers that have been dealing with Intelligent Tutoring Systems (ITS). An example of an ITS is presented by [5], who developed "*Passive Voice Tutor*", which is a system for teaching the Passive Voice to Greek students. This ITS, in fact, includes knowledge of one domain, tools for modelling a student, recommendation generator to a student, and user interface. In [6] was created another ITS system, this one aimed at the system of English tenses – *English Tutor*. *English Tutor*, similarly to *Passive Tutor,* is usable only for a limited spectrum of the

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 71–78, 2017.
DOI: 10.1007/978-3-319-49625-2_9

language, grammar tenses. Moreover, it was overcome by *Passive Voice Tutor* in its ability to identify not only mistake in tenses, but also spelling and other mistakes likeable to occur in the answer. *Passive Voice Tutor* also creates a long-term profile of the student, which is not possible in *English Tutor*.

Comparing the above-mentioned systems, all of them differ from the two systems described. Either they do not work with learning styles and focus only on a limited spectrum of a subject matter, see [5, 6], or they do not use fuzzy-oriented expert systems for adaptation of the system, see [7]. Thus, a comprehensive, universal adaptive system that would combine elements necessary for modern e-learning, such as integrating learning styles/sensory preferences, identification of student's knowledge, assigning suitable learning objects and creating a personalised study plan, which has been tested and run in practice cannot be found in current sources.

The following chapters introduce two systems which were designed to eliminate/ remove the above-mentioned limitations.

2 Virtual Teacher

There are numerous ways how to try to make learning more effective using new technologies. New technologies are represented by a computer in our case. A teacher can use the computer more than just for a passive transfer of electronic study materials to students. A teacher can, to a certain limit, pass over his knowledge to a computer, his active way of teaching, reactions to certain situations or problems. And a computer can, to a certain limit, repeat teacher's behaviour. This results in an imperfect computer copy of a teacher, virtual teacher. Compared to a real teacher, a virtual teacher has its limits as well as several key advantages:

- it can be at more places at the same time, i.e. it can serve to more students scattered throughout the world. Their number is limited only by hardware means,
- it can gather experience from a lot of real teachers. The amount of experience is limited by hardware means,
- it can reliably remember a large number of data about each student's progress. It can then adapt the learning process,
- it can last hundreds of years and improve itself,
- after initial operation, it has low operational costs compared to real teachers [8].

This idea led to a proposal of a complex system to realise e-learning adaptive education, primarily focused on adaptation of the content as it is the major source of information for a student in electronic environment and significantly influences the learning process.

Structure of the system Barborka. LMS Barborka, as the system was named, works with a deeply structured study material to adapt it with respect to sensory preferences and levels of difficulty. The study is controlled by an algorithm whose parameters are set by an expert on adaptive education [9]. The system activities are divided in modules *Student, Author and Expert* described below.

2.1 Module *Author*

The content of this module consists of individual courses prepared for adaptive learning. Each course is divided into lessons, frames, variants and layers. The learning content is inserted into the system by an author using forms as formatted text added with metadata. The author creates only the content, but has nothing to with adaptation. Technically, the author has to be familiar only with basic work in the editor and know the meaning of individual form fields. The author does not have to know HTML or any other language.

2.2 Module *Student*

In adaptive learning, this module is primarily responsible for gathering information about a student, i.e. to find out his learning style and to evaluate the learning progress. Currently, the learning style is analysed using a questionnaire [10], whose results are not very accurate, but it can be filled in in 5 to 10 min compared to other questionnaires taking one hour and more. This module follows student's learning progress, primarily time in individual parts and the level of correct answers. The student is offered those materials that corresponds his characteristics the most. The student can also adapt the displayed study material to his needs. Thus, he can choose another sensory form or another level of knowledge. The system monitors such changes together with other student's activities.

2.3 Module *Expert*

This module defines the activities of the so-called **virtual teacher**, which displays suitably sequenced layers of the given frame in a suitable variant. The activities of the virtual teacher are set by a set of rules designed by an expert in adaptive learning. Each rule consists of assumptions and inferences. An assumption of the rules is student's knowledge.

The inference is the depth individual layers should have and the sensory type of the given frame. The inference can also be adapted in the sequence of individual layer types using three methods: by defining the basic sequence, which determines the basic sequence of layer types; by defining the sequence at the beginning and at the end; by defining the way of displaying of so-called multi-layers, i.e. more layers of the same type. Those are displayed either gradually with all layers of the same type, or individual types of multi-layers alternate according to the multi-layer sequence.

The system uses two algorithms. The following part briefly introduces their principle.

Algorithm of adaptive selection of learning style. Based on the rules, this algorithm creates a recommended learning style for a given student (i.e. it specifies sensory variants and defines the sequence and depth of a layer). The algorithm contains abbreviations and their values as follows:

- sign **Fix** gets values 0, 1 and 2 and determines the rule activity:
  - 0: the rule determines the sequence at the beginning or at the end,
  - 1: the rule determines the basic sequence,
  - 2: the rule determines the layer depth.
- sign **Int** gets values 0, 1 and 2 and determines the sequence of displayed layers:
  - 0: sequence set by the author
  - 1: successive multi-layers
  - 2: alternate multi-layers
- variables **MSt** represents individual characteristics of a student
- variable Form represents one of sensory types: verbal, visual, aural and kinesthetic
- variables **Vri,** where i is a natural number, represent layer type
- variables **Hli**, where i is a natural number, represent layer depth

In [14], the algorithm is introduced as follows:

Input: *Vector of static characteristics of a real student*
Student ({ver,viz,aud,kin}, MStAfek, MStSoc, MStSyst, {MStExp,MStTeor}, {MStHol,MStDetail}, MStHloub, MStAutoreg, MStVysl)
Output: *Learning style recommended for a givens student in a form of a vector*
StylSt (Form, {Vr1, Hl1}, {Vr2, Hl2}, {Vr3, Hl3}, ..., Int)

The algorithm itself was described in [11] in detail.

Algorithm of adaptive control of learning. Based on the above-selected learning style, this algorithm selects particular layers which are to be displayed. Apart from that, the algorithm controls system's reactions to an incorrect answer to a question.

This algorithm uses similar abbreviations and terminology as the previous one.

Input: *1. recommended learning style of the student*
StylSt (Form, {Vr1, Hl1}, {Vr2, Hl2}, {Vr3, Hl3}, ..., Int)
2. selected course, lesson, frame
3. metadata of frames of current lesson of current course
Output: *Recommended sequence of displaying particular layers of current frame.*

The algorithm itself was described in [11] in detail.

The used expert rules (IF-THEN type) constitute "pedagogical experience, knowledge and skills" in controlling personalised learning. Of course, it cannot be assumed that the currently defined rules will be optimal for all types of students. Similarly, pedagogues can be of different opinions on their formulation. Thus, the system is designed and implemented in a way that enables to easily refine or replace them without any program change. Every pedagogue-expert can adjust and verify his own theory on controlling adaptive learning.

3 Adaptive ELearning

3.1 Focus

The objective was to create an adaptive e-learning system, primarily for language education.

The pedagogical perspective considered the student itself, i.e. to gather information about his learning and absorbing information (sensory preferences), to gather information about his input knowledge of language. Such information is used to adapt the learning process at the beginning as well as during the learning process according to the initial and progress tests. The primary objective in this perspective was to adapt current e-learning courses which are rigid and the same for all students towards individual students' needs.

The technical perspective considered a proposal of a new methodology in language education, which stems from a general model of decision-making under indeterminacy [12] when deciding on next step in the learning process. It means to introduce such processes into current LMSs, which would result in more effective adaptation of the content and form of the content. It is done based on identification of student's knowledge and its assessment (adaptation of the content) and identification of student's sensory preferences (adaptation of the form of the content). It leads to the creation of a personalised study plan for a given student. Identification and creation of a personalised study plan is done using a fuzzy oriented expert system containing a knowledge base with IF-THEN linguistic rules. The rules have been created by an expert on language education.

A complex model of an adaptive e-learning system has integrated the above described areas into several subsequent processes in a way that enables to adapt the whole learning process. Processing information from a student, teacher and expert leads to a significantly effective and user-friendly way of teaching/learning of language using e-learning.

3.2 Structure of Adaptive eLearning

Adaptive eLearning is the name of an application designed as a new e-learning tool. Figure 1 depicts the scheme of its decision-making processes.

Acquisition of information about a student. Input information is information gathered before the learning process itself as well as during its progress. The input is a Didactic test and a Questionnaire of sensory preferences. Selection of the didactic test depends on the course that the student has selected in the given semester. Selection of the didactic test implies values related to the given course and test. The Questionnaire of sensory preferences is only one, standardised. It does not relate to any particular course or to other values.

Process M1a. Process M1a determines the combination of sensory preferences based on percentage calculation of frequency:

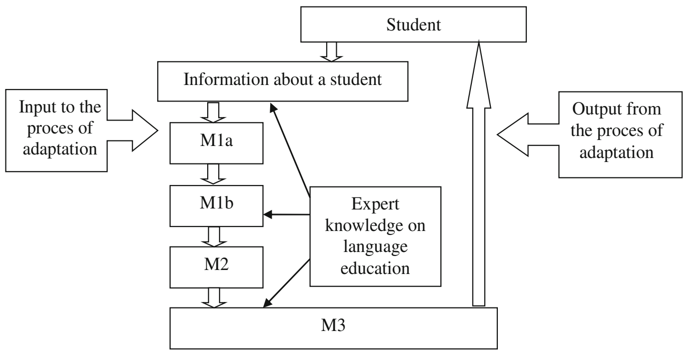


Fig. 1. Scheme of the decision-making process

$V_{\%}$ = [Frequency*V*/(Frequency*V* + Frequency*A* + Frequency*R* + Frequency*K*)]*100
$A_{\%}$ = [Frequency*A*/(Frequency*V* + Frequency*A* + Frequency*R* + Frequency*K*)]*100
$R_{\%}$ = [Frequency*R*/(Frequency*V* + Frequency*A* + Frequency*R* + Frequency*K*)]*100
$K_{\%}$ = [Frequency*K*/(Frequency*V* + Frequency*A* + Frequency*R* + Frequency*K*)]*100

A detailed study was presented in work [13].

Process M1b. Process M1b is a process which assesses the level of knowledge of the given student in the given course. The didactic test is assessed as a whole:

$$\left(Q_i + Q_j + \ldots + Q_n\right) \geq Q_{\mathrm{TOTAL}} * 0.4$$

If the minimum requirements are met, step 2 follows. This step consists in assessment of each category separately. The process uses a fuzzy logic expert system [14] and a knowledge base containing a set of IF-THEN rules to process the input variables (V1−V4) and assess the output variable (V5). The knowledge base contains 135 linguistic rules. A detailed study was presented in work [15, 16].

Process M2. This process consists in selecting only relevant study objectives ($\mathrm{Category}_{\mathrm{i}}$, $\mathrm{Category}_j$, …, $\mathrm{Category}_n$) for the given student out of the set of all study objectives. This is done based on the assessed objective relevance from M1b. Relevance assessment means meeting or failing to meet the requirements for the given objective, i.e. acquiring the needed knowledge (expressed by V5 value, or by Progress and Cumulative test results). At the end of the learning process, the selected relevant objectives, if successfully met, are added to already completed study objectives and thus create a whole set of study objectives.

Process M3. Activities in this process lead to the creation of a personalised study plan itself. When creating a plan, the input data is processed in several follow-up steps. The whole process is affected by factors influencing the final form of the generated study plan. A detailed study was described in [17].

4 Merging the Systems

A comparison of the two above-mentioned systems can be done only partially. It is obvious that the systems differ right in the core of their structure and in the principle of using adaptive elements.

A different and more interesting view than a mere comparison is the view how to merge both systems into one – in a system that would take over the best of *Virtual Teacher* and *Adaptive eLearning*. It means such features that make them specific against other ITS as well as those that make them adaptive. Individual features are described according to the processes used/done by the systems:

1. Testing and assessing sensory preferences – used by both systems. Adaptive eLearning without manual interference.
2. Testing and assessing the level of knowledge – assessment by an expert system (Adaptive eLearning)
3. Creating a study plan – various depths of study materials (Virtual Teacher); no predefined students' models (Adaptive eLearning, each student has a unique study plan); works with time (Adaptive eLearning).
4. Possibility to adjust the form of study materials – Virtual Teacher.
5. Diagnostics of student's progress – used by both systems but assessed by different algorithms.
6. System versatility – yes for Virtual Teacher; Adaptive eLearning was verified on language learning and shows signs of versatility.

Adaptive eLearning is a modular system, i.e. a part (module) can be added or taken out (or used in another system). Adaptive eLearning has its strength in the area of assessment of student's knowledge by an expert system which, used by Virtual Teacher, would lead to more accurate selection of the lesson, layer and depth of study materials. Integrating the time perspective of studying into Virtual Teacher would also significantly bring Virtual Teacher closer to optimisation of the learning.

5 Conclusion

This paper presented two representatives of existing Intelligent Tutoring Systems-*Virtual Teacher* and *Adaptive eLearning*. These systems use adaptive elements in order to be usable for as wide target group as possible. The systems are different in their structure of processes taking place in them and in the methodology of using study materials. However, a deeper analysis reveals that keeping the identical elements and implementing the differences (with certain limitations), it can lead to a newer, more sophisticated ITS. This finding lays bases for future research of the authors.

Acknowledgment. The research described here has been financially supported by University of Ostrava grant SGS02/UVAFM/2016.

References

1. Bos, E., van de Plassche, J.: A knowledge-based, english verb-form tutor. J. Artif. Intell. Educ. **5**(1), 107–129 (1994)
2. Murphy, M., McTear, M.: Learner modelling for intelligent CALL. In: Jameson, A., Paris, C., Tasso, C. (eds.) User Modeling. ICMS, vol. 383, pp. 301–312. Springer, Heidelberg (1997). doi:10.1007/978-3-7091-2670-7_31
3. Brusilovsky, P.: methods and techniques of adaptive hypermedia. User Model. User Adap. Inter. **6**(2–3), 87–129 (1996). Springer
4. Brusilovsky, P., Millán, E.: User models for adaptive hypermedia and adaptive educational systems. In: Brusilovsky, P., Kobsa, A., Nejdl, W. (eds.). LNCS, vol. 4321, pp. 3–53 Springer, Heidelberg (2007). doi:10.1007/978-3-540-72079-9_1
5. Virvou, M.: Web passive voice tutor: an intelligent computer assisted language learning system over the WWW. In: IEEE International Conference on Advanced Learning Technologies, pp. 131–134, Madison, WI (2001)
6. Wenger, E.: Artificial Intelligence and Tutoring Systems. MorganKaufmann Publishers, Los Altos (1978)
7. Pokorný, M.: Expertní systémy, Ediční středisko CIT OU, University of Ostrava, Ostrava (2004)
8. Beaumont, I.: User modelling in the interactive anatomy tutoring system ANATOM-TUTOR. User Model. User Adap. Inter. **4**, 21–45 (1994). http://wwwis.win.tue.nl/ah94/Beaumont.html
9. Kostolányová, K., Šarmanová, J., Takács, O.: Learning Characteristics. In: ECEL Proceedings, p. 107. Academic Publishing Limited, Porto (2010)
10. Takács, O., Kostolányová, K., Šarmanová, J.: Experimental verification of learning styles in e-learning. In: Efficiency and Responsibility in Education, pp. 302–311 (2011)
11. Takács, O.: Automatizované řízení adaptivní výuky v e-learningu podle stylů učení studenta. Dissertation thesis. VŠB – Technická univerzita, Ostrava (2014)
12. Klimeš, C.: Model of adaptation under indeterminacy. Kybernetika **47**(3), 355–368 (2011)
13. Bradáč, V.: Adaptive model to support decision-making in language e-learning. In: EDULEARN Proceedings, pp. 4036–4045, Barcelona (2013)
14. Habiballa H. et al.: Using software package LFLC 2000. In: 2nd International Conference Aplimat 2003, pp. 355–358, Bratislava (2003)
15. Bradáč, V., Klimeš, C.: Language e-learning based on adaptive decision-making system. In: ECEL Proceedings, pp. 48–58. ACPI, Reading (2013)
16. Bradáč, V.: Enhacing assessment of students' knowledge using fuzzy logic in e-learning. In: DIVAI Proceedings. pp. 251–262. Wolters Kluwer, Štůrovo (2014)
17. Bradáč, V.: Adaptivní e-learningový systém pro výuku jazyků. Dissertation thesis. Ostravská univerzita (2015)

Online Distance Education Materials and Accessibility: Case Study of University College of Estate Management

Tharindu Rekha Liyanagunawardena(✉) and Asma Hussain

University College of Estate Management,
Horizons, 60 Queen's Road, Reading RG1 4BS, UK
{tharindu, a.hussain}@ucem.ac.uk

Abstract. Distance education is accessible to those who have restricted access to more traditional forms of education due to their geographical location, employment, caring duties or disabilities. Therefore, it is important that online distance education providers seriously consider the accessibility of their materials. However, accessibility measures may limit the scope of interactive learning resources and may result in less dynamic and eye-catching materials, unless alternative accessible content is offered. If the content is not designed with accessibility in mind, there is also the financial cost of additional time and resources required to make reasonable adjustments. This case study examines the development of a comprehensive approach by University College of Estate Management to make its materials more accessible. Awareness-raising amongst staff and gaining senior management support are important factors that determine the success of accessibility initiatives. Weaving accessibility into an institutional culture is a long-term project that requires dedication and thorough planning.

Keywords: accessibility · distance education · online education

1 Introduction

Distance education caters for a diverse range of needs in different settings and is widely considered to be a more accessible form of higher education than traditional routes. UNESCO identifies distance education as being more accessible for indigenous people and communities based in rural, remote locations without convenient access to higher educational institutions [1]. Furthermore, it is accessible to armed forces personnel, prison inmates, carers and people with disabilities (including but not limited to motor, visual, hearing, cognitive/learning impairments) who may find it difficult or impossible to travel to attend lectures. This form of education also helps working professionals to keep up with the fast pace of change in this knowledge economy by providing an opportunity for lifelong learning alongside full-time employment.

A variety of technologies can be used to provide learning materials and facilitate communication between students and educators and based on the technologies used at the time, various phases of distance education have been identified in the literature [2]. However, the important fact is that the phases of distance education are associated with

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 79–86, 2017.
DOI: 10.1007/978-3-319-49625-2_10

global technology changes [3]. Today, education providers increasingly use internet technologies for content delivery (e.g. virtual learning environments (VLEs), streaming audio and video, web content, and e-books) and facilitation of both synchronous and asynchronous communications (online chat, webinars and discussion forums). While the majority of students are able to take advantage of the new and exciting learning activities these technologies offer, some, especially disabled learners, will not be able to access the material unless accessibility and good design practices (such as universal design principles [4]) are adhered to.

1.1 Accessibility

The term "accessibility" may be perceived differently depending on the context. For example, in the context of low bandwidth internet connectivity, accessibility could be attributed to the bandwidth usage of the service/application. Accessibility can also refer to access across time zones to participate in synchronous activities; or it can refer to access to a physical space (e.g. a building) or to a digital space (e.g. a website).

The World Wide Web Consortium (W3C) uses "web accessibility" to mean "people with disabilities can perceive, understand, navigate, and interact with the Web, and that they can contribute to the Web" [5]. In this paper, we use the term "accessibility" to describe equal access to the *content* of learning materials by students regardless of their disability or impairment. This may not necessarily mean that they are able to access the full multi-sensory experience of materials, but that they can access the content in some way; in many cases this will involve the use of assistive technologies. We also consider accessibility in relation to: device, platform and browser used by students to access materials; accessibility of content from geographical location of students (e.g. some websites are not accessible from certain countries); and anytime access to materials (e.g. synchronous activities such as webinars are recorded and uploaded).

Disabilities can pose huge challenges to learners, especially in a technology-mediated distance education setting. For example, videos (unless supplemented by an audio description of on-screen actions) can make content inaccessible to visually impaired learners. Similarly, unless accompanied by a transcript, a podcast is inaccessible to a hearing impaired learner; and colour-blind learners will be unable to recognise information differentiated solely by colour. While some assistive technologies such as screen-readers can provide support to disabled learners, unless the electronic materials are designed with accessibility in mind it is not easy, or pleasant, to navigate the content with these technologies.

1.2 Accessibility Standards

The Web Accessibility Initiative (WAI) of the W3C has published a series of web accessibility guidelines, which are widely adopted. These are known as the Web Content Accessibility Guidelines (WCAG). The current version, WCAG 2.0, published in 2008, later became an ISO standard. WCAG 2.0 defines three levels of accessibility conformance: Level A (the minimum level of conformance), Level AA and Level AAA. There are other standards such as the British Standard BS 8878:2010, which provides a framework for developing policies and procedures for accessibility.

1.3 Legal Obligation

Governments around the world have legislations to ensure the rights of disabled citizens are upheld. In the US, "The Americans with Disabilities Act of 1990" (or ADA) [6]; in Canada, "Ontarians with Disabilities Act of 2001" [7] prohibits discrimination and ensures equal opportunities for disabled people. In the UK, the "Equality Act 2010" [8] is the piece of legislation that protects people with disabilities against discrimination.

Disability rights groups and individuals have held North American universities accountable for inaccessible content and technologies used in teaching and learning. There are many higher education institutions that have faced lawsuits, complaints and settlements due to inaccessible content [9]. For example, in 2015, EdX, an online course platform co-founded by MIT and Harvard, entered into a settlement with the Department of Justice to address the violations of the ADA over their video lectures not containing captions [10]. In the UK, the Equality Act imposes a duty on service providers to make "reasonable adjustments" to enable disabled users to access their services, though these are open to interpretation and do not seem to be enforced as rigorously as in North America. There are charities such as AbilityNet [11] that provide accessibility testing services for businesses in the UK, helping them to comply with the legislation.

The next section of the paper presents University College of Estate Management (UCEM) case study; its investigations into what is required to meet the accessibility needs of disabled students; and how it plans to implement accessibility across its range of learning materials.

2 University College of Estate Management (UCEM)

UCEM, previously known as the College of Estate Management (CEM), has been a distance education provider since its inception in 1919. UCEM is the leading provider of supported online learning for the built environment, offering a range of distance learning programmes, from certificate courses to postgraduate programmes. Historically, the learning materials provided to students were predominately print-based, but more recently the learning materials in most UCEM courses are offered fully online using a variety of learning technologies. For example, UCEM's VLE is based on the Moodle platform and interactive eLearning materials are created using Articulate Storyline software. Regular webinars and chat sessions are used in almost every course to provide an engaging and varied experience for the learner.

UCEM uses a similar learning material production process to the Open University where subject experts, learning designers and editors work together as a team. Templates are used to provide a similar look and feel across the range of materials, while at the same time leaving room for creativity in content creation.

The materials with embedded audio/video (with sound) are almost always accompanied by a transcript. Generally accepted best practices, such as appropriate font, font sizes, colour schemes and layouts, to improve accessibility are used in all materials. However, these practices are largely individual efforts and not part of a wider and consistent institutional accessibility initiative.

2.1 Why Accessibility?

Part of the core purpose of UCEM, as described in its vision statement, is to "provide truly accessible, relevant and cost-effective education". UCEM, as a distance education provider, caters for students in various circumstances by providing them with the opportunity to gain professional recognition. Many students would not, due to their circumstances, have had this opportunity in a more traditional university setting. The institution has an international student body and offers exam centres in over 100 countries around the world.

UCEM does its best to support students regardless of disability or impairment. At present, 10.2% of students have registered with the disability and wellbeing service at UCEM. If any student has difficulties accessing materials, they can raise their concerns with the UCEM disability and wellbeing office, and UCEM can then make reasonable adjustments as appropriate. For example, in the past, large print versions of exam papers have been offered to visually impaired learners. More recently, UCEM negotiated with an e-book provider to offer higher resolution versions of diagrams within the e-book platform for a visually impaired student.

As well as its ambition to become the leading online vocational provider of programmes for the built environment, UCEM also aspires to become a leader in offering "accessible" education. Universal design principles and accessibility practices improve the experience for all users. For example, providing closed captions and/or a transcript is necessary for hearing impaired learners to understand the content of a video/audio resource. At the same time, international students, who in most instances are learning in a second (or subsequent) language, may find closed captions on videos or transcripts for audios to be an additional help. Students, irrespective of disability, will find closed captions to be useful in a noisy environment such as on trains when accessing materials during the commute to work.

The institution was recognised as a University College in November 2015, which meant that all learning material templates needed to be rebranded and updated. This was identified as an ideal opportunity to ensure that accessibility was incorporated into all UCEM learning material templates.

2.2 The Process

At the start of 2016, an exercise was undertaken to audit the accessibility of UCEM learning materials. The internal report revealed good practices at the University College, but also highlighted areas in which UCEM could improve the accessibility of its materials. The report's recommendations were divided into three broad areas: accessibility awareness, enhancing capability and a system for checking accessibility.

In order to update the learning material templates to reflect the new University College status of UCEM, a project team was assembled from the Online Learning Team within the Education department. Within this team, an instructional designer and a media designer (the authors) were appointed as the leads on the accessibility initiative. Both had a prior knowledge of, and interest in, accessibility, and had already completed online courses on the topic and conducted extensive desk research.

During the eight-week part-time project to redesign the templates, the authors further researched and identified best accessibility practices, and how these would translate to UCEM learning material templates and subsequent content that would be created from the templates. However, the authors soon realised that accessibility is a vast subject with many ‘grey’ areas which are open to interpretation. The authors had followed online courses on accessibility and, of these, the three noteworthy courses that helped them with this project were:

- Accessibility: Designing and Teaching Courses for All Learners – SUNY Empire State College and SUNY Buffalo State College
- Professional Web Accessibility Auditing Made Easy – The Chang School of Continuing Education, Ryerson University, Canada
- Digital Accessibility: Web Essentials – Equality and Human Rights Commission, AbilityNet and BCS, the Chartered Institute for IT.

These courses compiled and presented useful resources for accessibility in a concise format. After reviewing the desk research presented by the authors, the project team agreed that the WCAG 2.0 Level A was the appropriate standard for UCEM to adopt.

With practical guidance from the authors, the project team created accessible Microsoft Word and Microsoft PowerPoint templates. Furthermore, a decision was made to purchase Adobe Captivate software to create new eLearning materials as it supports the creation of accessible and responsive design across mobile devices. A set of mobile devices were purchased so that content could be tested on these.

Using the guidelines from WCAG 2.0, the authors created a list of practical ‘accessibility enhancements’ where each item of accessibility enhancement can be filtered according to the type of learning material it applies to (e.g. Microsoft Word, Microsoft PowerPoint, video, audio) and the user groups that it supports (e.g. visually impaired, colour-blind). Each item also includes a brief explanation of how it supports these user groups. This allows the user of the list (e.g. tutor, instructional designer) to understand how each action supports disabled students so that these actions are not just seen as a series of processes but as meaningful ways to help students access and engage with the content of learning materials. The authors also classified these items according to the timescale required to implement each enhancement: immediate (building into templates), ongoing (material creation from templates) and longer term (items which require technology upgrade and/or institutional IT support). An extract from the accessibility enhancement list is shown in Table 1.

After creating this list, the authors invited the Online Learning Team to comment on it. This feedback exercise identified items that needed further clarification.

The next step will be to decide which of these accessibility enhancements is to be adopted by UCEM. In this process, the impact of the proposed enhancement and cost/benefit associated with it will have to be taken into account. Some of the considerations are:

- the additional time/resource requirements to perform the enhancement, including additional technology, processes, staff, subcontractors, etc.

Table 1. Partial extract of the entry on alternative text from authors' 'accessibility enhancements' document.

Action	Use alternative text for simple images/diagrams (and also for buttons). If the image is only for decorative purpose, set the alt text to "" (null) so that the image will be ignored by assistive technologies
Guideline	WCAG 1.1.1
User types supported	Blind, visually impaired, all users - if for some reason images fail to load the alternative text will be shown
How this support users	Without a text alternative, images would not be perceived by users with visual impairments. These users rely on assistive technologies to access information. If an image is published without an alt tag then a screen reader would inform the user that there is an image present, but would not be able to give them any information about it, or it may read the image file name (if this is automatically attached as the alt tag), which will not adequately describe the image. Complex images may not be adequately explained by an alt tag so would require a more detailed description. If for some reason, the image fails to load in a web page or email, the alternative text will provide a description of the image for the user
Resource types this applies to	Any resource with images – Word/ PowerPoint/ Web pages/ eLearning

- any subsequent loss of interactive and engaging content which may come about as a result of the accessibility enhancement, and alternative solutions that could be offered to a student.

There was also the question of identifying which of these actions should be performed routinely to enable accessibility and which of these actions could be offered as "reasonable adjustments". For example, if a YouTube video published by a third party is used in a course and does not have closed captions, should a transcript be offered routinely; or if a student with a disability is registered on the course; or should it only be offered if requested?

Once these decisions have been made, accessibility checklists for different resource types will be derived from this list, i.e. a checklist for Microsoft PowerPoint content and a checklist for video resources. Newly created and completed resources can then be reviewed against these checklists as appropriate in the quality assurance process to ensure they meet the institution's standards for accessibility.

3 Discussion - Challenges

Implementing changes in an organisation is always challenging, especially when it involves changing established practices. Furthermore, it is more likely to be resisted if the changes make processes more time-consuming or more difficult than they used to be, or if the changes are seen to be imposed on employees by the management. To promote change, the following actions were taken:

- the authors were in continuous dialogue with the project team responsible for updating the templates, the Online Learning Team and the Online Learning Research Centre, presenting their findings and welcoming feedback;
- an organisational awareness presentation was given and the content was also shared with all employees via email. Staff from other departments of the organisation also volunteered their help with specific aspects of the research.

As a result, the authors were welcomed as accessibility champions within the organisation. It is also worth noting that the authors were in contact with, and benefited from advice and guidance provided by UCEM's Disability and Wellbeing Adviser.

Another challenge was to identify the appropriate standard to be followed and interpreting the WCAG 2.0 guidelines. While some guidelines (for example, using alternative text for non-text content) are clear, others are not so clear and are open to interpretation. This challenge involved researching how other institutions have interpreted these guidelines.

Furthermore, there is the task of defining what should be done when third party content is not as accessible as content created by UCEM. This can be tricky, especially where third-party content such as a YouTube video is seen as necessary to reinforce a learning point. But these videos may not have closed captions, transcripts or audio descriptions of any on-screen actions. Some ways of tackling this could be: removing all inaccessible content and finding or creating alternatives; providing transcripts and/or alternatives for inaccessible content as a standard (though this could be a waste of effort if, for example, the video then disappeared from YouTube); or using a disclaimer to acknowledge that the content has accessibility issues and the organisation would provide alternatives for students with special needs (reasonable accommodation).

Another decision was whether to recreate learning materials that are already in use but which do not comply with the accessibility standards. If it were to be applied retrospectively, it would mean the recreation of old content which may become obsolete within a short time frame compared with newer content.

There are likely to be practical difficulties that have to be considered on a day-to-day basis. For example, tutors create weekly summary videos for their students to provide feedback and such videos are embraced by students. These videos are generally created using webcams and smart phones and can be instantly uploaded to the VLE by tutors. In order to be fully accessible, these videos require a text-based alternative. However, the transcripts cannot be processed in the short time frame it would require. Thus, more creative ways of implementing accessibility need to be explored; for example, giving access to speech-to-text software so that tutors can instantly create transcripts along with the videos (these can then be checked for accuracy); writing a script to record the video; or summarising important points in a text document that accompanies the video. Making tutors aware of any disabled students registered on their modules and how to support their accessibility needs will create a better learning experience for students.

4 Conclusion

Designing for accessibility is a way to support universal access to learning materials. Accessibility is even more important in distance education as it generally caters for a range of learners who are unable to take up more traditional forms of learning. Accessible learning materials benefit not only the students with disabilities but also provide a better and more consistent user experience for all students. This can benefit the institution indirectly by contributing to student retention, as students who have a positive learning experience are more likely to continue with their studies. UCEM has taken its first step towards identifying accessibility standards and making a commitment to adhere to them. However, implementing accessibility is a long-term project that requires buy-in and commitment from both the institution and its employees.

Acknowledgments. The authors would like to thank Linda Dempsey, Jules Dracott, Adrian Shell, Andrew Belt and Katalin Hanniker for their help with comments on an earlier draft and proofreading the article.

References

1. UNESCO: Open and Distance Learning: Trends, Policy and Strategy Considerations. UNESCO Division of Higher Education. (2002)
2. Rumble, G.: Re-inventing Distance Education 1971-2001. Int. J. Lifelong Educ. **20**(1&2), 31–43 (2001)
3. Liyanagunawardena, T.R.: Information Communication Technologies and Distance Education in Sri Lanka: A case study of two universities. Ph.D. thesis, School of Systems Engineering, University of Reading (2012)
4. Meyer, A., Rose, D.H., Gordon, D.: Universal Design for Learning: theory and practice. CAST, Wakefield MA (2014)
5. World Wide Web Consortium: Introduction to Web Accessibility (2005). https://www.w3.org/WAI/intro/accessibility.php
6. United States Department of Justice Civil Rights Division: The Americans with Disabilities Act of 1990 and Revised ADA Regulations Implementing Title II and Title III. http://www.ada.gov/2010_regs.htm
7. Ontarians with Disabilities Act (2001). https://www.ontario.ca/laws/docs/01o32_e.doc
8. Equality Act (2010). http://www.legislation.gov.uk/ukpga/2010/15/contents
9. Carlson, L.L.: Higher Ed Accessibility Lawsuits, Complaints, and Settlements. http://www.d.umn.edu/~lcarlson/atteam/lawsuits.html
10. Duehren, A.M.: EdX Settles with Department of Justice, The Harvard Crimson http://www.thecrimson.com/article/2015/4/3/edX-settles-department-justice/
11. Ability Net, www.abilitynet.org.uk

Raising Engagement and Motivation Through Gamified e-Portfolio in Kolej Profesional MARA (KPM), Malaysia: A Preliminary Survey

Monisa Abdul Wahab(✉) and Mike Joy

Department of Computer Science, University of Warwick,
Coventry CV4 7AL, United Kingdom
{M.Abdul-Wahab, M.S.Joy}@warwick.ac.uk

Abstract. The gamification of e-portfolio is an educational approach to motivate students to learn by using game elements in online portfolios. The goal is to increase enjoyment and engagement through capturing the interest of learners and encouraging them to continue learning. This preliminary survey is important to better understand the intended users in a Malaysian institution, find out their readiness, and identify the infrastructure and facilities currently in place. The work in progress investigates students' demographics information, students' current styles in organizing their learning material, their prior experience with portfolio creation and development, their prior experience in using game applications and their current knowledge of 'gamification'. The outcome of this survey shows that there are currently acceptable levels of current infrastructure and facilities provided at the institution with a satisfactory knowledge of portfolios and game elements. However, there is an interesting misconception of what 'gamification' is from the student's perspectives.

Keywords: e-portfolio · Higher education · Gamification · Gamified e-portfolio · User engagement · Motivation

1 Introduction

Majlis Amanah Rakyat (MARA), or the Council of Trust for the People is an autonomous body under the purview of the Ministry of Rural and Regional Development in Malaysia. The Council is responsible for facilitating economic and social development in the federation, particularly in rural areas. MARA can be divided into four main sectors: Entrepreneurship, Education, Management Services, and Investment. The Higher Education Division (HED) – one of five within the MARA Education Sector – is responsible for controlling, planning and supervising the activities carried out by the Ministry of Education (MOE) and four HE institutions including Kolej Profesional MARA (KPM). KPM, previously known as Institut Perdagangan MARA (IPM), has been established since May 1977, and now has six campuses in Beranang (KPMB), Bandar Melaka (KPMBM), Indera Mahkota (KPMIM), Seri Iskandar (KPMSI), Bandar Penawar (KPMBP), and Ayer Molek (KPMAM), which are currently populated with

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 87–94, 2017.
DOI: 10.1007/978-3-319-49625-2_11

young adults aged 17–26. Each of the colleges offers a range of different courses from preparatory level to diploma level.

The e-portfolio is an emerging technology solution for assessing student achievement and showcasing learning evidence that gives significant benefits to the students and educators. However, e-portfolios suffer from user engagement issues. To engage users in the application is a challenging task for many education institutions and there is still no specific solution which has been identified to solve the problems. Continuous user engagement is important to ensure the success of the e-portfolio implementation.

Computer games have long been known for their success in modeling behavior and engaging users. Despite the disadvantages of using computer games in classrooms, such as ineffective use, losing focus on the content, causing addiction, too much time spent playing computer games, and time required for playing games being educationally inappropriate [1], players seem to like the game-based approach to learning and find it motivating and engaging [2]. Games put learners in the role of decision-maker, pushing them through ever-harder challenges while engaging them in experimenting with different ways of learning and thinking [3]. Following the success stories of user engagement in computer games, educators and researchers are still trying to explore ways to engage users by trying to integrate game elements in education and learning [4, 5]. 'Gamification' is the use of game mechanics and game design techniques, such as the awarding of points, rewards or other incentives, in non-game contexts, in order to change behavior [6, 7], and gamification has been used as a tool to increase engagement in e-learning platforms [8], however integration of game mechanics in e-learning needs further exploration.

A difference between a developed country such as the United Kingdom (UK), and a developing country such as Malaysia, is the degree to which people have access to computers and the Internet. In developing countries, access to desktop or laptop computers and to the Internet is limited while in western countries these are considered as primary ICT devices and services. For example, in 2013, only 65.1% of households in Malaysia had computers compared to 88.2% in the UK, and only 64.7% of Malaysian households had Internet access compared to 88.4% in the UK [9]. Hence, it is important to identify, quantify, and evaluate the level of technical background of KPM students to ensure the success of the e-portfolio implementation.

2 Methodology

The framework for gathering the research data was a mixed mode, based on the use of online questionnaires carried out in two phases (preliminary survey and post survey) for quantitative data, and supported with qualitative data in the form of comments and interviews. This paper reports the outcome of the first phase of the research work.

This preliminary survey has been conducted at three KPM colleges: KPMB, KPMIM, and KPMBM. These findings are based on online pre-survey of 174 students from these colleges aged 17 to 26 enrolled in three different courses: Higher National Diploma in Computing (Software Development) (HND SD), Diploma in Computer Networking (DCN), and Diploma in Entrepreneurship (DEn). The survey was conducted in autumn 2014, and the questions were prepared in both English and Malay languages in order to ensure all respondents would understand the questions.

3 Main Findings

In this section, the demographics of the participants are summarized, followed by subsections focusing on students' current styles in archiving and organizing their learning material, their prior experiences with portfolio creation and development, their prior experiences in using technology, games, gamification and their perceptions towards game elements in e-portfolios.

3.1 Demographics

A total of 174 respondents aged between 17 and 26 participated in the online pre-survey. The mean age value is 19.42 and the standard deviation is 1.407.

There are more male students (67%) than female students (33%) in the target population. A suitable approach that takes gender distribution into account may be used. Interesting results from previous research regarding effects of video games has identified that video games are liked more and played more by males than by females [10], therefore it might be interesting to find out the results of gamified e-portfolios for this particular target group.

In Table 1, we see that most of the students have been using the Internet for 5 years and more and use it daily. This suggests that they are very comfortable with the Internet service and there would not be a problem to introduce an e-portfolio application to these students. This is to be expected because younger generation unsurprisingly shaped by technology. Hence, an e-portfolio application can be beneficial for them.

Table 1. Internet usage duration, frequency, and internet skills satisfaction

Items	In percentage (%), n = 174		
	KPMB (n = 29)	KPMIM (n = 126)	KPMBM (n = 19)
How long have you been using the Internet?			
Less than 6 months	3.45	3.17	5.26
6 months to less than 1 year	0	0	5.26
1 year to less than 3 years	6.90	10.32	15.79
3 years to less than 5 years	0	31.75	21.05
5 years and more	89.66	54.76	52.63
How often do you use the Internet?			
Occasionally	3.45	8.73	5.26
Monthly	0	2.38	5.26
Weekly	3.45	6.35	0
Daily	93.10	82.54	89.47
How satisfied are you with your internet skills?			
Very satisfied - I can do everything that I want to do	24.14	27.78	63.16
Satisfied - I can do most of the things that I want to do	51.72	54.76	31.58
Neither satisfied nor unsatisfied	20.69	13.49	0
Unsatisfied - I can't do many things that I want to do	3.45	3.97	0
Very unsatisfied - I can't do most of the things that I want to do	0	0	5.26

For Internet skills satisfaction, the majority of the students said that they are satisfied and very satisfied with their Internet skills. These students are very confident of their Internet skills which give a good indicator to the researcher.

The top three used devices to access the Internet are smartphones (35.4%), followed by laptops (34.2%) and desktop computers (22.5%). Thus, more than 60% of the used devices are mobile devices (smart phones and laptops). This shows that students prefer using mobile devices to access the Internet compared to fixed terminals.

The distribution of locations where students usually access the Internet shows that most of the students usually access the Internet from home (49.4%) and college (44.9%). Only a small number of students access the Internet from public terminals and cyber cafés (5.86%).

More than half of the students said their Internet speed changes from time to time (77%), with a range of connections some of which drop frequently, some of which are reliable. The majority of the students rate their Internet connection speed as acceptable, which indicates the Internet service provided by the college is acceptably good.

Most of the students pay for themselves (59%), which reflect the students' affordance to pay the Internet fee. Otherwise, the Internet services would be paid by their parents (33%) followed by school (7%) and others (1%).

75% of the students agree that their current Internet service does not restrict the way they use the Internet while more than half of the students (62%) agree that their Internet connection speed ranges from acceptable to excellent level. This means the students do have good Internet services supported by the acceptable infrastructure for Internet services at home and at the colleges.

The target users are comfortable using computers and have good Internet skills and experience. Furthermore, they have acceptable Internet connections and do access the Internet regularly.

3.2 Student's Current Style in Archiving and Organizing Their Learning Materials

Most students regard their learning materials as important, and 97% keep their learning materials either in general or selectively. There is no significant difference between keeping any materials or just selected materials which suggest that all materials are valuable to the students. 91% of the students admitted that they keep their learning materials properly (in a file).

Nearly all of the students (95%) like to refer to their previous work in order to complete new tasks and 92% like to keep their learning materials for future use. However, 80% of the students reported that some of their artefacts have gone missing. This shows that a paper based evidence were hard to save.

Most of the students do share (93%), like to share (87%), and like their friends to share (90%), their learning materials. The majority of the students also like to receive feedback on their completed work (94%). Most of the students (61%) like to receive feedback from their peers and lecturers compared to peers only (36%), lecturers only (14%) or family only (2%). This shows students trust their lecturers and friends to give feedback on their completed work and value the feedback highly.

3.3 Prior Experiences with e-Portfolios

Roughly half of the students know what an e-portfolio is (Table 2) because nearly half of the students already have a paper-based portfolio of their learning experiences. 58% of the students who already have a paper-based portfolio spend at least 1 h daily updating their portfolio.

Table 2. Prior knowledge and experience of e-portfolios

No.	Item	Student response (%)		
		Yes	Yes - through given text	No
1	I have already heard of the “e-portfolio” concept	58.05	–	41.95
2	I already know what “e-portfolio” means	15.52	52.3	32.18
3	I already know what should be included in an e-portfolio	13.22	51.72	35.06
4	I have already had a paper-based portfolio of my learning	45.98	–	54.02

Many students update their portfolio daily (38%) while 21% update weekly, 19% monthly, and 23% less than monthly, suggesting that students try to keep their portfolios up-to-date.

In Fig. 1, the profile page is the most selected content that they like to be included in an e-portfolio followed by resume, coursework, work experience, other skills, and multimedia materials, each of which selected after the profile page. Other than that, autobiography, extra-curricular, second language, and recommendations are also considered important as e-portfolio content. The least selected content are awards, notification of last update, link to social networking sites, link to other systems, link to a personal blog, and notification of inactivity.

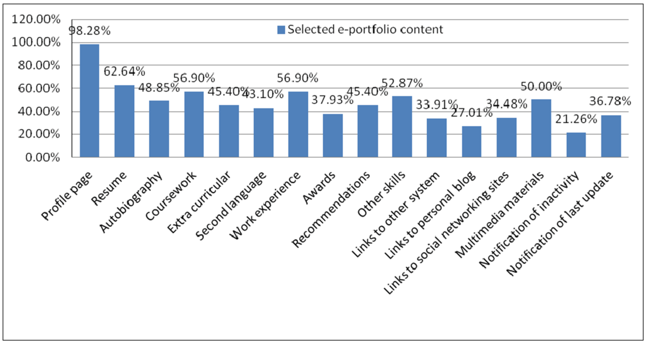


Fig. 1. Preferred e-portfolio content

3.4 Prior Experiences in Technology, Games, and Gamification

A significant number of students think the Internet and computers play a vital role in teaching and learning and in completing their assignments. 88% of the students like to play computer games, and this show the students are comfortable with game play elements and applications. However, there is a misconception of what a game is and what gamification is from the students' point of view because more than half of the students think that games are the same as gamification. Nearly half of the students said they already heard of gamification in education and half of the students said they know what game elements and game dynamics are. This tells us that the students don't really understand the differences between games and gamification, and this would be interesting to explore further based on the results in Table 3.

Table 3. Perception and prior experiences of games and gamification

No.	Item	Student response (%)	
		Yes	No
1	Do you think that Internet plays a vital role in teaching and learning process?	99.43	0.57
2	Do you think computers play important role in completing assignment?	99.43	0.57
3	Do you like to play computer games?	87.93	12.07
4	I spend more than 1 hour daily playing computer games	62.64	37.36
5	I have already heard of "gamification" concept	50.57	49.43
6	I think that games is the same as gamification	68.97	31.03
7	I have already heard of gamification in education	47.7	52.3
8	I know what game elements and game dynamics are	55.75	44.25

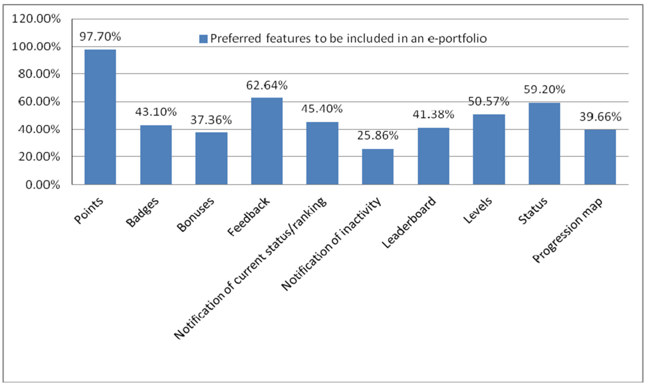


Fig. 2. Preferred features to be included in an e-portfolio

In Fig. 2, the preferred features to be included in e-portfolios are points followed by feedback, status, and levels. Badges, notification of current status/ranking, and levels are equal while bonuses, progression maps, and notifications of inactivity are the least selected features. Many students like receiving points because it shows their level of achievement and motivates them to collect more. It would be more motivating if the points can be changed to a voucher or coupon or to something beneficial to the students like extra marks.

4 Discussion and Conclusion

This preliminary study was conducted in order to get the KPM students' perception of the implementation of e-portfolios and understanding the target users' requirements for e-portfolio content and functions. The prospective users of the e-portfolio application (KPM students) were expected to have a hint of what are portfolios, e-portfolios, and gamification in education. The students were encouraged to give suggestions of what should be included in an e-portfolio, and what game-like features that they want to be included in a gamified e-portfolio.

From the results gained through the pre-survey, we can learn about KPM students' demographics information (Sect. 3.1). Some of the significant results show that KPM is currently populated with generation Z, and gender distribution shows a majority of male students. This information will help in identifying suitable e-portfolio features. If a gamified e-portfolio would be implemented in these colleges, it would be an advantage because previous research has proven males are more likely to be attracted to a game-like application [11]. For the current status of students' computer skills, Internet skills, devices used to access the Internet and current Internet services status, we can see no visible constraints for the students in these areas because currently, they have a quite good infrastructure and Internet/computer skills.

From the students' current learning styles in archiving and organising their learning materials (Sect. 3.2), this pre-survey show that most of the students keep their learning materials appropriately, like to share them, like to receive feedback on them, and like their friends to share their learning materials with them. The main point to consider from the result in this section is that the majority of the students have experienced missing file and previous work. So an e-portfolio would be a solution for them to keep them safe and available when they need it.

Section 3.3 shows that, half of the students have prior experience and knowledge with portfolios and e-portfolios. For e-portfolio content preferences, the profile page is the most preferred content while other items have the same level of importance to students with a slight difference in numbers.

Section 3.4 shows students do perceive the Internet as an important technology in the teaching and learning process as well as computers. Other findings in this section are that many students like to play computer games, which reflect the male and female distribution and preferences at the beginning of the survey. Half of the students know what gamification is. Half of the students also have a misconception of games which they perceive is the same as gamification. About half of the students also knew what game elements and game dynamics are. This shows a partial understanding of games and gamification.

The result of this pre-survey confirmed the assumptions of the researcher that the students are likely to use the e-portfolio application if it is available without major constraints in terms of existing infrastructure and available facilities in each of the colleges to be worried about. Furthermore, the students' current computer and Internet skills are sufficient.

References

1. Bakar, A., Inal, Y., Cagiltay, K.: Use of commercial games for educational purposes: will today's teacher candidates use them in the future? In: World Conference on Educational Multimedia, Hypermedia and Telecommunications 2006, pp. 1757–1762 (2006)
2. Connolly, T.M., Boyle, E., MacArthur, E., Hainey, T., Boyle, J.M.: A systematic literature review of empirical evidence on computer games and serious games. Comput. Educ. **59**, 661–686 (2012)
3. Kim, B., Park, H., Baek, Y.: Not just fun, but serious strategies: using meta-cognitive strategies in game-based learning. Comput. Educ. **52**, 800–810 (2009)
4. Silva, E.: Gamifying learning – Enzo Silva blog. Enzosilva.com (2016). http://enzosilva.com/blog/2010/10/14/gamifying-learning/. Accessed 1 July 2016
5. Simões, J., Redondo, R.D., Vilas, A.F.: A social gamification framework for a K-6 learning platform. Comput. Hum. Behav. **29**, 345–353 (2013)
6. Domínguez, A., Saenz-de-Navarrete, J., De-Marcos, L., Fernández-Sanz, L., Pagés, C., Martínez-Herráiz, J.-J.: Gamifying learning experiences: practical implications and outcomes. Comput. Educ. **63**, 380–392 (2013)
7. Deterding, S., Sicart, M., Nacke, L., O'Hara, K., Dixon, D.: Gamification: using game-design elements in non-gaming contexts. In: Proceedings of the 2011 Annual Conference Extended Abstracts on Human Factors in Computing Systems - CHI EA 2011, p. 2425 (2011)
8. Muntean, C.: Raising engagement in e-learning through gamification. In: Proceedings of 6th International Conference on Virtual Learning ICVL (2011)
9. ITU: Measuring the information society report (2014). http://www.itu.int/en/ITU-D/Statistics/Documents/publications/mis2014/MIS2014_without_Annex_4.pdf, http://www.itu.int/ITUD/ict/statistics/Gender/index.html
10. Lucas, K., Sherry, J.L.: Sex differences in video game play: a communication-based explanation. Commun. Res. **31**, 499–523 (2004)
11. Graner Ray, S.: Gender Inclusive game design: expanding the market, p. 350 (2003)

Student Choice: Blends of Technology Beyond the University to Support Social Interaction and Social Participation in Learning

Martina A. Doolan(✉) and Theo Gilbert

University of Hertfordshire, Hatfield, UK
{m.a.doolan, t.l.gilbert}@herts.ac.uk

Abstract. This paper presents an overview of a blended collaborative learning design driven by assessment and feedback. To extend class based activities students were provided with a private group space on the university managed learning environment. They chose to supplement this using technologies beyond those provided by the University to support their social interactions and participate in their learning. Qualitative data analysis of student's reflections provides insights into the students own blends of technology including Skype, What's App, Facebook amongst others and accessed via their hand held mobile devices such as Smartphones and laptops. These were used by the students to connect and collaborate with their peer group to complete the set tasks throughout the module and the final group based assessment.

Keywords: Blended learning · Collaborative learning · Technology enhanced learning · Group work · Assessment · Social media · Social interaction · Social participation · Student choice

1 Introduction

This is an ongoing study which builds on previous funded work undertaken with final year undergraduate students studying a BSc in Computer Science [6] and postgraduate students studying an MSc in Software Engineering [8]. The research presented in this paper is a subset of the Social Experiences and Emotional Intelligence in Learning (SEaEIL) project which is a collaboration between the Schools of Humanities and Computer Science and funded under the Social Science Arts and Humanities Research Institute multi-disciplinary research grant 2015-16 at the University of Hertfordshire in the United Kingdom. This study took place over two semesters with 240 first year students undertaking the Human Dimensions module as part of a BSc in Computer Science programme of study.

Situated in a blended social learning context students were engaged in collaborative learning [3] to complete set tasks which hereafter, will be named 'mini-projects', in small groups [11] from the module outset. The mini-projects were developed and formed part of the two in-class tests and the final module group based assessment. These were intended to act as a vehicle to provide formative assessment or assessment *FOR* learning opportunities [1]. In these, students obtained immediate feedback on

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 95–102, 2017.
DOI: 10.1007/978-3-319-49625-2_12

their work on a weekly basis in class, from their tutor and peers, to help progress learning. The aim was to move away from focusing on a mark usually obtained through summative assessment or assessment OF learning [2] which may fail to engage students in learning [9]. The focus of practice in this paper is on bringing students together inter and intra groups, in and out of class, to learn from each other and gain a better grasp of the subject to develop the necessary knowledge and skills to meet the module learning outcomes. This coming together is described as social participation [10, 13] which encourages social constructivism [12] - the co-creation of knowledge essential for learning. Situated learning theory [10] and community of practice theory [13] also purport that social participation is a key component of learning. [5, 7, 8] argues that the social and cultural context of learning is crucial and a central tenet of learning itself. These social construct theories places emphasis explicitly on the fundamental role that social interaction and social participation play in the process of learning, arguing that meaning is constructed and formed through the social experience, dialogic negotiations and situated in the learning context. In this way, knowledge is socially created and skills developed. Embedding learning within social activity, social context and a social culture encourages learning through observations people make of themselves, others and in the learning environment [7, 13]. The learning environment whether online, offline or a blend of both, is viewed as one that is learner-centric and organic; growing and developing collectively with learners over time and sustained by students and tutors sharing knowledge, ideas and artefact [6–8]. In this study blended learning is defined where *"Students actively engage with the technology alongside traditional face-to-face meetings and class contact"* [4].

2 The Assessment and Feedback Design

The final assignment was undertaken by 240 students studying a module delivered on the first year BSc programme in Computer Science. Students were allocated to a group of between 4 and 6 students within their respective tutorial group, by the module leader at the beginning of the first semester. Students were expected to work with this group throughout the two semesters. This included completing the final end of year assessment and participating in 12 mini-projects delivered weekly from the module outset. Group changes were permitted if students had met the deadline for requesting a change which was in the second semester. All group members were advised they would receive the same mark for the final group based assessed tasks outlined below. Differences between individuals were expected to be made known in the reflective tasks and submitted separately (if required) from the group report. Where differences were brought to the tutor's attention, students were invited to attend a viva.

The final assessment comprised two individual and two group tasks to be submitted as one group report and worth 40% of the total module assessment. To successfully perform on this module, students were expected to pass the module overall. There was no examination component, the module was assessed by 100% coursework. In total there were four assessments. Two in each semester which comprised one individual written piece and two in-class tests and the final penultimate group based assessment. The students were required to produce a report and undertake a group presentation which was assessed at the end of the module in the second semester. To support knowledge and skills acquisition within group's 12 mini-projects were provided from the outset of the module and aligned with the lecture and assessment material. These were designed to be divisible amongst the group, to engage the students and promote the sharing of knowledge, skills and resources. Moreover, to create a sense of ownership and shared responsibility for learning amongst the student groups.

The mini-projects were delivered on a weekly basis intended to drive the students group learning outside of class to be undertaken together during their independent and self-directed study time. In this way, the learning activities were designed to provide students with an opportunity to collaboratively practice and demonstrate learning, understandings and misunderstandings and to take these back into the classroom for discussion. Moreover, this design also encouraged students to ask and seek answers to questions.

Crucially, the mini-projects were designed to elicit evidence of learning and to obtain feedback from the tutor and potentially up to 25 peers in their tutorial group. Feedback was formative and presented a means for the tutor to reinforce the expected standards and to spontaneously adapt teaching and learning practice to meet the student needs. This feedback was formative by means of informing both student and teacher response Students were required to act on the feedback to develop their work further and seek additional feedback as needed. The completed mini-projects were stored within the students allocated private group space on the MLE, ready to feed-forward into the two in class tests in the first semester and the final group based assessment at the end of the second semester.

The mini-projects were not awarded marks as these were deemed to be formative assessment opportunities. Verbal comments were provided by the tutor and the students in the tutorial. Throughout the two semesters of the module, students uploaded their completed mini-projects on a weekly basis to their allocated private group space on the institutional Managed Learning Environment (MLE). This was required and stipulated on the mini-project specifications. In this way, the online group space was intended to act as a shared repository for students and enabled them to easily locate their work to present to their tutor and peers in class. Storing the mini-projects in this way, removed the necessity for each student group to input a storage device during presentations saving valuable class time.

In summary, the first and fourth tasks of the final assessment were individual reflective pieces on the group process which included the completion of the 12 mini-projects, the group based assessment, technologies used and how these supported the group work amongst others. Each student was required to complete the reflective statements, guidance was provided by means of referring students to lecture material and their completed mini-projects. Students were expected to demonstrate how they acted upon the feedback provided by tutors and peers throughout the weekly tutorials and to substantiate their claims with evidence. The second task was a group based essay, on a user experience teardown of a game. Students engaged in discourse around key themes related to the game. The final and third task was a group presentation which provided an opportunity for the students to present their conclusions to their peers and at least two tutors, to ensure double blind marking as part of the assessment process.

3 Students Use of Technologies Beyond the University MLE

Content analysis was undertaken on the students reflections submitted as part of their final assessment and involved a methodical reading of the texts and the supporting evidence in the form of screen shots. Key themes to emerge related to technology type, application and devices used by students. Presentation of these themes is interweaved with the student comments and the authors' discussion of findings. The student comments were chosen as a unit of text; a phrase, a sentence or multiple sentences and presented verbatim to share their experiences using the students own voice, these appear in italics. The numerical data was produced by counting the number of students associated with each technology type, application and device.

234 students used WhatsApp, an instant messaging application to communicate and collaborate throughout the module and especially to support completion of the mini-projects and the final group based assessment. Evidence in the form of screen shots submitted by students clearly demonstrated their engagement in collaborative discussions over WhatsApp regarding their use of Skype and Google Drive. These were technologies commonly used by students, in addition to, WhatsApp, 180 used Skype and 80 used Google Drive to support their learning.

A student commented on the rationale for using these social technologies:

"Maintain communication" [sic] particularly as *"everyone in the group does own a smartphone"* [sic].

This was the case for the majority of the students with 220 owning more than one mobile phone, of which, 200 were smartphones. Students reported using these hand-held devices as a portal to access Skype, WhatsApp, Facebook, Twitter, Google Drive and the University MLE known as StudyNet. A student comments:

"Our mobile phones aided in the use of WhatsApp and also Study Net" [sic].

Some students found WhatsApp to be *"a far quicker and more responsive way of communication for when the members and I were away from the university*" [sic].

Other comments included:

"The chat helped us plan our meetings and plan the work" [sic].

"This increased productivity and friendships as everyone could speak with everyone in the group" [sic].

"*For simplicity and because we all use it already"* [sic]

This was commonly cited (180), the majority of students chose to use WhatsApp for ease of use and because they were familiar with the application. In their reflections students discussed how they used this to support learning and to connect and maintain friendships. Some deemed their peer group to be friends. Overall, it was used for planning purposes such as to arrange either Skype or Face to Face meetings and to obtain support from their peer group. Screen shots submitted as evidence for the final assessment showed incidences of students jointly problem solving, asking questions and findings answers from peers.

A group of six students in their reflections noted that using WhatsApp enabled their group to divide into pairs to complete tasks.

"Getting into pairs to complete tasks allowed our shyer individuals significantly more ability to complete tasks and make sure their ideas were heard" [sic]

This was especially important to this group given they discussed having a number of talkative group members. They described how getting into pairs and communicating over WhatsApp helped to reduce overtalkative members propensity to take over communication in the group, to allow others to be heard which created a more inclusive group.

Evidence by means of screen shots included in their reflections clearly show this group of six members using WhatsApp to help each other, and through this social participation were seen to be co-creating knowledge. Furthermore, identities seemed to shift as students became tutors teaching one another.

This student group discussed how sharing ideas strengthened the bond between them and helped develop confidence. They felt encouraged by their peers to share further. It was deemed important to support each other.

For another group of six members WhatsApp was replaced with Kikchat an instant messenger application for mobile devices as this was deemed by this group to be;

"More effective considering Kikchat has features of identification through a username rather than phone number" [sic].

This student group noted this was important to them, as they could use a common password using the group identification number, which they shared amongst the group members and they reported accessibility was easy through their mobile phones. The group found this application useful as it was easy to share images and sketches of work undertaken, as well as to send and receive messages.

Additionally, the majority of students (180) used DropBox to share files. Some reasons given include:

"Dropbox to synchronise certain files to where each team member could view and edit them at ease" [sic].

"Dropbox can also restore files that were deleted or discarded by mistake" [sic].

"It also has a feature that indicates the user in case the file is already being modified by somebody else" [sic].

"The decision to get everyone to download Dropbox so files could be synchronised and shared on-demand and over the cloud" [sic].

Skype was used by half the students (120) to communicate whilst working on the mini-projects and the assessed tasks. Evidence provided by means of screen shots clearly demonstrate how groups multi-tasked. For example working between Skype and a Word document. A student comments:

"We also used Skype for those late night and early morning sessions for discussing ideas and inputting into Word at the same time" [sic].

Team Viewer was used by half of the students (120). These students found it useful to be able to view team member's computer screens remotely to share ideas and support each other. A student comments

"to go onto the computer screen of another team members through remote control and help them without being next to them" [sic].

Facebook was used by half the students (120) to carry out discussions in real time, share files and images including photos, especially deemed to be useful by the students when putting together their evidence for the final assessment. Two student comments illustrate this:

"Anyone is struggling we can also send them a video chat using this social platform and show them what is meant by evidence to include in the report" [sic].

"Those who wanted to ask each other about the assessment whilst browsing on Facebook, could now do so through its messenger service" [sic].

Twitter was used by two groups of students (12).

It appears text and phone calls were used sparingly rather the majority of students used social media technologies to collaborate. Student's comments on this include:

"We used normal text messaging in case the individuals couldn't be reached on WhatsApp or Facebook Messenger" [sic].

"General phone calls were hardly ever made as we preferred to have most things finalised over chat, where it could be read at any time" [sic].

On using laptops a student comments:

"Laptops were used in making communication work. It was used in checking through Study Net" [sic].

"It was used to surf through Study Net, checking online libraries as well as our group created on Study Net" [sic].

Regarding the institutional MLE, the group spaces provided by the module lead to support mini-project completion and the final assessment were used by the majority of students (200) to store their mini-projects. This was not a surprise given they were required to use this as stipulated by the tutor on the mini-project specifications. Other uses of the MLE included the blog (18) and discussion forum (36) features provided within the group space. Some students (24) used the discussion facility within the group space to organize meetings as per the student comment below. Students predominately accessed the MLE using their hand-held devices, mobile phones and laptops.

"Study Net was also used as means for communication. Time slot for our Group meeting sessions are posted on Study Net.

However, its use was minimal in comparison to the social technologies the students chose to use beyond the university. It seems the majority of students preferred WhatsApp rather than the University MLE, a student comments *"to ease the sharing of ideas, we decided to open a group Chat on WhatsApp to enable us share ideas besides just at our group meetings. WhatsApp was chosen because it is commonly used among students and it is quicker to access than Study Net"* [sic].

4 Conclusion

This paper provided an insight into a formative assessment design as a driver to encourage social interaction and social participation between students using a collaborative learning approach to support completion of the 12 mini-projects throughout the module and the final group based assessment. Private group spaces housed on the MLE were provided and intended to support students' group work. The majority of students chose to use a blend of technologies and applications familiar to them which were beyond those provided by the University. These enabled easy access to their peer group and resources.

Acknowledgments. The students and tutors who participated on the module and sincere gratitude to the Social Science Arts and Humanities Research Institute at the University of Hertfordshire in the UK for funding this project.

References

1. Black, P., Wiliam, D.: Developing a theory of formative assessment. In: Gardner, J. (ed.) Assessment and Learning 2006, pp. 81–100. Sage, London (2006)
2. William, D., Black, P.: Meanings and Consequences: a basis for distinguishing formative and summative functions of assessment? Br. Educ. Res. J. **22**(5), 537–548 (1996)
3. Dillenbourg, P.: What do you mean by collaborative learning? In: Dillenbourg, P. (ed.) Collaborative Learning: Cognitive and Computational Approaches. Advances in Learning and Instruction Series (1999). General Learning Press, New York (1999)
4. Doolan, M.A.: Effective strategies for building a learning community online using Wiki. In: 1st Annual Blended Learning Conference, pp. 51–63. University of Hertfordshire, United Kingdom (2006)
5. Doolan, M.A.: Developing pedagogy: the role of the tutor in enabling student learning through the use of a Wiki. In: Wankel, C. (ed.) Educating Educators in Social Media 2010, pp. 189–206. Emerald Group Publishing Ltd., Bingley (2011)
6. Doolan, M., Morris, P.: Developing principles in practice: a dialogue in assessment and feedback In: 5th International Blended Learning Conference, pp. 38–45 University of Hertfordshire United Kingdom (2010)
7. Doolan, M.A.: A pedagogical framework for collaborative learning in a social blended e-learning context in wankel. In: C & Blessenger, P. (eds.) Increasing Student Engagement and Retention in e-Learning Environments: Web 2.0 and Blended Learning Technologies 2013. pp. 261–286 Emerald Group Publishing Ltd Bingley (2013)
8. Doolan, M.A.: Enhancing the postgraduate experience of assessment and feedback in a learning community. In: 8th International Conference on E-Learning pp. 136–142 Cape Peninsula University of Technology: Cape Town, South Africa (2013)

9. Ecclestone, K.: From testing to productive student learning: implementing formative assessment in Confucian-heritage Settings. Assessment in Education: Principles, Policy & Practice **19**(2), 255–276 (2012)
10. Lave, J., Wenger, E.: Situated Learning Legitimate Peripheral Participation. Cambridge University Press, Cambridge (1991)
11. Lewin, K.: Field Theory in Social Science. Harper and Row, New York (1951)
12. Vygotsky, L.S.: Mind in Society. Harvard University Press, Cambridge (1978)
13. Wenger, E.: Communities of Practice: Learning: Meaning and Identity. Cambridge University Press, Cambridge (1998)

Teaching Syllogistics Using E-learning Tools

Peter Øhrstrøm[1(✉)], Ulrik Sandborg-Petersen[1], Steinar Thorvaldsen[2], and Thomas Ploug[1]

[1] Department of Communication and Psychology, Aalborg University, Rendsburggade 14, 9000 Aalborg, Denmark
{poe,ulrikp,ploug}@id.aau.dk

[2] Department of Education, University of Tromsø, 9037 Tromsø, Norway
steinar.thorvaldsen@uit.no

Abstract. This paper is a study of various strategies for teaching syllogistics as part of a course in basic logic. It is a continuation of earlier studies involving practical experiments with students of Communication using the Syllog system, which makes it possible to develop e-learning tools and to do learning analytics based on log-data. The aim of the present paper is to investigate whether the Syllog e-learning tools can be helpful in logic teaching in order to obtain a better understanding of logic and argumentation in general and syllogisms in particular. Four versions of a course in basic logic involving different teaching methods will be compared.

Keywords: Syllogistics · Argumentation · Learning analytics · Logical proofs · Deduction · Gamified quizzing · Logic teaching

1 Introduction

In this paper we discuss problems and teaching challenges related to courses in basic logic and argumentation offered to 2nd year students in "communication and digital media" (previously known as "humanistic informatics") at Aalborg University in Aalborg and Copenhagen. The present study is a continuation of previous studies and practical experiments cf. [6–9,11]. Data from the courses in 2012, 2013, 2014 and 2015 will be discussed. The general structure of these courses can be outlined in the following manner:

- Period 1. Lectures + homework: General introduction to logic and argumentation. Introduction to classical syllogistics.
- Period 2. Lectures + homework: Classical syllogistics (Euler diagrams, Venn diagrams, proofs) and propositional logic (truth tables, proofs).
- Period 3. Lectures + exercises in groups + homework: Proofs. Syllogistic validity.
- Period 4. Lectures + homework: Ideas of formal reasoning. The role of logic in everyday life and in scientific argumentation.

About 20 lessons are offered in the course. In addition the students have to do homework. The total number of students has been 150–200 each year. During

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 103–110, 2017.
DOI: 10.1007/978-3-319-49625-2_13

2012–2015 courses with four different versions of Period 3 have been tested. The tests have focussed on syllogistic reasoning.

In order to test and measure the students' ability to do syllogistic reasoning the program Syllog has been developed. Syllog is implemented[1] as a Java-Applet running in the student's browser, developed using PROLOG+CG (see [2–5,12]). However, the system is not only useful in order to measure the students' ability to do syllogistic reasoning. Versions of the system can also be used in order to support the students in their process of learning the principles of logic.

In Sect. 2 we present the theory of Aristotelian syllogistics as a deductive system in the classical manner, and it is also explained how the deductive system can be presented in terms of controlled natural language. In Sect. 3 we present the use of the Syllog system in the study of the educational problems related to the courses in basic logic. We also discuss two Syllog tools which have been used during the courses. Finally, in Sect. 4 we compare the outcome of the studies of the four versions of the course.

2 Aristotelian Syllogisms as Deductive Structures

Aristotelian syllogistics has been an essential part of almost all courses in basic logic since the rise of the European university in the 11^{th} century; cf. [1,10]. In modern logic teaching the classical (medieval) syllogistics is often presented as a fragment of first order predicate calculus. A classical syllogism corresponds to an implication of the following kind: $(p \wedge q) \supset r$, where each of the propositions p, q, and r matches one of the following four forms: $a(U, V)$ (read: "All U are V"); $e(U, V)$ (read: "No U are V"); $i(U, V)$ (read: "Some U are V"); and $o(U, V)$ (read: "Some U are not V").[2]

In this way, 256 different syllogisms can be constructed. According to classical (Aristotelian) syllogistics, however, only 24 of them are valid. The medieval logicians named the valid syllogisms according to the vowels, $\{a, e, i, o\}$, involved. In this way the following artificial names were constructed (see [1]):

1^{st} figure: barbara, celarent, darii, ferio, barbarix, feraxo
2^{nd} figure: cesare, camestres, festino, baroco, camestrop, cesarox

---

[1] See http://syllog.sourceforge.net/ and http://syllog.emergence.dk/2015/.

[2] We may express these functors in terms of first order predicate calculus in the following way:

$a(U, V) \leftrightarrow \forall x : (U(x) \supset V(x))$ $e(U, V) \leftrightarrow \forall x : (U(x) \supset \neg V(x))$
$i(U, V) \leftrightarrow \exists x : (U(x) \wedge V(x))$ $o(U, V) \leftrightarrow \exists x : (U(x) \wedge \neg V(x))$

The four basic propositions can be related in terms of negation:

$i(U, V) \leftrightarrow \neg e(U, V)$ $o(U, V) \leftrightarrow \neg a(U, V)$

The classical syllogisms occur in four different figures:

$(u(M, P) \wedge v(S, M)) \supset w(S, P)$ (1^{st} figure)
$(u(P, M) \wedge v(S, M)) \supset w(S, P)$ (2^{nd} figure)
$(u(M, P) \wedge v(M, S)) \supset w(S, P)$ (3^{rd} figure)
$(u(P, M) \wedge v(M, S)) \supset w(S, P)$ (4^{th} figure)

where u, v, $w \in \{a, e, i, o\}$ and where M, S, P are variables corresponding to "the middle term", "the subject" and "the predicate" (of the conclusion).

3rd figure: darapti, disamis, datisi, felapton, bocardo, ferison
4th figure: bramantip, camenes, dimaris, fesapo, fresison, camenop.

In these names some of the consonants signify the logical relations between the valid syllogisms, and they also indicate which rules of inference should be used in order to obtain the syllogism in question from the four syllogisms which were considered to be fundamental (i.e. axiomatic): barbara, celarent, darii, ferio (see [1,4,8]).

An even more convincing representation of the deductive system of syllogisms than the one suggested in medieval logic, may be obtained using five fundamental deduction rules. These rules can be formulated symbolically in terms of the conceptual graph interchange format (CGIF) as it was suggested in [8]. However, the rules may also be formulated in terms of a controlled fragment of natural language:

(TRANS)	All Y are Z All X are Y Therefore: All X are Z	(SUBST)	All Y are Z Some X are Y Therefore: Some X are Z
(CONTRA)	All X are Y Therefore: All non-Y are non-X	(MUT)	Some X are Y Therefore: Some Y are X
(EX)	All X are Y Therefore: Some X are Y		

Note that we allow for negations of terms. The term non-X simply stands for all elements in the universe that are not instants of X. Clearly, non-non-X (i.e. a double negation) would be equivalent with X. It should also be noted that the e-proposition, “No X are Y”, can be reformulated as “All X are non-Y”. Similarly, the o-proposition, “Some X are not Y” can be reformulated as “Some X are non-Y”. This means that in terms of the controlled natural language the number of types of propositions in syllogistic reasoning can be reduced from four to two, namely the universal propositions (i.e. “All ... are ...”), and the particular propositions (i.e. “Some ... are ...”). In combination with the option of term negation and the above inference rules we have everything that we need in order to evaluate all possible syllogisms in classical syllogistics.[3]

The above inference rules may be seen as an axiomatic system that makes it possible to derive the conclusion in a syllogistic argument from its premises if

[3] It should be noted that (TRANS), which is in fact short for ‘transitivity’, may in fact be read as the syllogism barbara in Fig. 1. Furthermore, by substituting Z by non-Z we get the syllogism celarent in Fig. 1. — Similarly, it is obvious that (SUBST), which is short for ‘substitution’, leads directly to the syllogism darii in Fig. 1, and if Z is replaced by non-Z we get ferio in Fig. 1. The three remaining rules are different from the first two in the sense that they only depend on one premise each. (CONTRA) — which is short for ‘contraposition’ — makes it possible to transform a universally quantified proposition, whereas (MUT) — which is short for ‘mutation’ — makes it possible to transform an existentially quantified proposition. (EX) — which is short for ‘existence’ — makes it possible to derive an existentially quantified proposition from a universally quantified proposition.

and only if the syllogistic argument under consideration is a valid syllogism. It is easy to present (TRANS), (SUBST), (CONTRA), (MUT) and (EX) in terms of Euler circles. In this way it can be made clear that the rules are intuitively reasonable.[4]

3 Teaching Syllogistics Using Syllog

The Syllog system generates syllogisms at random, and the user is supposed to evaluate them using the system. The activities of the students when working with the system are logged, and the log-data from the use of the system may give rise to very interesting learning analytics. Figure 1 shows the interface of one the Syllog versions.

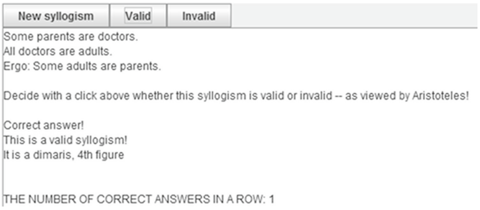


Fig. 1. Gamified quizzing with syllog.

A student's ability to do syllogistic reasoning can be analysed in terms of the score calculated on the basis of log-data from the use of Syllog. This score is calculated as: Score = correct answers/answer count.

The score measures how well the user is doing in evaluating the validity of syllogistic arguments. Logic teaching is at least in part aimed at raising this score. The statistical analyses of the scoring data were performed using standard methods from descriptive statistics and statistical testing. An interesting question concerns the students' competence to evaluate the validity of syllogisms before receiving formal training on this subject [6–8]. In the previous studies we have provided evidence to the effect that the students' ability to distinguish between valid and invalid syllogisms before the teaching starts is significantly higher than the level of guessing. The value of this early score appears to be

[4] Using this deductive approach to the syllogisms, it is possible to show a number of interesting results concerning the invalidity of certain syllogistic arguments. For instance, by going through the five rules of inference it is evident that if both premises are existential, then nothing new follows regarding the relation between subject and predicate. The same holds if both premises are negative i.e. o-propositions or e-propositions. The use of the inference rule (EX) has sometimes been seen as controversial, and the 9 syllogisms which depend on this rule have consequently been seen as "questioned". Clearly (EX) has to be rejected, if we hold that the statement "all S are P" is true given that S is the empty set. Therefore, if this is accepted it should obviously not be permitted to deduce "some" from "all". If the EX rule is excluded, the number of valid syllogisms is reduced from 24 to 15.

rather stable from year to year during the period 2012–2015. The studies suggest 0.608 as the value of this early score.

This kind of information is clearly valuable for teachers who want to design a course in basic logic. However, it is certainly also interesting to measure the average score after some logic teaching. The study based on data from the 2012 version of the course showed that there is no or very limited improvement in the score if it is measured after a traditional course in basic logic (with traditional work with exercises on paper during Period 3). No significant improvement of the average score was detected in this case (see [6]).

In the user interface shown in Fig. 1 it should be noted that "The number of correct answers in a row" is displayed. Using this facility it is in fact possible to establish a competition between the groups and this rather simple gamification element actually turns out to work as a motivation in the practical setting. This effect of simple gamified quizzing was studied based on the data from the course in 2013 and further studies in 2015. This study showed that the use of gamification elements can have some positive effects on the motivation to learn, and in combination with a traditional course on syllogistics it can lead to a an increased understanding of logical validity in the sense that the student's ability to evaluate the validity of an arbitrary syllogism becomes better (see [7,9]).

During Period 3 of the 2014 version of the course the students could do exercises in small groups using a version of Syllog including the deduction rules presented in Sect. 2. The rules were presented on the screen in terms of the CGIF formalism after a general introduction to the formalism (a lecture). The gamification facility mentioned above was also included in the interface. The study showed that only a small fraction of students could benefit from the use of this system. No significant improvement of the average score was detected [8].

During Period 3 of the 2015 course the students could work in small groups with a proof facility based on the five deduction rules mentioned in Sect. 2, presented in terms of controlled natural language. The user interface is shown in Fig. 2. The user can click on New to get a new syllogism presented on the screen. Then the user may apply some of the inference rules ('Trans', 'Subst', 'Contra', 'Mut', 'Ex') to see what follows from the two premises and from other propositions that have been proved so far. This is done by clicking on the button corresponding to the inference rule that the student wants to apply. Whenever ready the user may decide whether he or she believes the syllogism to be valid or invalid. This is done by clicking on the relevant button. In this way the user may perform experiments with the syllogisms in question. Hopefully, this leads to a deeper understanding of syllogistic validity.

As is indicated in Fig. 2, the system automatically translated the premises of the argument into a controlled fragment of natural language. E.g. the premise "No parents are doctors" is immediately translated into "All parents are non-doctors", etc. In this way it becomes easier for the user to see which of the rules (if any) may be applied.

The average score was measured at the beginning Period 3 when the work with the deduction module starts (and after some work with "gamified

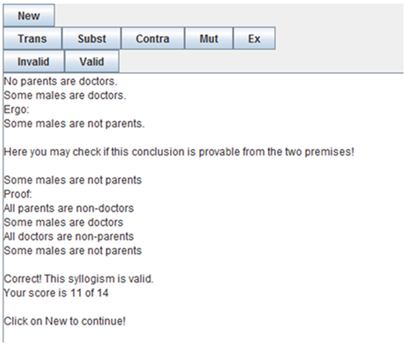


Fig. 2. The interface of the syllog system used in 2015.

Table 1. The 2×2 table summarizing counts from the 2015 course of how often students replied correctly to the syllogisms in the beginning of Period 3 and immediately after this period. These values may be compared with the value (from earlier studies) of the score before the teaching starts, i.e. 0.61.

	Correct reply?		
	Yes	No	Score
The beginning of Period 3 (n = 133)	1145	615	0.651
After Period 3	1112	462	0.706

quizzing"). After Period 3 the average score was measured again. The aggregated results and the scores are shown in Table 1. The results support strong statistical evidence against the presumption that student will handle the syllogisms equally well before and after Period 3 (p-value < 0.001 by the χ^2 test).

4 Conclusions

The present study as well as the previous studies provides strong evidence for the usability of the log-functionality of PROLOG+CG in order to establish relevant analytics regarding the teaching and learning of logic.

Based on the study of the Syllog data from the courses in 2013 and 2014 we have seen that we may benefit from the use of interactive e-learning tools during a logic course, whereas no significant improvement of the ability to do syllogistic reasoning could be detected after the traditional course offered in 2012. Our study provides evidence that students during a course using such a system improve their ability to evaluate logical validity significantly. In particular, the student could benefit from having access to Syllog with deduction rules in terms of natural language, whereas a similar system in terms of CGIF (as in the 2014 course) was of almost useless in most cases. Table 2 shows the result from the four versions of the course.

Table 2. A comparison of the results based on log-data from the four versions of a course in basic logic. Only the content of Period 3 of the course has been changed from year to year.

Year	Period 3	Results
2012	Traditional work with logic exercises (no use of e-learning tools)	No significant improvement of the ability to do syllogistic reasoning was detected after the course [6]
2013	Traditional work with logic exercises + gamified quizzing with Syllog	A small but significant effect of the teaching was detected [7]
2014	Traditional work with logic exercises + gamified quizzing with Syllog + work with a deduction module in terms of CGIF	Mixed result. Only some of the students could benefit from the work with the CGIF module. No significant improvement of the average ability to do syllogistic reasoning was detected [8]
2015	Traditional work with logic exercises + gamified quizzing with Syllog + work with a deduction module in terms of natural language	A significant improvement of the ability to do syllogistic reasoning was detected. The highest value of the average score (0.706) was measured in this case

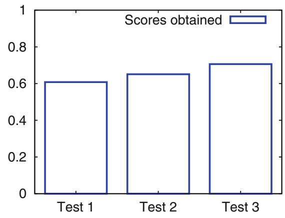


Fig. 3. Scores obtained in Test 1 (2012, without the use of e-learning tools), Test 2 (2013, repeated in 2015, with a gamified quizzing tool) and Test 3 (2015, with a gamified quizzing tool and a tool to the investigation of the deductive structures of syllogisms).

Observations of the students during their work with the tools suggest that the work with the tools in 2013 and in 2015 stimulated their motivation and interest in the topic. Figure 3 is an attempt to put the results in perspective:

The 2014 study [8] shows that most of the communication students were unable to benefit from a Syllog tool using CGIFs in order to investigate the deductive structure of the syllogisms. It is likely that this will be the case for any tool that makes use of a complex formalism or symbolic language. However, the present study shows they can in fact benefit from the use of the deductive module presented in terms of controlled natural language. Still, an average score of 0.706 in the 2015 test is not very impressive. Obviously, the challenge is to develop better e-learning tools and teaching strategies in order to improve the students' ability to do syllogistic reasoning even more. For this purpose, it might be useful to know more about the kind of difficulties that the students are facing when they are working with syllogisms. Further studies of the log-data may provide such information, and we may thereby obtain useful information on how to develop more effective e-learning tools and teaching strategies.

References

1. Aristotle: Prior analytics. Translated by A.J. Jenkinson. The internet classics archive (1994–2000). http://classics.mit.edu/Aristotle/prior.html
2. Kabbaj, A., Frasson, C., Kaltenbach, M., Djamen, J.-Y.: A conceptual and contextual object-oriented logic programming: the PROLOG++ language. In: Tepfenhart, W.M., Dick, J.P., Sowa, J.F. (eds.) ICCS 1994. LNAI, vol. 835, pp. 251–274. Springer, Heidelberg (2005)
3. Kabbaj, A., Janta-Polczynski, M.: From PROLOG++ to PROLOG+CG: a CG object-oriented logic programming language. In: Ganter, B., Mineau, G.W. (eds.) Conceptual Structures: Logical, Linguistic, and Computational Issues. LNCS, vol. 1867, pp. 540–554. Springer, Heidelberg (2000)
4. Kabbaj, A., Moulin, B., Gancef, J., Nadeau, D., Rouleau, O.: Uses, improvements, and extensions of Prolog+CG: case studies. In: Delugach, H.S., Stumme, G. (eds.) ICCS-ConceptStruct 2001. LNCS (LNAI), vol. 2120, pp. 346–359. Springer, Heidelberg (2001). doi:10.1007/3-540-44583-8_25
5. Øhrstrøm, P., Sandborg-Petersen, U., Ploug, T.: Syllog - a tool for logic teaching. In: Proceedings of Artificial Intelligence Workshops 2010 (AIW 2010), Mimos Berhad, pp. 42–55 (2010)
6. Øhrstrøm, P., Sandborg-Petersen, U., Thorvaldsen, S., Ploug, T.: Classical syllogisms in logic teaching. In: Pfeiffer, H.D., Ignatov, D.I., Poelmans, J., Gadiraju, N. (eds.) ICCS-ConceptStruct 2013. LNCS (LNAI), vol. 7735, pp. 31–43. Springer, Heidelberg (2013). doi:10.1007/978-3-642-35786-2_4
7. Øhrstrøm, P., Sandborg-Petersen, U., Thorvaldsen, S., Ploug, T.: Teaching logic through web-based and gamified quizzing of formal arguments. In: Hernández-Leo, D., Ley, T., Klamma, R., Harrer, A. (eds.) EC-TEL 2013. LNCS, vol. 8095, pp. 410–423. Springer, Heidelberg (2013). doi:10.1007/978-3-642-40814-4_32
8. Øhrstrøm, P., Sandborg-Petersen, U., Thorvaldsen, S., Ploug, T.: Teaching syllogistics using conceptual graphs. In: Hernandez, N., Jäschke, R., Croitoru, M. (eds.) ICCS 2014. LNCS (LNAI), vol. 8577, pp. 217–230. Springer, Heidelberg (2014). doi:10.1007/978-3-319-08389-6_18
9. Øhrstrøm, P., Sandborg-Petersen, U., Thorvaldsen, S., Ploug, T.: Teaching syllogistics through gamification and interactive proofs. In: Conole, G., Klobučar, T., Rensing, C., Konert, J., Lavoué, É. (eds.) EC-TEL 2015. LNCS, vol. 9307, pp. 609–612. Springer, Heidelberg (2015). doi:10.1007/978-3-319-24258-3_70
10. Parry, W.T., Hacker, E.A.: Aristotelian Logic. State University of New York Press, New York (1991)
11. Sandborg-Petersen, U., Schärfe, H., Øhrstrøm, P.: Online Course in Knowledge Representation Using Conceptual Graphs. Aalborg University (2005). http://cg.huminf.aau.dk
12. Petersen, U.: Prolog+CG: a maintainer's perspective. In: de Moor, A., Polovina, S., Delugach, H. (eds.) Proceedings of First Conceptual Structures Interoperability Workshop (CS-TIW 2006). Aalborg University Press, Aalborg (2006)

The Effective of Learning by Augmented Reality on Android Platform

Kunyanuth Kularbphettong(✉) and Nutthawut Limphoemsuk

Computer Science Program,
Suan Sunandha Rajabhat University, Bangkok 10300, Thailand
{kunyanuth.ku,nutthawur.li}@ssru.ac.th

Abstract. In this paper, we present the effective of Learning system based on Android operating system in Physics. The objective of this system is to advice student to learn Physics more convenient through mobile platform. The design approaches and functional components of this system were described and this application was developed on Knowledge. A quasi-experimental design of the pretest, posttest for non-randomized control group design was employed for this project. And, it was divided the result by the research purposes into 2 parts: developing the Mobile application for students and testing and evaluating the system. Black box technique was used to evaluate application performances and Questionnaires were applied to measure user satisfaction with system usability by experts and students.

Keywords: Augmented reality · Android platform · Quasi-experimental · Black box technique

1 Introduction

In the recent years, smart phone has prevalently become as a significant medium to completely change and support in many aspects of life. With no longer barrier by space and time, advance technologies has changed the way of e-Learning and mobile learning systems. According to [1], the use of technology is essential in teaching communications, mathematics and science and it is no less important in the arts. Educational technology has three significant contributions for teaching and learning: the use of technology can accelerate the learning; technology can access more information related to any topic; and the Internet can serve as a method of multiple communications among numerous individuals, organizations and communities. Also, MoLeNet [2], mobile learning was defined "The exploitation of ubiquitous handheld technologies, together with wireless and mobile phone networks, to facilitate, support, enhance and extend the reach of teaching and learning." Augmented Reality (AR) is a technology that allows computer-generated virtual 3D objects with a live direct or indirect real-world environment in real time [3, 4]. Furthermore, Johnson, et al. [5] claimed that, "AR has strong potential to provide both powerful contextual, on-sitelearning experiences and serendipitous exploration and discovery of the connected nature of information in the real world." Augmented Reality (AR) plays an important rule to dramatically shift the

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 111–118, 2017.
DOI: 10.1007/978-3-319-49625-2_14

way of the location and timing of learning and training, moreover, it effects on the future of education [6].

The remainder of this paper is organized as follows. Section 2 presents related works used in this work. Section 3 we describe the experimental design based on the purposed model and Sect. 4 shows the results of this experiment. Finally, the conclusion and future research are presented in Sect. 5.

2 Related Works

In this section, we describe the related concepts used in the specific literature and also adapted in the proposed application. Gwo-Jen Hwang and et al. [7] proposed method to conducted research in a natural science course on an elementary school and the experimental results show that the proposed approach not only enhances learning attitudes, but also improves the learning achievements of the students. The application was designed to be customizable by teachers and, based on collected data from observation, video and interviews, the design process and trial illustrate application use, and how it supports a geospatial approach to science education and raises issues around mobile technologies, teacher pedagogies and adoption [8]. D. Pérez-López and M. Contero [9] proposed the use of augmented reality (AR) for delivering multimedia content to support the teaching and learning process of the digestive and circulatory systems at the primary school level and the results show using AR multimedia is a promising tool to improve students' motivation and interest in contents. The effects of the use of augmented reality (AR) technologies was conducted in science laboratories on university students' laboratory skills and attitudes towards laboratories by using a quasi-experimental pre-test post-test control group design approach [10]. The SMILE project is a fantasy 3D virtual environment game to engage deaf and hearing children in math and science-based educational tasks that shows the key elements of successful computer games, emotionally appealing graphics, and realistic real-time 3D signing, with goal-oriented, standards-based learning activities that are grounded in research on effective pedagogy [11]. Hannes Kaufmann et al. [12] presented an augmented reality application that observed 3D objects in their textbooks and interacted to improve student's spatial abilities. However, when educational learning and AR technology are combined together, learners can gain experience and improve learning with a hugely positive way. Additionally, mobile application was used to provide management of learning environment [13]. There is much of research that indicated how to provide requirements for design of a mobile learning [14]. R. Rattanachai et al. [15] developed the lifestyles of Thai Buddhist application based on Android operating system to learn about lifestyle of Thai Buddhist serving.

3 Experimental Design

RAD (Rapid Application Development) was used to implement the mobile learning application [16], and user's requirements were analyzed for design processes to indicate student's interest in a mobile learning device and this prototype is effectiveness and usefulness to enhance their abilities. According to Kunyanuth et al. [17], the architecture of the system consists of 3 parts: the User Interface part, the Application part, and Data Storage part, as shown in Fig. 1. The user interface part receives input from the user and sends the information to the related parts for processing. Student/learners can register his/her profile, such as personnel information, email address, username and password, and etc., and he/she is assigned to take pre-test so as to initialize the student profile. Moreover, students can search supplementary information on demand by choosing the words or phrase appeared in the content page. In learning content module will prepare content for learning. This module consisted of conversion lesson content and indexed the topic of the lesson in database. Search module shows results related with the lessons and Fig. 2 presented the overview of this application.

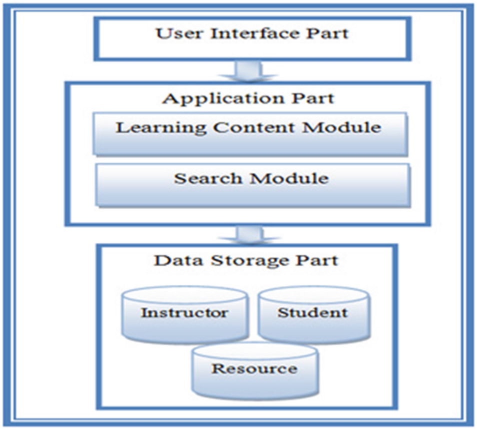


Fig. 1. The system architecture

The research aims to implement mobile learning system in Physics subject based on AR technology and to determine the comparative effect of the uses of standard materials and a supplemental instructional activity. The sample of this project consisted of 29 students using this prototype and the control group consisted of 30 students in the primary school level during academic year.

Also, this research is the quasi experimental research and, on the development of learning and teaching, the instruments used to collect data were: (1) a questionnaire and interview forms inquiring about the mobile learning course (2) a lesson plan for Physics course (3) an achievement pre-test and post-test (4) a questionnaires inquiring the students' opinion for this application. The collected data were analyzed by the statistical means $(\bar{x})$, standard deviation (S.D.) and the t-test statistical analysis. The level of the significance was $p = 0.05$ that formed the basis for or rejecting or not rejecting each of the hypotheses.

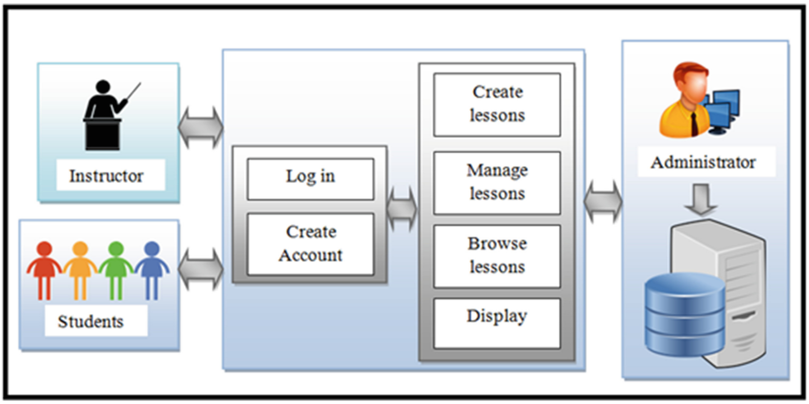


Fig. 2. Framework of the system

To compare physics learning achievement between the experimental and control groups, null hypotheses were formulated and tested at p = 0.05 to obtain answers to the research questions:

Research hypotheses

- There is no significant difference in the performance students learning with standard instructional materials
- There is no significant difference in the performance of the students learning with a supplemental instructional activity.

To assess students' learning achievements in the experiment of this study, two groups of students were pretested before learning. After testing was completed, the teacher taught the first group in a regular classroom, while the second group was introduced to learn from this application concurrently. Also, after week later, 2 groups of students were tested to find out students' achievement after learning. The instrument was examined by experts and teachers. Student from the control group and experimental group were took a pre and post-test that contain 30 items 4 option multiple choice objective test. Moreover, this research took Black box Testing and Questionnaires to test and evaluate the qualities of this application. Black Box testing was assessed in the error of the project as following: functional requirement test, Function test, Usability test, Performance test and Security test. The experimental procedure included participants used and learned mobile application and after finished, participants were asked for rating the quality of the application. A 5-point Likert scale was utilized to range from "strongly agree" to "strongly disagree".

4 Experimental Results

In this section, experimental results were separated to 2 parts: assessing students' learning achievements; and evaluating the performance and satisfaction of the application.

4.1 Assessing Students' Learning Achievements

The system was evaluated by students at the primary school level. This study took places in a class with 59 students. SPSS was used to analyze the student learning achievement of both the experimental and control groups. Table 1 displays the means and standard deviations in pre-tests and post-tests of the learning evaluation.

Table 1. The results of the students' learning achievement

Group	N	Pre-test		Post-test	
		$\bar{x}$	SD	$\bar{x}$	SD
Experimental group	29	17.85	2.98	42.03	4.95
Control group	30	18.22	4.15	39.30	3.88

The result in Table 1 indicates that learning achievement of students who learned under AR mobile application was significantly higher than that of students who learned under conventional instruction at the .05 level. The experimental results showed that experimental group taught with instructional materials achieved better scores than those taught without instructional materials and this project can help student learning and reduce time consuming study. To evaluate the effectiveness of learning material collected data from test and post-test was analyzed and measured by using E1/E2 effectiveness with 80/80 condition.

$$E_1 = \frac{\frac{\sum X}{N}}{A} \times 100 \quad (1)$$

$$E_2 = \frac{\frac{\sum F}{N}}{B} \times 100 \quad (2)$$

When

E1 = the efficiency of the developed material
E2 = the efficiency of performance result
$\sum$X = total score from lesson testing
$\sum$F = total score from post-test
A = Total score of lesson testing
B = Total score of post-test
N = total number of students

The result shows that the effectiveness of learning material was effective 80.75/82.25 with the criteria 80/80. Also, students were asked to give their opinions towards this application and the findings revealed that they had positively high attitudes with this application at rated above 4.05.

4.2 Evaluating the Performance and Satisfaction of the Application

Developing the Physics Learning system based on Android operating system, Fig. 3 shows the example results of application. In the experiment of this study, students took a pre-test and completed a questionnaire for analyzing their knowledge before participating in the mobile learning. Also, user can search for available learning resources, learn the interested lessons and take an exam through mobile application.

Fig. 3. The example result of application

To test and evaluate the qualities of the system, Black box Testing and Questionnaires by teachers and students were used to test this application. Black Box testing was assessed in the error of the project as following: functional requirement test, Function test, Usability test, Performance test and Security test. The ability of this application was evaluated by Functional Requirement test in needs of the users and Functional test was used to evaluate the accuracy of the system. Usability test was tested the suitability of the system. Performance test was used the processing speed of the system. Finally, Security test was evaluated the security of the system.

The results revealed that means for teachers and students in all aspects were 4.07 and 4.10, and standard deviation for teachers and users were 0.67 and 0.74 respectively as shown in Table 2.

Table 2. The results of Black box testing

	Teachers		Students	
	$\bar{x}$	SD	$\bar{x}$	SD
1. Function requirement Test	4.18	0.62	4.03	0.75
2. Functional test	3.91	0.74	4.03	0.66
3. Usability test	4.06	0.76	4.25	0.74
4. Performance test	4.15	0.55	4.03	0.80
5. Security test	3.91	0.55	4.29	0.78
Summary	4.07	0.67	4.10	0.74

5 Conclusion and Future Works

In this paper, the Physics Learning system based on Android operating system was proposed and this application can assists students to enhance student's abilities. The experimental group had significantly better performance in learning achievements. This system can be beneficial to use in different courses so that students can enhance and improve their ability and also this system supports teachers in handling and managing their course. However, in term of the future experiments, this supported material should be available into all subjects and teachers should adapt the social network like Facebook to participate during class. Also, we are looking forward to advanced technologies to support in learning preferences and interest of learners based on social networks and to create adaptive learning for learners.

Acknowledgments. The authors gratefully acknowledge the financial subsidy provided by Suan Sunandha Rajabhat University.

References

1. Assay, J.: The future of technology in K-12 arts education. In: Forum on Technology in Education: Envisioning the Future Proceedings, Washington, D.C, p. 15, 1–2 December 1999
2. The Mobile Learning Network, Information. http://www.molenet.org.uk/
3. Azuma, R.T.: A survey of augmented reality. Presence: Teleoperators Virtual Environ. **6**(4), 355–385 (1999). (August 1997). Cambridge, MA. The MIT Press 3
4. Zhou, F., Duh, H.B.L., Billinghurst, M.: Trends in augmented reality tracking, interaction and display: a review of ten years of ISMAR. In: IEEE International Symposium on Mixed and Augmented Reality, Cambridge, UK, 15–18 September 2008
5. Johnson, L., Levine, A., Smith, R., Stone, S.: Simple augmented reality. In: The 2010 Horizon Report, Austin, TX, pp. 21–24. The New Media Consortium (2010)
6. Lee, K.: Augmented reality in education and training. TECH TRENDS **56**(2), 13–21 (2012)
7. Hwang, G.-J., Wu, P.-H., Ke, H.-R.: An interactive concept map approach to supporting mobile learning activities for natural science courses. Comput. Educ. J. **57**, 2272–2280 (2011)

8. Laouris, Y., Laouri, R.: Can information and mobile technologies serve to close the gap and accelerate development? In: Proceeding of MLearning 2006, Alberta, Canada, 22–26 October (2006)
9. Pérez-López, D., Contero, M.: Delivering educational multimedia contents through an augmented reality application: a case study on its impact on knowledge acquisition and retention tojet. Turk. Online J. Educ. Technol. **12**(4), 19–28 (2013)
10. Akçayır, M., Akçayır, G., Pektaş, H.M., Ocak, M.A.: Augmented reality in science laboratories. Comput. Hum. Behav. **57**(C), 334–342 (2016)
11. Adamo-Villani, N., Wright, K.: Smile: an immersive learning game for deaf and hearing children. In: ACM Proceedings of SIGGRAPH 2007 Educators Program. ACM Publications, San Diego (2007)
12. Kaufmann, H., Meyer, B.: Simulating educational physical experiments in augmented reality. In: ACM SIGGRAPH ASIA 2008 Educators Programme, SIGGRAPH ASIA 2008, New York, NY, USA, pp. 1–8. ACM (2008)
13. Sevillano-Garcia, M.L., Vazquez-Cano, E.: The impact of digital mobile devices in higher education. Educ. Technol. Soc. **18**(1), 106–118 (2015)
14. Sharples, M.: The design of personal mobile technologies for lifelong learning. Comput. Educ. **34**(3), 177–193 (2000)
15. Rattanachai, R., Luebangyai, S., Kularbphettong, K.: Developing a lifestyle of thai buddhist knowledge mobile application. In Proceeding of 6th World Conference on Educational Sciences (2014)
16. Javatechig. "Rapid Application Development Model", Information. http://javatechig.com/se-concepts/rapid-application-development-model
17. Kularbphettong, K., Putglan, R., Tachpetpaiboon, N., Tongsiri, C., Roonrakwit, P.: Developing of mLearning for discrete mathematics based on android platform. In: 7th World Conference on Educational Sciences, (WCES-2015), pp. 793–796 (2015)

The Use of Physical Artefacts in Undergraduate Computer Science Teaching

Edward Currie(✉) and Carl James-Reynolds

Department of Computer Science, Middlesex University, London, England, UK
{e.currie,c.james-reynolds}@mdx.ac.uk

Abstract. This paper describes the introduction of the use of physical artefacts in the teaching of the undergraduate curriculum in the Department of Computer Science at Middlesex University. The rationale for the change is discussed, together with a description of the various technologies and the areas in which they were deployed. We conclude with a discussion of the outcomes of the work and the conclusions reached, prime amongst which are that the policy has been successful in motivating and engaging students, with a resultant improvement in student progression.

Keywords: Physical computing · Microcontroller · Robotics

1 Introduction

The study of Computer Science has always involved a balance of abstract concepts and practical work. Students sometimes find the former difficult to grasp in isolation and in the curriculum, they are not always closely integrated with the latter. Practical computer programming courses have often involved exercises that are not related to real-world problems and are often considered by students to be rather dull. This, in turn, has tended to make programming and other problem solving tasks seem to students like a necessary evil, rather than something exciting and engaging. This can affect the amount of effort that students are willing to put into their study, which together with the incremental nature of programming, tends to result in the 'falling behind and staying behind' reported by [1, 8]. This effect has been noted in programming courses at all levels and in all countries and cultures worldwide. Those who succeed in programming and problem solving tend to be those who immerse themselves in the subject. There is evidence that the use of physical artefacts can promote the necessary level of engagement and motivation for successful study in computer science. In the rest of this paper, we describe some examples of the deployment of physical technologies within the Information Technology and Computer Science undergraduate programmes at Middlesex University and discuss some of the outcomes.

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 119–124, 2017.
DOI: 10.1007/978-3-319-49625-2_15

2 Related Work

Much of the existing literature focuses on encouraging the uptake of STEM-based subjects and use of physical computing in schools [3]. In the UK there has been a dramatic shift in the school curriculum and a new focus on computer programming; however this is not yet reflected in the experiences of those who are entering undergraduate study. Blikstein [2] has noted that some platforms such as Arduino expose children to too much detail, at too low a level of abstraction. Kato [6] has attempted to address this by the development of visual interfaces. This does not seem to be the case at undergraduate level, where Okita's [7] work suggests that students who learn via low transparency text based programming languages not only did equally well in assessment as those students who learned in high transparency visual coding environments, but additionally were better placed to solve new problems with unfamiliar materials.

Herger and Bodarky [5] identified, in workshops with schools, that it is important to manage time and resources effectively in order to complete planned exercises and this is equally important at undergraduate level.

Cambron [4] explored the use of Arduino in a first-year robot-based project as a first experience of electronics and processors and found it "invaluable for retention purposes". Rubio et al. [9] also found value in increased retention and engagement and the number of students who learned effectively. They also identified that the mean grades and number of high performance students did not change significantly.

3 Context

In 2013, the undergraduate programmes in computing at Middlesex University underwent a revalidation. For many years, students had stuggled with the computer programming and problem-solving strand of the BSc Computer Science (CS) programme, while the BSc Information Technology (IT) programme was very much management-oriented, with minimal computer programming content. Many CS students, after struggling with the programming content in the first year of their course, would transfer to the IT programme to avoid further study of programming. We were unhappy with this role for the IT programme, and with the poor progression rate of students on the CS programme, and it was decided that the revalidated programmes should both have a strong programming and problem-solving core thread. Furthermore, they should embrace the use of physical artefacts to motivate and engage students in project-based learning. Through this, students could be exposed to concrete implementations of theoretical concepts to reinforce their understanding. We now describe some of the technologies used and the areas in which they were deployed.

4 Arduino Microcontrollers

The use of Physical Computing in the IT curriculum was introduced 5 years ago as a trial with final year students and fully integrated since the revalidation of the programme. First year undergraduates take a module that introduces concepts such as smart homes, embedded systems, sensors and automation, personal online presence, and simple machine learning. Six weeks are dedicated to Physical Computing workshops using Arduino. Although most of the coursework is completed over a period of three weeks, it was considered to be important to give the students time to try out ideas and to encourage a sense of "playing" with the technology. The two-year trial had highlighted some of the difficulties students had with mapping schematics to breadboards and identification of components such as resistors. Students were also frustrated with the practical difficulties of rewiring breadboards at the start of each taught session. A kit was therefore developed as part of an undergraduate project [14], that allows the use of a wide range of sensors; however, these were prewired and accessed by simply patching them in using 3.5 mm jack to jack patch cables. Students were originally given a specific group challenge, but are now presented with a set of criteria to which their projects must conform; the actual project is negotiated with the tutor. As the students concurrently study a Java programming module, the challenge is not just about writing code from scratch, but the process of reuse and modification of existing code, for incorporation into the system. Through this, students gain insights into the techniques of real-world development of software projects. In practice over the last two years, approximately 40% of students have chosen to move beyond the kit to using breadboards directly and have had the technical expertise to feel comfortable with this. There have been a range of different reasons for this, but greater flexibility in developing their products seems to have been paramount among these. Students post their work on Social Media, which is an important part of maintaining a portfolio and personal profile, but also serves to allow others to critique their work and for employers, family and friends to view their work in an easily accessible form.

Arduino microcontrollers have also been deployed in the first year of the CS programme. Here, they are used for group-based projects over a period of weeks, running in parallel with the students' other studies. These projects are used to give the students practical experience of otherwise rather abstract concepts such as finite state machines, set theory, functional programming and propositional logic. The students learn Racket, a multi-paradigm dialect of Lisp, and they are able to control the Arduino directly with this language by running the Arduino Service Interface Protocol (ASIP), which was developed for this purpose and is available at [11]. Typical projects have included a three-way traffic light system and games such as noughts and crosses and battleships. CS students also learn about assembly programming with the Arduino, through use of the Atmel Studio simulator.

In a third year Multimedia Engineering module, students use the Arduino to develop a multimedia experience. This is criteria-based and must include the use of sensors and the control of media. The assessment criteria include "meaningful interaction" and a "fun" component as well as an overview of the processes involved. As in the first year, plenty of time is given to explore ideas. Those students who engage with the work produce a wide range of interesting artefacts. It is permitted to use existing code, but this has to be modified or adapted to give a new type of interaction, with any code written by others being clearly referenced. Examples of projects include 'light chimes' – sensing the position of a swinging torch to generate music, interactive T-shirts that respond to proximity of others and smart home automation.

5 Robots

A bespoke robotic platform (MIRTO; Middlesex Robotic plaTfOrm) was developed for use with the first year CS students [12]. This comprises a set of HUB-ee wheels [13], an Arduino Teensy and Raspberry Pi computer running Linux. The robot is equipped with quadrature encoding, wireless card, bump sensors and infrared detectors for use in line-following algorithms and similar. The Teensy interfaces to these components and the Raspberry Pi is connected to the Teensy via its serial port. The ASIP protocol is used to enable the robot to be controlled by Racket programs loaded onto the Raspberry Pi.

The robots are used in projects that reinforce a number of CS concepts. For example, the functional programming concept of higher order functions is used to map Arduino pin-setting functions across a number of pins and the concepts of functions as first class objects and side effects are demonstrated through lists of functions employed in causing the robot to explore an unknown area. Another example is the use of Racket Contracts to specify required robot behavior [10]. Through the use of Linux, students also gain familiarity with use of a command line interface, which most are unfamiliar with, having grown up using only graphical user interfaces.

Student projects using this technology have included PID line-following algorithms using the IR sensors and controlling robots remotely through web pages, the Twitter API and email servers. A number of students go well beyond the taught material and one team competed successfully in the Eurobot national championships, coming 4th out of 17 teams.

6 Logic Circuits

The CS students also build simple combinatorial and sequential logic circuits using components such as logic gates, adders, clock sources and breadboards. This reinforces their knowledge of a number of concepts, including propositional logic. The latter is an example of the holistic approach to the curriculum, as students see the same concept in their study of fundamental underpinnings and in their programming workshops.

7 Discussion and Conclusions

Some of the benefits of engaging students with a physical computing approach are

- Motivation through hands on experience
- A chance to experience a whole lifecycle from concept to prototype
- Opportunities to engage with family, friends, potential employers and contribute to online communities
- Understanding testing strategies and designing tests
- Opportunities to be creative with open-ended assignments
- Engaging with current debate about sensors/data/internet of things

Motivating students and encouraging an exploratory outlook in their learning is important in terms of retention and also for their induction into university culture. Working with physical manifestations challenges students perceptions of computing and require them to work in new ways, with success in the set tasks giving them confidence to tackle new problems. One of the key areas that is explored through physical computing is the need to develop test strategies to clearly identify the nature of any problems. Errors may lie in hardware, software or the communication between devices and students need to develop analytical skills to identify where the problems lie. Physical computing also lends itself to group work and in the first year, this allows students to develop a stronger cohort identity.

For first year students, assessment sets a threshold for progression, but does not count towards their final classification. For the final year students, it is important that assessment enables grades assigned to accurately reflect each student's achievement. The Arduino community actively encourages code reuse, but this must be properly cited and documented so that a student's individual contribution can be evaluated.

Another issue with physical computing is the need to engage with the work over a period of time. Students often become adept at managing deadlines with a "just in time" approach. The physical computing tasks require more time than students might expect when they have less experience of this type of work. However, emphasising the exploratory nature of the projects and providing the necessary time in the labs helps to overcome this.

Developing kits, storing them and ensuring that damaged or missing items are replaced is also time consuming. Breadboards are not ideal, as often circuits are unreliable and temporary in nature. On the other hand, there is a loss of flexibility in using self-contained kits. Introducing soldering makes it difficult to reuse components and requires specialist lab provision, but is the better option for final year projects where students may wish to keep the artefact and be able to demonstrate it without the risk of failure.

Use of a Physical Computing approach has been beneficial in Computer Science and IT in motivating students and helping them engage with the area. It does not offer an easy option for the tutors, as they have to manage more equipment and ensure that students get through initial thresholds such as a working circuit and code, help students develop test strategies and negotiate the deliverables. For final year students, it is important that tutors are continually aware of student progress and that the "rules" for code and hardware reuse are clear.

Physical computing is not a panacea for teaching programming and it is important that tasks relate to the area being taught. However, we have found that it does help students with understanding some of the more abstract aspects of programming and other computing concepts. It also plays a major role in student motivation; we often find that students do not want to leave at the end of their lab sessions. Progression rates have improved since the introduction of physical computing and many students have engaged in external activities to show off their work. These include open days, National Science Week events and robotics competitions as described above.

References

1. Ahadi, A., Lister, R., Teague, D.: Falling behind early and staying behind when learning to program. In: Proceedings of the 25th Psychology of Programming Conference, PPIG (2014)
2. Blikstein, P.: Gears of our childhood: constructionist toolkits, robotics, and physical computing, past and future. In: Proceedings of the 12th International Conference on Interaction Design and Children, pp. 173–182. ACM (2013)
3. Buechley, L., Eisenberg, M., Catchen, J., Crockett, A.: The LilyPad Arduino: using computational textiles to investigate engagement, aesthetics, and diversity in computer science education. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 423–432. ACM (2008)
4. Cambron, M.E.: Using the Ardunio in freshmen design. In: Sixth Annual (FYEE) First Year Engineering Experience Conference on Enhancing the First Year of Engineering Education College Station, TX, 7–8 August 2014
5. Herger, L.M., Bodarky, M.: Engaging students with open source technologies and Arduino. In: 2015 IEEE Integrated STEM Education Conference (ISEC), pp. 27–32. IEEE (2015)
6. Kato, Y.: Splish: a visual programming environment for Arduino to accelerate physical computing experiences, pp. 3–10. IEEE (2010). doi:10.1109/C5.2010.20
7. Okita, S.Y.: The relative merits of transparency: investigating situations that support the use of robotics in developing student learning adaptability across virtual and physical computing platforms: relative merits of transparency in learning adaptability. Br. J. Educ. Technol. **45**, 844–862 (2014). doi:10.1111/bjet.12101
8. Robins, A.: Learning edge momentum: a new account of outcomes in CS1. Comput. Sci. Educ. **20**, 37–71 (2010). doi:10.1080/08993401003612167
9. Rubio, M.A., Romero-Zaliz, R., Mañoso, C., de Madrid, A.P.: Enhancing an introductory programming course with physical computing modules. In: 2014 IEEE Frontiers in Education Conference (FIE), pp. 1–8. IEEE (2014)
10. Boender, J., Currie, E., Loomes, M., Primiero, G., Raimondi, F.: Teaching functional patterns through robotic applications. In: Proceedings TFPIE 2015: The Fourth International Workshop on Trends in Functional Programming in Education (2015)
11. Racket Asip Client Library. https://github.com/fraimondi/racket-asip
12. The MIddlesex Robotic plaTfOrm (MIRTO). https://github.com/fraimondi/myrtle
13. Creative Robotics: HUB-ee, About-HUBee-Wheels. http://www.creative-robotics.com/
14. Clarkson, R.: A Self Contained Arduino Toolbox, Middlesex University Undergraduate Project submitted, 24 April 2014

ThesesDB – Single-Source of Information and Workflow Support for Students' Work

Fabian Ball(✉), Thomas P. Hummel(✉), Andreas C. Sonnenbichler, and Victoria-Anne Schweigert

Karlsruhe Institute of Technology, Karlsruhe, Germany
{ball,thomas.hummel,sonnenbichler,v.schweigert}@kit.edu
http://em.iism.kit.edu

Abstract. e-Learning can be seen as service creation process including core, enabling and enhancing services. We focus on enhancing services for managing thesis and seminar processes at our university in order to support transparency, track-ability, communication, and success for our students and lecturers. We analyze the processes for bachelor, master, and PhD theses and bachelor and master seminars. Consequently, we suggest process templates to cover these processes. The process templates are implemented as an enhanced IT web application, named ThesesDB, utilizing modern web technologies and used in our lectures. We evaluate our approach by the Computer System Usability and USE Questionnaire.

Keywords: e-Learning · Service enhancement · Process · Workflow · Tutoring · Supervised student publication

1 Introduction

e-Learning is not a new trend, but a trend seemingly accelerating. Just recently the LearnTec 2016 fare was hold in Karlsruhe, Germany. We observed three major trends at this important fare: (1) workplace and blended learning, offering low-cost solutions especially for technical and facts-based training contents, e.g. new product information for all sales employees, (2) gamification, thus melding gaming and learning,(3) the fusion of e-Learning ideas and "Industry 4.0".

As a university having a focus on both, top research and high-quality teaching for our students (and teachers), our department follows closely the development on the e-Learning field trying to apply new ideas in our environment. We see teaching as a special kind of service being provided for our students coming along with some specialties. The attribute "special" arises from the setting that our "client" in universities' teaching services are mainly students who are assessed by the service provider, e.g. by examinations. In more typical services, e.g. a hair-stylist or a restaurant, the client assesses the service provider and not

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 125–134, 2017.
DOI: 10.1007/978-3-319-49625-2_16

vice versa[1]. Seeing teaching and e-Learning as services it seems reasonable to apply (research) principles of service management to this kind of service, too. C. Grönroos is a very influencing researcher teaching the so-called "Nordic School" with focus on high-quality service creation and delivery and considering external consequences of decisions made by the service provider (cf. [2,6]). Grönroos (e.g. in [5]) distinguishes three basic service types for every service a service provider can offer to its clients:

– Core services: these are services that are basically the reason for a service provider to be in the market. E.g. for a hair-stylist this is styling hairs, for universities this is giving lectures.
– Enabling services: these are services which must be offered in order to enable the core services to be able to function, e.g. the paying services or offering examination for lectures.
– Enhancing services: these are services enhancing the service experiencing of the clients providing advantages in competition for the service provider, e.g. offering a cup of coffee to the client at the coiffure.

Looking at university lectures with this kind of mindset, we realized, that a lot of e-Learning activities are tailored towards the core services. Identifying this gap, we decided to improve the enabling and enhancing services in e-Learning.

In this paper we describe an innovative approach how to improve the interaction between students and lecturers. We focus on the creation, support and supervision process for student theses, e.g. bachelor thesis, master thesis, PhD thesis and student seminars. Lecturers at our department are supervising quite a number of these types of works simultaneously and, despite their best efforts, sometimes lose track, what in detail has been going on in every specific thesis/seminar. Consequently, our research targets for this work are

– analyze and formalize the process for creating and supervising seminars, bachelor/master/PhD theses (on a general level).
– design, implement, and introduce an IT tool to support these processes. We named the IT tool *ThesesDB* (theses database).
– evaluate (or at least start the evaluation) of the ThesesDB.

To our knowledge, no such effort has been undertaken so far.

2 Related Work

A study of Mc Farland and Hamilton in 2005 [11] compares the performance of offline and online students. They conclude that no major difference can be found on a general level, but that (structured) online material can have positive effects on the success of students.

[1] We are aware that lecture assessments are a increasingly used instrument to establish the client (student) assessment of the service provider (lecturer), however, at least in Germany, the consequences of bad or even good assessments for a lecturer are very limited.

Johnson, Killion and Oomen [8] put forward success factors for online courses. These factors are design (target group), flexibility, contact (make contact to lecturers easy), student-student interaction, monetary support (for the online systems), and orientation (which we interpret as process-focus).

Alanazi and Abbod [1] did a general research on the needs for e-Learning repository systems at Saudi Universities. They analyze different type of media (e.g. source materials, videos, audio) and how these materials can be connected/linked. However, apart from the collection and sharing process they avoid to elaborate on processes that are necessary for such a repository system, e.g. versioning, diffs, notification of further materials for students and teachers (e.g. during a course when material is added), lifetime analysis, archiving and so on.

Eybers and Giannakopoulos [4] do research on the engagement of students in an online environment and compare this to the face-to-face perspective. They conclude that "the teachers' roles, the students' needs, the administration must satisfy e-Learning criteria providing a student centered collaborative approach which could lead to student satisfaction and thus get a more engaged student" [4, p. 74]. We see this as a strong argument towards IT systems supporting collaborative and structured processes in e-Learning environments; like our ThesesDB.

Caione et al. [3] analyze the effectiveness of e-Learning environments related to their respective goal. They do this by an example in the agri-food sector of unstructured information being analyzed with the help of an ontology. The feedback analysis is being planned to be implemented in our work.

A virtual assistant to provide aid in e-Learning in environments for students is tested by Harvey et al. [7]. They use rule-based systems for an avatar-based FAQ system for university services at a London university.

Radhamani et al. [12] suggest a virtual lab for biotechnology students at the Amrita School in India. Following a standardized process (selecting an experiment, protocol standardization, virtualization, sketching of story board, and value platform), the authors analyze the effectiveness in supporting the students to increase their active learning process. The result was, that "virtual labs [...] ensured a better performance during evaluations" [12, p. 145].

However, supervision, advising, and writing a thesis may be a special case, different from a typical subject-based e-learning situation. We focus on the structured and process-oriented way, on how this approach was conducted.

3 Key Features

We propose the platform ThesesDB that supports the creation process of students' work from the different views of authors, supervisors or administrators. Based on customizable processes (e.g. for bachelor, master, PhD theses or seminar papers), the platform stores all related information from announcements of open theses through official dates for presentations to the final archiving step.

Due to the integrated rights management and personalized views, each involved party can track the overall progress of the work and its own responsibilities and tasks. New processes can be created from scratch or extended by additional steps. Every step can point to additional material or it can require actions and activities from the users. When a process reaches a stage that requires attention of a specific role, notifications can be sent via e-mail and reminders appear in the users' overview sites.

In addition to explicitly modeled actions and activities in every process step, it is possible to upload attachments and notes. This allows to track meetings, add supplementary materials or keep track of relevant information for future reference.

External systems and services can be connected through custom code. For example, this can be used to file the final work with sources and references to a separate archive system.

4 Processes and Examples

Analyzing the typical papers created by students of our faculty (processes and their related participants), showed us high grades of similarities: The sequence of actions and participants are almost the same, although minor differences being present with PhD thesis being a kind of special case compared to the other processes. As we want to support those processes by our IT tool, we chose to opt for customizable process templates supporting each of the above processes. We found three different process roles (responsibilities) re-occurring in all process templates: author, supervisor, and administration. It is possible to add new processes or roles for special cases, for example when a thesis is supervised jointly with a third party. Utilizing these templates, the whole process of allocation, editing, submitting feedback, archiving, and accounting will become more transparent to all process partners and enable each party to see the current process state at one glance.

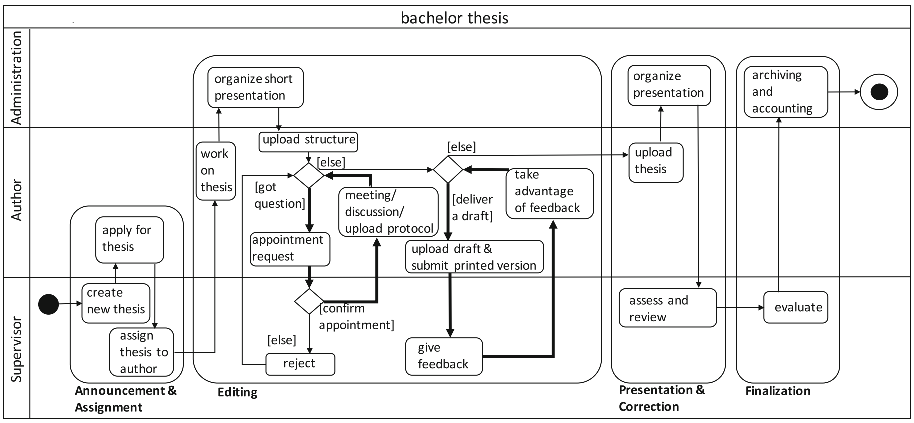


Fig. 1. UML activity diagram for a bachelor thesis. The four major activities are described in the text. Feedback loops in bold.

As an example, we depict our current process template for the bachelor thesis (Fig. 1) with the four activities *Announcement & Assignment*, *Editing*, *Presentation & Correction*, and *Finalization*. Each activity possibly consists of several (sub-)activities and/or atomic actions. These activities encapsulate atomic actions, e.g. the necessity to organize a presentation date. As process organization may differ between organizational units or universities, the described process could be modeled in another way. ThesesDB is capable of dealing with such requirements.

Here, the wording differs between UML and the concrete implementation. In ThesesDB, UML (sub-)activities are called *(sub-)process steps* and UML actions are split up into *activities* and *actions*. Details on that are provided in Sect. 5.

The process of a bachelor thesis can be summarized as follows:

1. Announcement & Assignment: As a first step, the supervisor publishes the topic of the bachelor thesis. Interested students can apply.
2. Editing: The student (author) works on the thesis, during that time a short presentation will take place, organized by the administration. Irregular meetings between author and supervisor are not modeled explicitly.
3. Presentation & Correction: In this process step, the author uploads the final submission. The submission includes the thesis as PDF and LaTeX, presentation slides and used literature. After the supervisor corrected the work, he gives a feedback to the author.
4. Finalization: Evaluation, archiving of materials and recording of results.

5 Implementation

This section describes the translation of the key features (see Sect. 3) into software, from the abstract concept down to some implementation details. In order to stay flexible in designing our processes (see Sect. 4), we divide the different specialized components into more general elements. These are outlined in the following as well.

Furthermore, we distinguish between design time and runtime of a process, well comparable with classes and objects in object-oriented programming. Each time the start of a process is triggered (e.g. a new bachelor thesis is made available), an instance of a previously designed process is generated.

Instances are linked to the "template" process. However, changes (e.g. due to process redesign) do not affect the instances. This is an important feature as thesis finished in the past or currently running must not be altered.

5.1 Design Time

We reduced our process model to the three building blocks *process steps*, *activities* and *actions*. As an overall structure we chose to model business processes in a tree-like manner:

– A unique *root process step* defines the process. Different business processes have different root processes.

- Each process step that is not a root process has a parent process step and an ordinal number which defines the ordering of process steps having the same parent. Such process steps are called *sub process steps*.
- *Activities* and *actions* also have process steps as parent. *Activities* are also ordered. These two elements represent the “dynamic” part of our process model whereas the process steps can be seen as “static” part.

By “dynamic” we mean the point of user interaction with the system. *Activity* and *action* are distinguished as follows:

- An activity is a predefined and reusable building block that requires a user to perform some simple task. These tasks can be e.g. entering a date/text/url, uploading a file or simply ticking a checkbox to signal that the manual task related to the activity is done. The semantic of an activity is given by its descriptive text which is assessed by the process designer.
- An action is much more complex than an activity and covers a special task that cannot be accomplished by an activity or a combination of several activities. Other than an activity, an action must be explicitly implemented by a programmer to perform this special task. An example is given in Sect. 5.3.

To complete the design time business process definition, we introduce special (user-)roles that are attached to process steps: On the one hand, there is a visibility relation that permits restricting visibility to only those users which have an appropriate role (not limited to one role). On the other hand, there is a responsibility relation that assigns exactly one role to be responsible for this process step.

5.2 Runtime

When a process is initiated, copies of the above defined elements are made and encapsulated within a “thesis” instance. This data model holds all meta-information (name, start/end dates, ...) that are needed at runtime and have nothing to do with the abstract business process definition. The instance elements' names are then prefixed with *thesis* (e.g. *thesis process step*). To assign to a user in a thesis, the user gets a role for the thesis. The user then can see all process steps visible for this role and can interact via activities and actions.

Furthermore, it is possible for every involved user to add *attachments* to a *thesis process step*. This allows the interchange of documents (e.g. meeting notes) that are not directly part of the business process itself. To prevent later changes (e.g. after some deadline due), *thesis process steps* can be locked manually or automatically if some point in time is reached. Locked process steps are read-only. To keep track of changes, users can subscribe to several events which allows them to be notified via email.

5.3 Implementation Details

We implemented our process model with the *Django web framework*[2] which has a powerful object-relational mapper (ORM) that allows quick modeling of structural data and rapid development overall. The design and runtime components are decoupled by using separate modules (called *apps* in the Django domain). The user interface is mainly written in plain *HTML* which fits best with Django's template engine and makes debugging easy.

As an example for an action, we implemented the submission procedure of a student's thesis: The student uploads the thesis' PDF file and the LaTeX source files. The related bibtex file is parsed and the student can upload the cited literature. The supervisor reviews the uploads and afterwards triggers the archiving process. The archiving process is done in a completely separate system and therefore includes invoking multiple web service calls which makes up the increased complexity that disallows the use of "simple" activities.

6 Example

In Fig. 2 we provide an example of the user interface depicting the sub-process "Delivery" and its assigned activities (we use the wording of Sect. 5). We now explain the functionality of ThesesDB by the example of a bachelor thesis.

The supervisor ("Supervisor Demo") chose the template "bachelor thesis", set the name "Single-Source of Information and Workflow Support for Students' Work" and added a small description. With this, the thesis is instantiated. The supervisor assigns himself the role "supervisor" for this specific thesis.

Next, interested students can find the newly available thesis, read the topic and description and apply for it.[3] The supervisor assigns the author-role for this process instance to the particular student. Additionally, the supervisor assigns "Office Demo" as contact person/responsible role for administrative purposes. As a result, only supervisor, author and assigned administrative contact person are able to interact with the process instance.

The student works on the topic. The short presentation event will be organized by the administration, the author uploads the structure of the thesis. As the author has some questions, she decides to ask for an appointment with her supervisor. The supervisor confirms the request (within ThesesDB); the meeting takes place. The student uploads the meeting notes to the ThesesDB making them accessible for all participants.

The author uploads the first version of the thesis as a PDF file. The reminder (check box) to hand in a printed version remains unchecked as a to-do for the author. After the correction by the supervisor, feedback is given to the student. The student takes advantage of the feedback and finalizes her work.

---

[2] https://www.djangoproject.com/ (last accessed 02/2016).

[3] The application process is currently not implemented in the ThesesDB. However, there are no technical limitations to extend ThesesDB with this functionality.

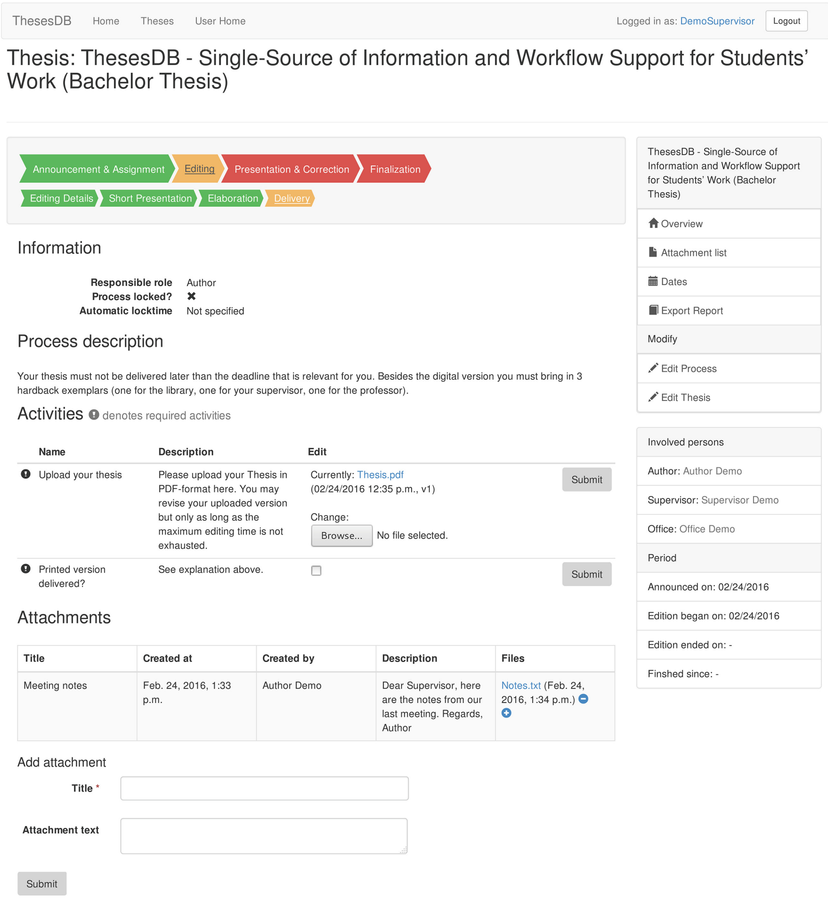


Fig. 2. The subprocess "Delivery" from the supervisor's point of view.

The author uploads the final version and all attachments (e.g. presentation slides, literature). The thesis will be archived and the student gets a result (mark). The supervisor checks the documents and uses an interface to the archive system to archive the documents.

7 Evaluation

In order to evaluate the usability of the proposed system, we conducted a study with 5 participants of our bachelor seminar in the winter term 2015/2016. The seminar takes place in the field of economics and computer science. We used self-reported metrics, as explained by Tullis and Albert [13, pp. 121–162] and selected the Computer System Usability Questionnaire (CSUQ) [9] as well as the USE Questionnaire [10].

Table 1. Scores of the CSUQ (top) and USE (bottom) scales

CSUQ	System usefulness	Information quality	Interface quality	Overall satisfaction
	0.85	0.69	0.78	0.86
USE	Usefulness	Ease of use	Ease of learning	Satisfaction
	0.65	0.69	0.68	0.72

The users rated their agreement on both scales on a seven-point Likert scale from *strongly agree* to *strongly disagree*. The score for the particular dimensions is calculated by the mean over the respective items and ranges from 0 to 1, where 1 represents full agreement.

As shown in Table 1, the reactions are mainly positive, since dimensions range between 0.65 and 0.86. In the free text answers students mainly criticize technical difficulties at the beginning but they emphasize the good structure and helpful guidelines provided by the system.

A time saver for supervisors is that students upload their (digital) bibliography in a structured way. Students request less organizational help than before, because they are pointed to relevant information in the system.

8 Conclusion and Future Work

In this work we treat the university as a service provider for its students. In particular, we look at the business process that represents the creation and supervision of students' theses or term papers.

Therefore, we propose a system that supports the creation of processes templates during design time and the management of a concrete work in runtime. It provides information for supervisors, authors, and administrators and can be extended to work with additional tools or services.

Future extensions could include better integration with existing systems, e.g. the application process. Meeting dates could be exported to personal calendars or presentation dates could be published on a website, for example. Application handling and the selection of candidates could be integrated as well. Finally, the use of a full-featured workflow management system with graphical process design would enhance the functionality and the ease-of-use even more.

References

1. Alanazi, A., Abbod, M.: E-Learning repository system for sharing learning resources among Saudi universities. In: Vincenti, G., Bucciero, A., Vaz de Carvalho, C. (eds.) eLEOT 2014. LNICSSITE, vol. 138, pp. 10–18. Springer, Heidelberg (2014). doi:10.1007/978-3-319-13293-8_2
2. Berry, L.L., Parasuraman, A.: Building a new academic field - the case of services marketing. J. Retail. **69**(1), 13–60 (1993)

3. Caione, A., Guido, A.L., Paiano, R., Pandurino, A., Pasanisi, S.: E-learning project assessment using learners' topic in social media. In: Vincenti, G., Bucciero, A., Vaz de Carvalho, C. (eds.) eLEOT 2015. LNICSSITE, vol. 160, pp. 92–100. Springer, Heidelberg (2016). doi:10.1007/978-3-319-28883-3_12
4. Eybers, S., Giannakopoulos, A.P.: Student engagement in an online environment: are we trying to mimic contact education? a South African perspective. In: Vincenti, G., Bucciero, A., Vaz de Carvalho, C. (eds.) eLEOT 2015. LNICSSITE, vol. 160, pp. 68–75. Springer, Heidelberg (2016). doi:10.1007/978-3-319-28883-3_9
5. Grönroos, C.: Service Management and Marketing: Customer Management in Service Competition, 3rd edn. John Wiley & Sons, Chichester (2007)
6. Gummesson, E., Lehtinen, U., Grönroos, C.: Comment on nordic perspectives on relationship marketing. Eur. J. Mark. **31**(1–2), 10–17 (1997)
7. Harvey, P.H., Currie, E., Daryanani, P., Augusto, J.C.: Enhancing student support with a virtual assistant. In: Vincenti, G., Bucciero, A., Vaz de Carvalho, C. (eds.) eLEOT 2015. LNICSSITE, vol. 160, pp. 101–109. Springer, Heidelberg (2016). doi:10.1007/978-3-319-28883-3_13
8. Johnston, J., Killion, J., Oomen, J.: Student satisfaction in the virtual classroom. Internet J. Allied Health Sci. Pract. **3**(2), 1–7 (2005). Article ID 6. http://nsuworks.nova.edu/ijahsp/vol3/iss2/6/
9. Lewis, J.R.: IBM computer usability satisfaction questionnaires: psychometric evaluation and instructions for use. Int. J. Hum.-Comput. Interact. **7**(1), 57–78 (1995)
10. Lund, A.M.: Measuring usability with the USE questionnaire. Usability Interface **8**(2), 3–6 (2001)
11. McFarland, D., Hamilton, D.: Factors affecting student performance and satisfaction: online versus traditional course delivery. J. Comput. Inf. Syst. **46**(2), 25–32 (2005)
12. Radhamani, R., Sasidharakurup, H., Sujatha, G., Nair, B., Achuthan, K., Diwakar, S.: Virtual labs improve student's performance in a classroom. In: Vincenti, G., Bucciero, A., Vaz de Carvalho, C. (eds.) eLEOT 2014. LNICSSITE, vol. 138, pp. 138–146. Springer, Heidelberg (2014). doi:10.1007/978-3-319-13293-8_17
13. Tullis, T., Albert, B.: Measuring the User Experience: Collecting, Analyzing, and Presenting Usability Metrics, 2nd edn. Elsevier/Morgan Kaufmann, Amsterdam (2013)

Validation of Course Ontology Elements for Automatic Question Generation

Noor Hasimah Ibrahim Teo(✉) and Mike Joy

Department of Computer Science,
University of Warwick, Coventry CV4 7AL, UK
{N.H.Ibrahim-Teo,M.S.Joy}@warwick.ac.uk

Abstract. Recent research has led to the emergence of ontology-based question generation and aims to benefit instructors by providing support and intelligent assistance for the automatic generation of questions. However, existing ontologies are not designed mainly for this purpose and the concern is that an ontology will not be competent enough to act as a semantic source for the question generation process. Therefore, the aim of this work is to validate how well the elements represented in a course ontology can be used for the purpose of automatic question generation. In this work, we choose to validate Operating System ontologies and identify related question sources from textbooks on this subject as competency questions. Finally, the result shows that the evaluated ontologies need more modification if they are to be used for question generation and we also suggest a list of concept naming patterns that need to be considered for such ontology modification.

Keywords: Competency question · Course ontology · Question generation

1 Introduction

Ontologies have been widely used in educational environments and the number of evaluations of them is increasing. Various techniques for ontology evaluation have been already proposed, comprising validation and verification of ontologies taxonomies as well as of their content. To develop a *complete* ontology is almost impossible in practice, but as long as an ontology can be used to solve a specific problem, it is considered to be sufficient. A course ontology is a subject domain ontology that represents knowledge of educational learning content and, like other ontologies, it contains concepts and the relationships that exist between those concepts. A course ontology can be used to automatically generate questions related to course content. Therefore, evaluation of existing course ontologies is crucial to determine their coverage, and validation of concepts presented in the ontologies towards real world assessment questions will help to achieve this purpose.

Course ontologies can be categorised as domain ontologies where the scope is limited to delivering educational learning content. There are some course ontologies found in the literature such as Object Oriented Programming [1], Operating Systems [2, 3], Mathematical Logic [4] and Networking [5], but the competency of each ontology to be used as a source of semantic information for automatic question generation is not

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 135–142, 2017.
DOI: 10.1007/978-3-319-49625-2_17

known. Therefore, we consider validation of course ontologies which are used as a source of information for automatic question generation later in this paper. Since validation needs real world examples, real assessment questions will be used as competency questions. The definition of competency question in this paper is slightly different from the one that normally use in other literature. We define a competency question as a question stated in natural language and containing required terms for the particular context. We will discuss the validation of course ontology elements relating to particular concepts and relations, using competency questions to determine the sufficiency of the information represented in the ontology to be used for automatic question generation.

An Operating System course from the Computer Science domain was chosen to begin with due to the availability of this course ontology on the web and the nature of the test questions being mainly factual. Operating System ontologies from Kent University Library [2] and ONKI Library [3] were chosen to be validated and have been named as *OntoA* and *OntoB* respectively throughout this paper. A set of competency questions related to this subject is chosen and discussed in the following section.

2 Competency Questions

Gruninger and Fox [6] had used competency questions as a means to evaluate whether an ontology is sufficient for its intended purposes. These questions are not only used for categorizing an ontology but also to drive the development of new ontologies to fit certain purposes. The use of competency questions is a well-known technique for determining the requirements the ontology should fulfil.

Competency questions used in this research are collected from Operating System review questions in Silberschatz et al.'s textbook [7]. The competency questions used for this ontology evaluation will be used to determine the coverage of concepts in the chosen ontology, as well as to enrich the ontology with missing concepts and relations. These competency questions cover 15 chapters and these are good for identifying which chapters have fewer concepts represented in the ontology.

The list of competency questions is used as an input for this validation, where a string similarity algorithm will be executed to extract any terms in the questions that match a given concept in the course ontology. The detailed discussion about the validation process will be discussed in the following section.

3 Ontology Concepts Validation Process

The evaluation was conducted using Operating System review question in [7]. A total of 259 questions from 15 chapters, which contain short answers and true/false question types, were analyzed. The two ontologies used are *OntoA* containing 97 triples and 97 concepts, and *OntoB*, which contains 1041 triples and 980 concepts. Both ontologies use only hierarchical types of relation. The main task for this validation is to match the extracted terms in each question against the concepts represented in both ontologies.

Dice's Similarity Coefficient (DSC) algorithm is applied by extracting character bigrams to calculate similarity scores of two strings. The algorithm had been modified to allow matching between pairwise words. This is because most of the terms exist in questions are linked pairwise. Therefore, instead of comparing one word with another, the algorithm matches a pair of words used in the question with a pair of words that represents a concept in the ontology. For example, the term 'operating system' appearing in a question can be matched with the 'Operating-System' concept in the ontology. Preprocessing was performed to create a combination of words from each sentence. The first word for each question will have an empty string as a pair and under-score will be added between two words. For example: the question "*What is an Operating System?"* is tokenized into a pairwise string as [" -What, What-is, is-an, an-Operating, Operating-System?"] and stored in an array. Later, each of these tokens will be mapped to the concept in the ontology. DSC is calculated as follows:

$$\text{similarity\_score}(\text{WP1},\ \text{WP2}) = \text{intersection}\ (\text{WP1}, \text{WP2}) * 2\,/\,\text{total} \qquad (1)$$

The similarity between strings WP1 and WP2 will give a similarity score of 1 when both strings have all their bigrams intersecting or matching and 0 if there is no intersection at all. Otherwise, it will have a score that varies between 0 and 1. The following is the algorithm for matching terms in a question with the concept in the ontology.

```
Score = 0
For every question Q do
   Split question Q into token
      While has more tokens
         For every concept C in ontology
              Create pair of word in question
              Calculate similarity score()
              If( similarity score > 0.9)
                   Display matched (M1) and its score
              Endif
          Endfor
      Endloop
Endfor
```

4 Result and Discussion

This section will discuss the results obtained for two evaluations. Concept validation analysis will first give an input to how well the ontology concepts can be used for question generation, and secondly the numbers of questions that can be generated from both ontologies by considering existing concepts and relations.

4.1 Concepts Validation Analysis

This evaluation analyses the numbers of questions that contain terms that matched the concepts present in the ontologies. After running the experiment, we found most terms in both ontologies were not matched with the concepts in the ontologies as the algorithm only detects *pairwise* terms. We investigate this problem further manually and found the result as in Fig. 1. We classify the result found into three matching levels which are M1, M2 and M3 that represent 'Concept is exactly matched with the term in the questions', 'Concept is partially matched with the term in the questions', and 'Concept does not exist in the ontology' respectively.

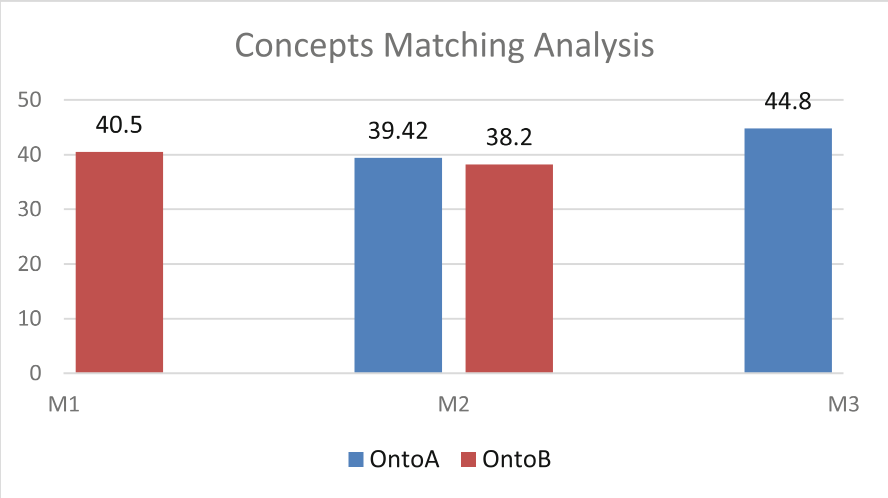


Fig. 1. Percentage of questions with different matching levels

The analysis results in Fig. 1 shows that 78.7 percent of terms in the questions exist in *OntoB* and 54.82 percent of terms in questions exist in *OntoA*. The figure is calculated by the total percentage of categories M1 and M2 combined. M1 is meant for the pairwise terms that have similarity score of 0.9 with the concept existing in the ontology, which is nearly half of the questions with the terms detected in *OntoB* but it appears less than a quarter were detected in *OntoA*. This category calculates similarity scores using methods discussed in the previous section. M2, representing partial matches, gave the highest percentage for both ontologies, which is nearly half of the questions. This level has included single terms, triple terms, multiterms, terms with suffices, terms with a combination of noun and verb phrases, and acronyms. Table 1 shows the numbers of ways of naming concepts and the numbers of each occurrence. The evaluation has been able to identify 9 categories under the M2 level of term pattern that may be useful information to be analyzed for developing a more useful course ontology. The example of all categories in M2 is shown in Table 2.

Table 1. Categories of concept naming and their occurrences.

No.	Categories	*OntoA*	*OntoB*
1	Single terms	9	23
2	Pairwise terms	47	121
3	Triple terms	1	8
4	Multiterms	0	2
5	Terms that form part of the concept	2	13
6	Term combinations	0	4
7	Parts of a concept that have different meanings	4	9
8	Terms with suffices	2	3
9	Combinations of several concepts in the ontology	0	5
10	Acronyms	0	3

Table 2. Term pattern examples in M2 category.

No.	Categories	Example	
		Inside question	Inside ontology
1	Single terms	Interrupts	Interrupts
2	Triple terms	Process control block	Process control block
3	Multiterms	Multiple feedback queue scheduling algorithm	Shortest-job-first-scheduling-algorithm
4	Terms that form part of the concept	Message passing	Message-passing-model
5	Term combinations	Communication + client server system	Communication–in-client-server-system
6	Parts of a concept that have different meanings	RAID	RAID-structure, RAID-level
7	Words with suffices	Process, scheduler	Processes, scheduling
8	Combinations of several concepts in the ontology	Distributed-information-systems	Distributed-information-systems/ distributed-naming-services
9	Acronyms	VFS	Virtual-file-systems’

M3 shows the numbers of terms that do not exist in the ontology and the number is higher in *OntoA* compared to *OntoB* with a difference of 26.3 percent. This may be due to two reasons which are (i) that the number of concepts in *OntoB* is much higher than *OntoA*, and (ii) that the concept representation in *OntoB* was mainly developed for the textbook which provided the questions used for this validation.

From the experimental evaluation, several important observations have been made. The first relates to the scope of the ontology that has been evaluated by means of concept completeness. Concept completeness in this work is defined as whether all important concepts in each course within the syllabus are represented in the ontology – if they are, the ontology is concept complete. Second, the result for *OntoB* has shown to have a better representation compared to *OntoA*. *OntoB* has shown that more than three-quarter of the terms in questions exist in the ontology with half of them identical and another half would need some minor modification. This would mean that the ontology needs only minor effort to be enriched and make it concept complete with only a quarter of new concepts needing to be added to the ontology.

4.2 Numbers of Questions that Can Be Generated from a Course Ontology

This evaluation discussed the number of questions that can be generated from both ontologies. The evaluation is classified into 4 categories and the following is an example to show how the questions are categorized. We assume a question contains ‘question word’, ‘noun’ and ‘action verb’ where noun will be represented as concept and action verb will be represented as a relation in the ontology.

Assume we have triples ‘`[Y] is-a [X]`’ and ‘`[Z] is-a [X]`’, ‘question word’ are [what, define, explain] and ‘action verb’ are [the purpose of, the advantage of].

A: Complete
All terms match the concepts in the ontology.
Examples: “What is [X]?” and “Define [X]”.

B1: Nearly Complete
Only some terms in question matched the concepts in the ontology.
Example: “Explain [X] in [Q]”.

B2: Incomplete
Question contains an action verb which does not exist in the ontology but all terms match the concepts in the ontology.
Example: “Explain the purpose of [X]”.

C: Cannot be generated
Question contains an action verb which does not exist in the ontology and no term matches any concept in the ontology.
Example: “Explain the advantage of [Q]”.

The result in Fig. 2 shows the outcome of the mapping process between questions and ontology elements, in particular the concepts and relations in the course ontologies.

The result shows that less than 5 percent of the questions can be generated using the ontology and all are questions that only need the existence of a concept and a template question such as “What is X?” to support question generation. Most of the questions can be partly generated from a hierarchical type of ontology. This shows that the ontology needs to have certain kinds of a predicate to relate two concepts in order for it to be able to generate meaningful questions. Category B1 contributes the largest number of cases for both ontologies where each question cannot be generated as the question has not enough concepts. Category B1 shows that significant effort can be made to add concepts to enable the ontology to generate questions. This effort will contribute to the larger number of questions that can be generated. However, for category B2, since both ontologies are hierarchical, adding object property relationships between concepts in ontology is troublesome. Varieties of words need to be considered for relationships and this is quite a tedious task.

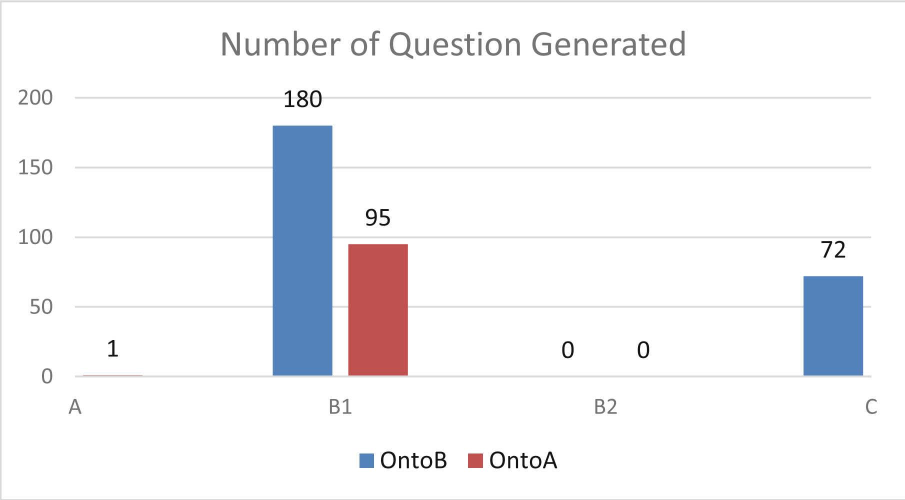


Fig. 2. Number of questions generated

In addition, many of the concepts in *OntoA* did not exist, and significant numbers in *OntoB* as well. Most of the concepts used in these two ontologies intersect and there is no need for combining the two ontologies to make it complete. The ideal way would be to use *OntoA* as a basic ontology for use with automatic question generation.

Furthermore, with regard to the relationship, '*is-a'* type of relation alone might contribute to just a small percentage of questions generated. Missing appropriate relations between concepts may not generate semantically correct questions. For example, in the question 'What *are three components of an Operating System*', and when we remove the word '*components-of'* that act as a relationship in ontology, the question becomes '*What are three Operating Systems*' and now has a different meaning. The result has shown that more than half of the question cannot be generated due to the absence of relations that link between two concepts.

5 Conclusion

The course ontology validation results could suggest different dimensions of improvement to prepare ontologies for automatic question generation. First, the hierarchical type of ontology is not comprehensive enough to use as a source of semantics for the question generation process. It will take a lot of effort to enrich the relations of the ontology especially given the huge size of many ontologies. Second, more than half of the terms in questions exist in the ontologies and this gives a good indication that the ontology scope is sufficient with little effort needed to redefine certain concepts. And finally, there is a need for other strategies to support question generation with ontologies in order to enhance question readability and to enable semantically correct question generation such as question templates. Future work will look into the techniques to enrich information in the course ontology and strategies for question generation.

Acknowledgement. This research was supported by Universiti Teknologi MARA and Ministry of Education, Malaysia.

References

1. Abuhassan, I., Al Mashaykhi, A.: Web Based OOP Domain Ontology (WOOPDO). LAP Lambert Academic Publishing, Deutschland (2012)
2. Khan, J., Hardas, M.S.: A technique for representing course knowledge using ontologies and assessing test problems. In: Wegrzyn-Wolska, K.M., Szczepaniak, P.S. (eds.) Advances in Intelligent Web Mastering. ASC, vol. 43, pp. 174–179. Springer, Heidelberg (2007)
3. Finnish Ontology Library Services. https://onki.fi/en/browser/overview/operating-system
4. Boyatt, R., Joy, M.: Developing an ontology of mathematical logic. Sci. J. Tech. Univ. Civil Eng. **6**, 6–11 (2010). Technical University of Civil Engineering, Bucharest
5. Jiang, L., Zhao, C., Wei, H.: The development of ontology-based course for computer networks. In: International Conference on Computer Science and Software Engineering, Wuhan, pp. 487–490. IEEE (2008)
6. Gruninger, M., Fox, M.S.: The role of competency questions in enterprise engineering. In: Rolstadås, A. (ed.) Benchmarking - Theory and Practice. IFIP Advances in Information and Communication Technology, pp. 22–31. Springer, New York (1999)
7. Silberschatz, A., Galvin, P.B., Gagne, G.: Operating System Concepts. Wiley, New Jersey (2012)

Online Track

CIR: Fostering Collective Creativity

Jaime Meza[1(✉)], Oswaldo Ortiz[2], Mónica Vaca-Cardenas[3], Sonia Roman[2], and Josep M. Monguet[1]

[1] Universitat Politècnica de Catalunya, Barcelona, Spain
jaime.meza@estudiant.upc.edu, jm.monguet@gmail.com
[2] Universidad de Las Fuerzas Armadas ESPE, Quito, Ecuador
{ojortiz,sdroman}@espe.edu.ec
[3] Kansas State University, Manhattan, KS, USA
monivcec@ksu.edu

Abstract. Nowadays, society and organizations face an accelerated innovation that requires of professionals with new skills and attitudes, especially those related to collective creativity. However, educational environments are slowly integrating emerging paradigms limiting the contribution to the development of key skills related to innovation. Multiple investigations claim that teachers have conservative attitudes toward collaborative schemes, while employers generally recognize the effectiveness of creativity at work. Management of ideas is the core of creativity in innovation processes in the industry and in production and service management. This depends largely on the collective work and individual social skills, as well as on the capabilities that information technology and communication ICT provide. This article presents a process of collective ideas refinement CIR. This process combines paradigms of swarm creativity and social skills as a means to capture the participants' emotions and evaluate the acceptability of ideas. We believe that it is necessary to use new forms of teaching and learning based on swarm creativity paradigms, on individual social skills, and on the use of ICT. Therefore, CIR is a tool that could become an effective way to encourage creativity in individuals.

Keywords: Emotional intelligence · Collective intelligence · Innovation · Creativity · ICT

1 Introduction

The information age confront companies to an accelerated rate of changes where innovation in its products and services is essential to their survival; however, educational environments are slowly integrating emerging paradigms that promote the development of collective creativity. Multiple investigations claim that teachers have conservative attitudes about the effectiveness of collective creativity, while employers generally recognize the effectiveness of creativity in their work. Google, Wikipedia, and Facebook are the best examples of innovation and collective intelligence in action [1].

Creativity currently combines a set of work paradigms, which is not only focused on the individual and on his or her individual creative abilities, but also on the ability to generate an environment of collective intelligence. In this environment, emerging skills

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 145–152, 2017.
DOI: 10.1007/978-3-319-49625-2_18

such as swarm creativity and emotions arise spontaneously allowing the participant to propose solutions without fear of direct criticism from the group, which can be generated in classroom environments (face to face). The use of ICT has proven to be an effective means to mediate creativity in groups, and for this purpose, the group support systems GSS are an effective communication solution in teams of individuals, especially in tasks related to idea generation [2].

This article presents a process of collective ideas refinement CIR, which combines the paradigms of swarm creativity and GSS as a means to capture the ideas and emotions of the participants [3].

2 Literature Review

Intelligence is part of the innate higher cognitive processes, which has allowed to determine the Intellectual Coefficient CI of individuals. According [4] considers three aspects of intelligence: the component element, which refers to the efficiency with which people analyze and process information. Element experience shows how people approach family tasks and the new ones. Finally, the contextual element, which allows to verify how people relate to their environment. In a conventional system where beliefs, traditions, habits and paradigms are everyday part of our society; technology has been incorporated in small portions as a silent body. This gradual and at the same time accelerated process, that technology suggests, has allowed to know the complex world of emotions and its role in the context in which the individual is involved.

(Goleman 1995) through his research has determined that the individual handles two minds, a mind that thinks and a mind that feels. For this reason, the emotional and the rational mind are two relatively independent faculties that reflect the operation of distinct but interrelated brain circuits [5]. This operation has allowed human beings to develop skills that allow them to unconsciously relate to and learn from interaction with other human beings.

The interaction of individuals with others of their kind in the everyday activities and in problem solving shape a space emerging collective intelligence (CI). Pierre Lévy (2010) defines collective intelligence as the ability of human groups to participate in intellectual cooperation in order to create, innovate and invent [6]. Engelbart (1995) states that collective intelligence refers to the measure of the collective capacity of a group, and it should be, in the near future, a key determinant of efficiency with a particular challenge that can be understood and addressed effectively by an organization [16].

Collective intelligence in the field of education has been reported by several authors. According to Gonzalez and Silvana (2012) [7], the vast majority of research in the last decade refers to collective intelligence with the use of technologies. Llon (2012) makes a critique about the educational system, and indicates that teaching is equal to 50 years, while it is not taking advantage of the collective intelligence, which allows the construction of global learning systems, content and networking. It is also maintained that the incorporation of collective intelligence implies not only a technological change or change in the attitude of the teachers, but also an education redefinition [8].

Tsai et al. (2011) [9] indicates that collective intelligence can be used in the teaching-learning process, and that both teachers and students can apply it to content, assessments, and educational materials. For instance, by using the web as a platform. Petreski et al. (2011) reports that there is a change in the approach to instructional design of learning content, allowing to create and share content, opening up new fields of collective intelligence research [10].

A research published by Thompson et al. (2014) [11] indicates that there is evidence that students can be autonomous in their learning and also participate collaboratively. Research carried out by Paus-Hasebrink, Wijnen and Jadin (2010) [12] reported a pilot study to evaluate the Wiki collaborative tool and investigate whether this could be used as a learning tool in schools. The results suggested that the use of this tool can enhance learning and encourage collaborative learning skills. Another study of Matthew, Felvegi and Galloway (2009) [13] applied a methodology that allowed to examine the benefits and challenges of contributing to a wiki; this study was conducted on Language and Literature classes. The results of this research indicate that the Wiki contribution has promoted collaborative processes among students by creating shared knowledge and strengthening the collective knowledge of the group, besides, [17] presented a framework about collective intelligence education.

(Basadur et al. 1982;. Isaksen and Treffinger 1985; Mumford et al. 1991;. Osborn 1957. Parnes et al. 1977) reported by [14], argue that creativity based on problem solving is known as a creative problem solving (CPS) process. According to the literature, CPS is a process of creative problem solving and is formed by the following stages (a) look at the facts, (b) problem formulation, (c) ideas generation, (d) evaluation and selection of the solution and, finally, (e) selection and application. Furthermore [14] they refer to Basadur et al. (2000), and argue that the Group Support Systems GSS could facilitate interaction and improve understanding among team members. According to (Nunamaker et al. 1991) [2] GSS are an effective solution to mediate communication in groups of individuals, especially in areas related to ideas generation.

3 Process of Ideas Collective-Refinement

With the general idea of promoting collective creativity in the educational environment, focused on problem solving, a prototype of GSS and refining process has been designed, developed and formally presented in this section (Fig. 1). The model allows teachers, students and groups, actively participate in the process of creative solution search, through ideas management and assessments according to the participant emotional factors. The archetype facilitates interaction and collaboration of students and groups through an organized refinement process, where in every phase ideas are obtained with greater refinement and acceptance of the participant group.

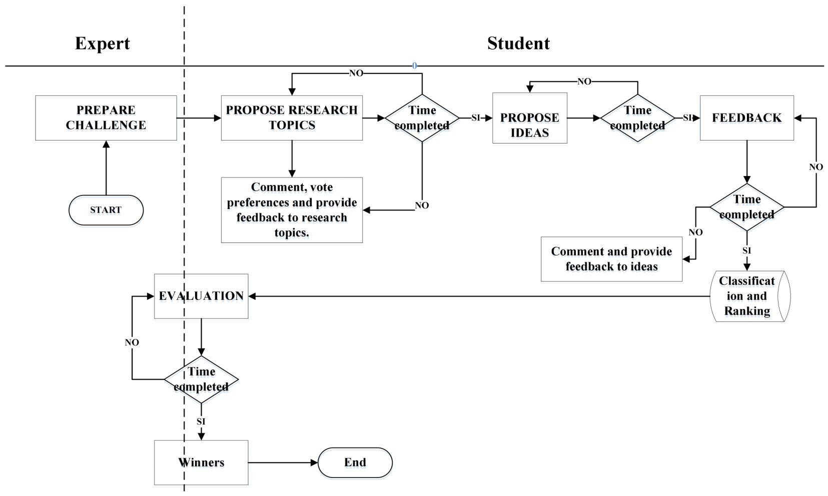


Fig. 1. CIR process

The objective of the proposed model considers the implementation of the GSS as an effective means of ideas refinement to solve a problem through collective creativity.

Figure 1 presents the participation of two actors, experts and students working asynchronously on a set of key activities of CIR. This is summarized in Table 1:

Table 1. CIR key activities

Activity	Description
Prepare Challenge	The expert(s) define an area of general interest (Example: Educational Projects) where it is required to seek for possible problem research areas as well as determine the allocated time for the fulfillment of each of the challenge stages
Topics of Interest	Each one of the participants are enlisted in the suggested challenge and during the assigned time to the challenge, they propose possible topics that present potential problems within the context of the challenge. Each participant in this process can propose as well as to make comments and vote for their preferences on the proposals submitted by other participants, encouraging a constant feedback
Ideas	In one or more topics of interest, even in those proposed by the same participant, solution ideas are prosed to the selected topics. The design of the proposal includes: a title of the solution, a short explanation on how to do it, besides, if required, a short essay of ideas, as well as videos and annexes that support the proposal could be included

(*continued*)

Table 1. (*continued*)

Activity	Description
Feedback	When the phase of ideas is finished, participants come with the first iteration of quantitative refinement. Each participant makes a vote (I like it / I do not like it) on each one of the ideas proposed as a solution, except on the own ones. They can also comment and provide feedback on the proposals of solutions to improve them. Comments include a brief description and, if necessary, a report that includes videos, images, etc. As a result of this process, a ranking of preferences of ideas is generated. The ideas that go to the next stage are classified according to the indicator of preferences ranking PR Table 2
Evaluation	The ideas that exceeded the preference ranking, come to be valued by the / the expert(s) as well as the participants as well as the proponent of the idea. The rating scale is done according to a set of rubrics Table 3. Each item is evaluated by the emotion caused on the evaluator (participant / expert) in accordance to the criteria in Table 4
Winners	Upon completion of the period of time assigned for the assessment, the final ranking of solution proposals is generated for subsequent application; addition, as a result of the refinement process a set of collective work indexes are generated Table 2

Table 2. Rate formula

Rate	Description
Preferences Ranking (RP)	It establishes as valid ideas the ones where the score is among the most voted minus one standard deviation
Final Ranking (RF)	It establishes a winers range which is given in terms of the rubric valuations of the expert(s) X 60 % and students' ratings X 40 %. Only those ideas which punctuation is among the most voted and the most voted minus one standard deviation will be eligible
Preferences Rate	It considers the ratio of the number of received votes by the number of total votes.
Preferences Filtering Rate	It considers the ratio of the number of ideas that reach the RP by the total number of proposed ideas, minus the unit. That is 1 - (RP / # Total Ideas)
Emotional homogeneity Rate	It is the standard deviation of evaluations, this is Average of evaluations ± 1 one standard deviation of evaluations
Similarity Rate	It establishes the similarity ratio of rubrics assessment criteria between the expert(s) and students [18]
Refinement Rate	It considers the ratio of the number of ideas that reach the RF among the total number of proposed ideas, minus the unit. That is 1 - (RF / # Total Ideas)

According to (Battisch, Solomon and Delucchi, 1993; Johnson and Johnson, 2008; Web, 2008) [15], there is some evidence that the effects of cooperative learning achievement depend on social cohesion and the quality of the group. In this sense, the list of indicators (Table 2) are a tool for monitoring levels of cohesion in the group. Therefore, it is maintained that low refinement rates denote groups with scattered criteria. It is also noted that the CIR assessment approach uses emotions as a criterion for assessing the rubrics (Table 3). In this sense, the classification of emotions in positive and negative groups has been considered (Table 4).

Table 3. Rubrics for evaluation

Rubric	Description
Novelty	The thing is new, it exists, it is known or used for a short time
Added Value	The proposal generates added value or contributes to the solution of the problem like never before
Innovation	The presented novelty can become a reality
Inspirer	The proposed content inspires new ideas and it can extend the discussion topic
Appropriate	It is suitable for the solution of the analyzed problem
Complete	The content is complete and it can be easily understood

Table 4. Emotional criteria

Emotion	Description	Group	Value
Dissapointment	I feel a little bad. The proposal is disappointing	Negative	3
Rage	It's terrible. It is the worst proposal I have ever listened about	Negative	1
Anger	There is no effort. It is bad. I do not think it helps to anything	Negative	2
Sadness	It might be better with a little more effort	Negative	4
Joy	I really like it. It makes me happy and I think it could be put into practice	Positive	5
Admiration	It's the best proposal I have ever read. It is excellent	Positive	6

4 Applying CIR Through a Web Tool

In this section, the empirical evidence of CIR application through a web tool is described. CIR was used by three group of student from the University of the Armed Forces of Ecuador ESPE (Table 5) in the academic year 2016.

For each group a challenge was proposed, at the end of the time (Table 5), the students applied a web tool (Fig. 2) for each one of the stages of CIR, at the end of time assigned for resolve the challenge some outcomes about of collective creativity were obtained measured thought the indicator shown in Table 2.

Table 5. Groups of students & empirical experience settings

Degree	Career	Subject of challenge	N	Time
Undergraduate	Early Childhood education	Problems and solution for Early Childhood education	23	15 d
Undergraduate	Science of Physical Activity and Recreation Sports	Physical Activity projects and its influence in the student performance	15	15 d
Posgraduate	Master in University Teaching	Higher education of Ecuador on the future	15	8 d

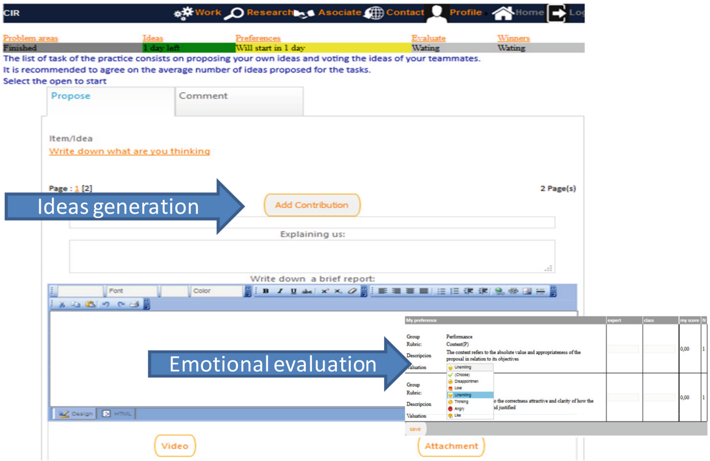


Fig. 2. Main interfaces of the web tool.

5 Conclusions

The objective of the presented work is to share the progress on a research program, which purpose is to provide a process, tools and resources for improving the collective creativity. CIR has a very broad and open conceptual framework and more theoretical and empirical research is necessary to generalize the application of the model.

The inseparable link between body, mind and spirit would help in the formation of a whole human being, using emotional intelligence strategies, collaborative work and ICT's, essential components for his or her formation.

The application of CIR has shown evidence on the usefulness of the model in the development of creative solutions to problems in the educational environment. In addition, the evaluation according to the emotions that generate a proposal on the individual, presents a new field for evaluation in the educational area. The proposed model and the corresponding web tool are the result of a creative combination of theoretical and practical perspectives. From this point, with a consistent model, it will be possible to continue with the development of new features oriented to make recommendations on the continuous improvement to the state of art in the field of collective creativity assisted by a GSS.

References

1. Malone, T.W., Laubacher, R., Dellarocas, C.: The collective intelligence genome the leading. MIT Sloan Manag. Rev. **51**(51303), 21–31 (2010)
2. Nunamaker, J.F., Dennis, A.R., Valacich, J.S., Vogel, D.: Electronicmeeting systems to support group work. Commun. ACM **34**, 40–61 (1991)
3. Monguet, J.M., Trejo, J., Bassolas, J., Martí, T., Martí, J.: Innovation Consensus: Collective decision making support system for innovation management, pp. 2–4, September 2014
4. Papalia, D.E.: Desarrollo humano. Santa fé colombia: Compañía editorial Ultra. McGraw-Hill Interamericana, S.A (1997)
5. Goleman, D.: Inteligencia emocional. Colección ensayo: kairós (1995)
6. Lévy, P.: From social computing to reflexive collective intelligence: the IEML research program. Inf. Sci. (Ny) **180**(1), 71–94 (2010)
7. Gónzalez, F., Silvana, V.: Procesos de inteligencia colectiva y colaborativa en el marco de tecnologías web 2.0 : Problemas Y Aplicaciones Fac. Psicol. - UBA / Secr. Investig. / Anu. Investig., vol. XIX, pp. 253–270 (2012)
8. Ilon, L.: How collective intelligence redefines education. In: Altmann, J., Baumöl, U., Krämer, B.J. (eds.) Advances in Collective Intelligence 2011. Advances in Intelligent and Soft Computing, vol. 113, pp. 91–102. Springer, Heidelberg (2012). doi:10.1007/978-3-642-25321-8_8
9. Tsai, W., Li, W., Elston, J.: Collaborative learning using wiki web sites for computer science undergraduate education: a case study. IEEE Trans. Educ. **54**(1), 114–124 (2011)
10. Petreski, H., Tsekeridou, S., Giannaka, E., Prasad, N.R., Prasad, R., Tan, Z.: Technology enabled social learning: A review. Int. J. Knowl. Learn. **7**(3/4), 253–270 (2011)
11. Thompson, C., Gray, K., Kim, H.: How social are social media technologies (SMTs)? A linguistic analysis of university students' experiences of using SMTs for learning. Internet High. Educ. **21**, 31–40 (2014)
12. Paus-Hasebrink, I., Wijnen, C.W., Jadin, T.: Opportunities of Web 2.0: Potentials of learning. Int. J. Media Cult. Polit. **6**(1), 45–62 (2010)
13. Matthew, K.I.: Wiki as a collaborative learning tools in language art methods class. J. Res. Technol. Educ. **42**(1), 51–72 (2009)
14. Ray, D.K., Romano, N.C.: Creative problem solving in GSS groups: do creative styles matter? Group Decis. Negot. **22**(6), 1129–1157 (2013)
15. Slavin, R.E.: Cooperative learning and academic achievement: why does groupwork work? Four major theoretical perspectives on co-operative learning and achievement. Anales de Psicología/Annals of Psychology **30**, 785–791 (2014)
16. Engelbart, D.C.: Toward augmenting the human intellect and boosting our collective IQ. Commun. ACM **38**(8), 30–32 (1995)
17. Meza, J., Monguet, Josep, M., Grimón, F., Trejo, A.: Fostering collective intelligence education. In: Vincenti, G., Bucciero, A., Vaz de Carvalho, C. (eds.) eLEOT 2015. LNICSSITE, vol. 160, pp. 165–172. Springer, Heidelberg (2016). doi:10.1007/978-3-319-28883-3_21
18. Monguet, J.M., Meza, J.: Guess the score, fostering collective intelligence in the class. In: Vincenti, G., Bucciero, A., de Carvalho, C.V. (eds.) E-Learning, E-Education, and Online Training. LNICSSITE, vol. 138, pp. 116–122. Springer, Heidelberg (2014). doi:10.1007/978-3-319-28883-3_21

E-Learning Authoring Tool for Reusing Web Multimedia Resources

Norah Aldaij(✉) and Jawad Berri

Information Systems Department, College of Computer and Information Sciences, King Saud University, P.O. Box 51178, Riyadh 11543, Saudi Arabia
{naldaij, jberri}@ksu.edu.sa

Abstract. Reusing web multimedia resources for instruction can help a great deal instructors in authoring e-courses. These resources are interesting as they promote non-linear learning which fits the needs and constraints of learners. This paper presents an e-learning authoring tool which reuses web multimedia resources and integrates them into learning objects to be used in e-learning.

Keywords: E-learning · Authoring tool · Web multimedia resources

1 Introduction

Reusability is an important approach that assists instructors to search for learning material and reuse it for authoring e-courses. Reusing available web sources can be a very effective general methodology to adopt for instruction. An organized resource pool is like knowledge which provides instructors a great opportunity to monitor the areas where learners are short of knowledge [1]. It can improve the collaborative assistance culture. These repositories are considered as a knowledge management instrument that can assist the management of course authoring as these also open up the way towards the development of systems that promote e-learning [2] at any time and from anywhere.

These systems will improve accessibility to better learning, minimizing cost of authoring material, the desire to offer unrestricted learning, and the use of data information and communication technology (ICT) advances in education systems. Actually, with the developing of ICT systems, the convenience and practicality of mobile devices that have an intimate relationship with learners, and the availability of networks in urban spaces, has made the approach become easier to adopt. This paper covers developing an e-learning authoring tool for reusing web multimedia resources and learning material, generally known as learning objects. The research also focuses on the need of re-usability of the learning objects to find out less time consuming and more cost effective ways of learning. The main objectives of this research are: (i) To investigate the opportunity to reuse existing web multimedia resources in e-learning, (ii) Support the instructor in reusing web multimedia resources interaction in an effective manner, (iii) Develop an authoring tool that allows generating e-learning course material [3].

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 153–160, 2017.
DOI: 10.1007/978-3-319-49625-2_19

In concurrence with The Academic ADL Co-Lab research paper [4], it is comprehendible that when we are able to create numerous e-learning resource centers or hubs, with an objective of storing and saving information on education and reserve the material for teaching, the chances of benefitting the learners and new instructors will enhance notably. Authors may be short of some specific skills or knowledge as the need for creation of the entirely fresh alteration policies altogether and a system for re-using materials will assist a lot to improve the procedures [5]. These materials may differ in many ways, but they do develop an association of ideas. The ease of access may help the creators of the content to develop their skills to a higher level. Effective implementation of these systemized approaches may benefit the end users, principally the learners and the instructors to develop learning material with a web based interface.

2 Related Work

With the increasing popularity of Internet, the insistence of e-learning has surpassed the expectation of many educators. This opportunity demonstrates an idyllic idea for a supple and less costly proficiency growth because these may be utilized with no limitations regarding actual placement of the person, and required time [6]. Multimedia techniques generally refers to the expansion and utilization of diverse sorts of ICT resources to improve presentation of learning material and involvement of the learner. This integrated methodology deserves proper attentions for the above mentioned approach [7].

Considering its importance, it is appropriate to focus on the new approaches to promote e-learning system [8]. Multimedia resources can be a helpful tool for problem based learning. It is described as an instructive approach with particular focus on the learner that creates notable and realistic, but complex conditions, particularly during the provision of learning, supervision, and chances for students when they enhance their capability to solve certain problems [9]. Multimedia resources can play a role of a subject matter specialist who is available all the time, and totally free of cost.

Efficient development of authoring tools using web based systems may set a base to develop a user friendly interface for better applicability [10]. This supports our idea that integration of ICT can be really simple to adopt when introduced on a basic level. Web based instruction mechanism is an accessible technique to prevail educational and learning objectives, although the emphasis should vastly be on the instruction procedures. The impact of the background cannot be neglected, which proves the significance of the technical background of instructive atmosphere; both for virtual or non-virtual education [11]. In the current era, only some interpreted instruction materials are accessible on the internet and still, these resources may not be exactly suitable for the requirement to reuse.

This generates the need for instructor availability for adaptation of the knowledge material. This can also help in systemizing manual contributions of the authors into web based tools, though those can still be annotated [12]. To Manage knowledge through such authoring tools, all information may be included to organize and to feed the systems in order to develop the organized resource center. These systems may be tabulated and arranged [13], in such a manner that these could be searched at the time of need. Proper coding and tagging may help the searcher; however, clarity on the search terms is required. In the social media platforms, the authors tag their data themselves through manual entries, which makes it simple to reuse [14]. As we can now attach multiple structures, the quantity of the learning object is increasing substantially even though the full scale development is yet to mature. It is anticipated that instruction material storage systems will handle the accessibility issues for the required content and its usage [15]. Considering the adaptive approach of reusing the learning objects, extensive amount of hard work is visible in the current era while developing instructive course material. These systems follow certain targets to achieve within a system that emphasizes on learner to develop his/her awareness, right through the interface with the learner with an objective to adjust to the requirements of that specific person [16].

3 System Design

Web based e-learning authoring tools, Interface and Resources storage system is a procedure that started by a demand from a function seeking to utilize network knowledge assets for a specific reason. The demand is examined by the networking system followed by activation of relative examination unit for interpreting the repositories according to the demand [13]. These are the systemized processes, which explain the nature of performing jobs and association between multiple situations and requirements [17]. The systemization of reusing material technology needs a high level accessibility of vast quantity of instructional material to ensure a diverse range of e-learning resource storage center [18]. Enabling large scale reuse requires the availability of infinite learning objects. Classification of these materials must also be appropriate according to the subjects. This requires a 3 level system as presented in Fig. 1, starting from resource handing level, statistics level and submission system level. The utility of the first level of application is the arrangement of sources from multiple media and creation of available information.

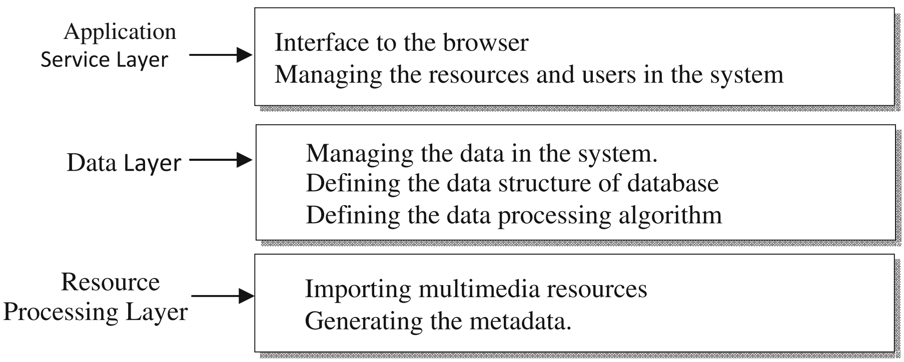


Fig. 1. System levels

The function of statistics level is organization of information in the system, so to make it reusable. The purpose of submission system level is organizing web based boundary to the searcher, supervision of the materials and learners in the system [19].

According to the above system in Fig. 2, the users will be linked with System interface and users themselves. These will be followed by Data Management, Data Publication, User Management, and Data Exploration; for further edition in the information. Then the user need to import multimedia resources to support his/her text, which include images, audio, video, text and animation sources. To enhance the chances of finding the required video information, the key tags must be defined and known by the users. The key tags may be related to the creator of the video, its theme, atmosphere or anything special that can be a helpful way to search. The learners or the instructors who need to find that information should attain actual information to find the right material to incorporate into the teaching resource. This way, they can not only develop an interactive learning object, but also a useful material with less effort [20].

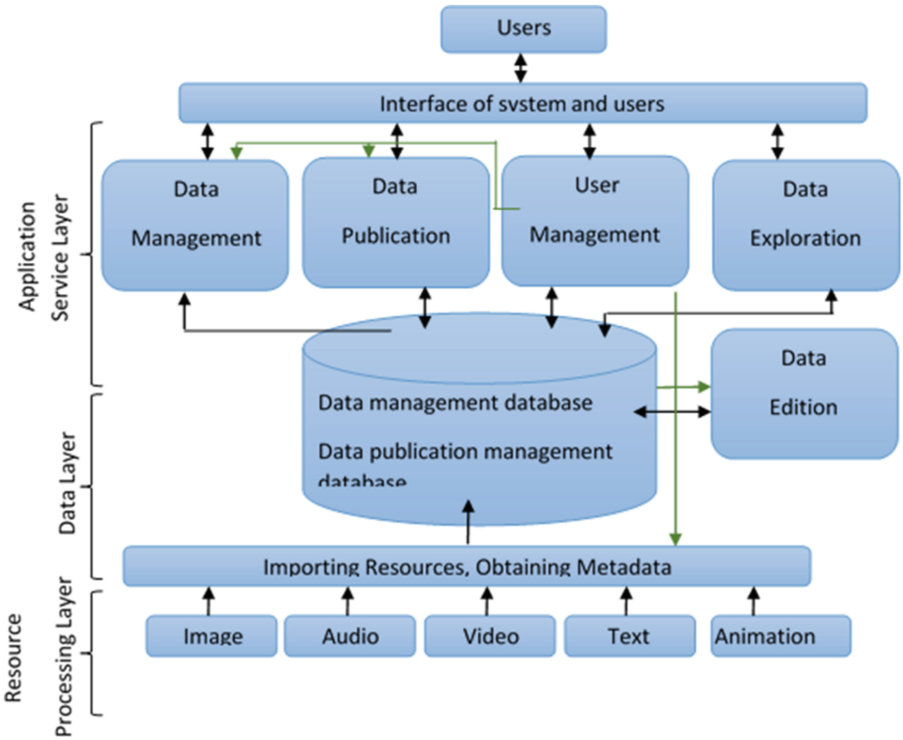


Fig. 2. System framework

The final system is a set of modules, perfectly collaborating with each other and providing unified user experience through its user interface. The data in the system is aligned, properly tagged and stored in a way that allows easy access and modification or re-tagging. The system has been designed to have multiple interfaces - user interface for learners, administration interface for teachers and system administrator and resources integration interface, that will allow for importing learning content (lessons, exams and such) and for simple modification of already imported data. The system communicates with other systems such as Web-portals, web-sites, resource libraries, mail systems and bulk operations scripts. For these purposes, the system uses Application Programmable Interface (API) to be able to communicate with other systems, and so called connectors – simple programs and scripts that can operate remote systems via their APIs (for example: MySQL connector, IMAP connector, Google API script, etc.) to enable it to work with remote APIs of other systems.

4 System Implementation

The proposed system named "LMS Oxford Learn" begins with a brief description about the proposed e-learning design, how the system works, how the students find resources and how upload can be done on an e-learning design. The design serves the purpose of e-learning as an authoring tool for reusing web multimedia resources. Drupal has been used to develop the system as it is a new platform and there are exciting features adding to its potential.

Figure 3 shows a sample of user interface screen. It is basically a forum in the main screen where users can participate and interact with each other in the main dashboard and also attach documents or video for learning. In the left corner, there is a main menu which has an administrative link that can be used to help both the server/host, teacher support group and users.

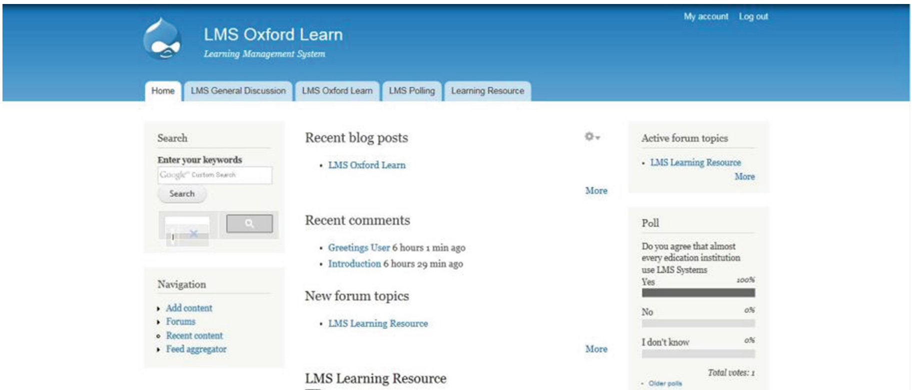


Fig. 3. System main user interface

Figure 4 shows an example of reusing multimedia sources – text, audio, video, and images. The instructor has to search for the source and they can upload it to Drupal folder or can copy the URL link for the media and paste into the web browser field allowing it to be added. This link can be a streamed video or a video file hosted on a server.

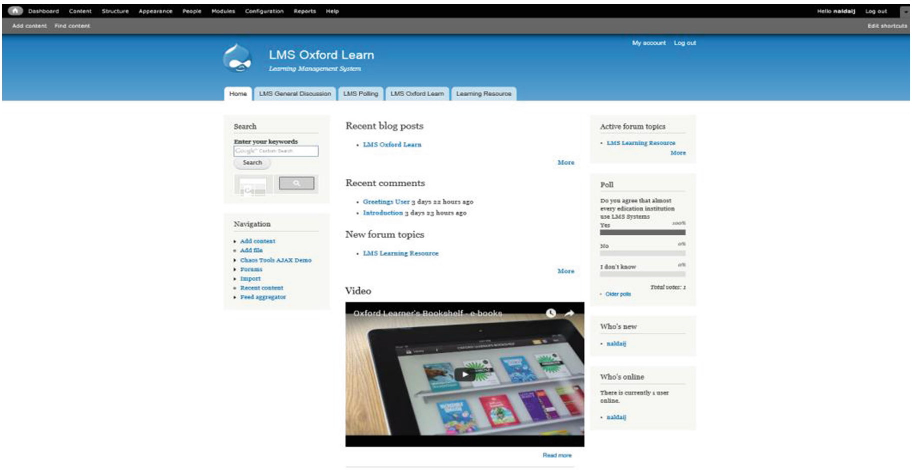


Fig. 4. Add media file

The "LMS Oxford Learn" will also be integrated with google custom search engine which will allow users to use "LMS Oxford Learn" as a link to other websites. The integrated Google custom search engine in the "LMS Oxford Learn" will make it an e-learning authoring tool for reusing web multimedia resources. The user only has to type Search Engine, then a list of all search engines are displayed and user can find Google Custom Search Engine.

5 Conclusion

This research presented the development of e-learning authoring tool for reusing web multimedia resources. The concept is compatible with the needs of contemporary education needs. The research concludes that re-usage of web multimedia resources is a great approach for the development of education materials. It also highlights that the use of multimedia sources may increase user interaction options and interest in the learning systems as well as improve the level of understanding. Innovations around e-learning authoring tool for reusing web multimedia resources can contribute significantly towards the improvement of education systems as a whole in the contemporary styles.

LMS Oxford is planned like a gathering on the Web where clients need to enroll with a specific end goal to partake in the discourse. In a like manner, LMS Oxford clients register themselves before they can enlist into a class, specifically for the subject and class.

LMS Oxford is not totally indistinguishable to a discussion, rather it has more elements that augment usefulness to the stage, making it a completely utilitarian class of its own, presented on the web and open to everyone.

LMS Oxford learn is essentially a tri-part programming that gives three parts to a client managerial, instructor and understudy. A managerial part can make new courses on subjects and organize new classes as indicated by the subjects. There are likewise four enlistments and working component for understudies. For example, the first that does not require a confirmation key from an understudy. The second that permits an understudy to be a visitor client and investigate the whole capacity of this product, without taking an interest in courses. The third that lets enlisting one by one with the instructor having the power of both enlistment and ejection. The fourth that gives a secret key to an understudy and guarantees a sheltered enlistment, counteracting unapproved understudies.

The main advantage of the LMS Oxford learn software is that it can efficiently and accurately provide database and course management for students. LMS Oxford learn software can become the most imperative resource available to connect the students with teachers and other students. Particularly at a time when education has brought a tremendous change in teaching and competition in learning, as people are keen to find new ways to learn or to help them develop expertise in new fields and learn new subjects.

References

1. Brusilovsky, P.: A distributed architecture for adaptive e-learning. School of Information Sciences, University of Pittsburgh (2004)
2. Cloud, S.: Desire2Learn. In: Hampton: VASS Virtual School Conference (2012)
3. Berri, J.: Leveraging web information for e-learning. In: Rocha, Á., Correia, A.M., Tan, F. B., Stroetmann, K.A. (eds.). AISC, vol. 276, pp. 477–486Springer, Heidelberg (2014). doi:10.1007/978-3-319-05948-8_46
4. ADL co lab: Finding and sharing elearning objects; standards based interoperability and federated repositories. The William and Flora Hewlett Foundation (2015)
5. Scotton, J., Cristea, A.: Reusing adaptation strategies in adaptive educational hypermedia systems. In: 10th IEE International Conference on Advanced Learning Technologies, pp. 528–532 (2010)
6. Haslhofer, B., Sanderson, R., Simon, R., Sompel, H.: Open annotations on multimedia Web resources. Multimedia Tools Appl. **70**, 848–868 (2012)
7. Lau, R.W.H., Yen, N.Y., Li, F., Wah, B.: Recent development in multimedia e-learning technologies. World Wide Web **17**, 189–198 (2014). Springer Science + Business Media, New York
8. Jeong, H.-Y., Yeo, S.-S.: The quality model for e-learning system with multimedia contents: a pair wise comparison approach. Multimedia Tools Appl. **73**, 887–900 (2013). Springer Science + Business Media, New York
9. Hoffman, B., Ritchie, D.: Using Multimedia to Overcome the Problems with Problem Based Learning. Kluwer Academic Publishers, Amsterdam (1997)
10. Dai, S., Zhou, H.: Research on multimedia resource management system based on web services. In: International Conference on Industrial and Information Systems. IEEE (2009)
11. Greener, S.: EDITORIAL, Interactive learning environments. Interact. Learn. Environ. **20** (2), 101–102 (2012)
12. Dehors, S., Zucker, C.F., Acacia, K.R.D.: Reusing Learning Resources based on Semantic Web Technologies. IEEE Computer Society, Washington, DC (2004)

13. Berri, J.: Web resources annotation for the web of learning. Int. J. Adv. Comput. Sci. Appl. (IJACSA) **4**(11), 132–139 (2013)
14. Eftekhar, M., Koudas, N.: Partitioning and ranking tagged data source. In: VLDB Endowment (2013)
15. Neven, F., et al.: An open and flexible indexation- and query tool for Ariadne. K.U.Leuven, Computer Science Dept (2003)
16. Brusilovsky, P.: From learning objects to adaptive content services for elearning. School of Information Sciences, University of Pittsburgh (2004)
17. Lohr, L.: Book review; e-learning and the science of instruction: proven guidelines for consumers and designers of multimedia learning. ETR&D **54**(2), 197–200 (2006)
18. Sampson, D.G., Zervas, P.: Learning object repositories as knowledge management systems. Knowl. Manage. E-Learning **5**(2), 117–136 (2013)
19. Najjar, J., Ternier, S., Duval, E., Chatti, M.A.: Learning object metadata: opportunities and challenges for the middle east and North Africa. Catholic University Leuven
20. Han, X., Wan, H.: Research on web-based multimedia resources system for ethnic minorities' nonmaterial heritages protection. In: 2nd International Conference on Education Technology and Computer (ICETC) (2010)

Experience in a Blended Learning Course – A Case Study

Blanka Klimova(✉)

University of Hradec Kralove,
Rokitanskeho 62, 500 03 Hradec Kralove, Czech Republic
blanka.klimova@uhk.cz

Abstract. Owing to the expansion of information and communication technologies (ICT), both teaching and learning have tremendously changed in the past two decades. The most suitable and popular teaching methodology nowadays seems to be blended learning. The purpose of this article is to reflect on the benefits and limitations of the blended learning approach in one of the blended courses run by the Faculty of Informatics and Management in Hradec Kralove, Czech Republic. Moreover, the author of this article emphasizes the importance of the teacher's/tutor's role in blended courses and provides a few suggestions for the improvement of blended learning in practice.

Keywords: Blended learning · e-Learning course · Course tools · Effectiveness

1 Introduction

Owing to the expansion of information and communication technologies (ICT), both teaching and learning have tremendously changed in the past two decades. At present teaching focuses on the student; it is the so-called student-centered learning in which student must be active in solving real-life tasks and responsible, i.e., aware of his/her learning. S/he must also critically reflect on the acquired knowledge and skills. In addition, student's learning is context-aware, which means that student's knowledge is built on his/her existing knowledge. Furthermore, learning is perceived as a social process in which students cooperate and collaborate with their peers [1]. The most suitable methodology to meet such a kind of learning seems to be blended learning (BL).

Currently, BL is a well-established and popular methodology worldwide. This can be demonstrated by the rise of articles published on this topic in ScienceDirect between the period of 2000–2015 [2].

Although there are many different definition of BL (cf. [3–7]), the most common defines BL as a combination of traditional, face-to-face teaching and online learning [8, 9]. Allen and Seaman [10] add that in blended courses 30–79% of content is delivered online. Based on literature search, the benefits of blended learning can be summarized as follows:

- it promotes personalized learning (i.e., it is tailored-made, adaptable to students' needs) [11];
- it encourages students' intrinsic motivation [1];

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 161–168, 2017.
DOI: 10.1007/978-3-319-49625-2_20

- it provides flexibility both for students and teachers in terms of planning, preparation, modification of materials, pace, place of learning, and timing [12, 13];
- it offers focused and constant feedback [14];
- it enables to expand, practice and revise students' knowledge and skills [15];
- it promotes students' independent learning [16];
- it encourages creative problem solving [17];
- it provides plenty of models and examples for students [1];
- it helps those who are not able to participate in class due to different reasons such as illness [18];
- it reduces costs on teaching and learning [19].

However, there are also some limitations of this BL approach. BL is quite time-consuming on preparation and management; it might enable procrastination by students if they are not constantly encouraged by their teacher, and thus, it might not be suitable for all students' learning styles [20].

The purpose of this article is to reflect on the benefits and limitations of BL described above in one of the blended courses run at the Faculty of Informatics and Management (FIM) in Hradec Kralove, Czech Republic. Moreover, the author of this article emphasizes the importance of the teacher's/tutor's role in blended courses and provides a few suggestions for the improvement of BL in practice.

2 Methods and Research Questions

The methods used in this article includes a literature search of available sources in the world's acknowledged databases such as Web of Science, Scopus, Springer and Science Direct in order to list the main advantages and disadvantages of BL and emphasize the importance of this topic. In addition, a method of comparison of the available sources was used [21]. To demonstrate the experience in the BL approach, a method of case study was implemented [22]. The benefits and limitations of the BL approach in practice was then based on the analysis of students' performance in the course. Students' performance was analyzed on the basis of evaluation reports generated from the online course and students' self-reflective essays. Furthermore, students' continuous assignments also help to reveal the difficulties students have to face during this course. The author of this study set the following research questions:

What are the most exploited tools of the e-learning course?

How effective is the whole blended course?

3 Findings

At FIM, the BL approach is implemented and exploited as well [12, 13, 23]. This is, for example, true for an optional, one semester course on Academic Writing. This course has run by the faculty already for ten years in the course of both semester. It is particularly aimed at the students of the first year, but it is also attended by students of higher classes who go and study abroad. The content of this course consists of six modules, which are run face-to-face for 90 min and their content is also implemented into the e-learning course on Academic Writing [14].

The modules are as follows:

1. Paragraphing and summarizing
2. Writing an argumentative essay
3. Writing a research article, including bibliography and references I
4. Writing a research article, including bibliography and references II
5. Writing an article for the English version of Wikipedia
6. Writing a self-reflective essay

Each module is then followed by home written assignment, for which students usually have one week at minimum and they submit it online through the e-learning course. Besides the teacher's written feedback, they also get an additional oral feedback in the face-to-face class the following lesson. Altogether students have to write five assignments before the last one – Writing a self-reflective essay is done in class and not included in final evaluation. The topics of the essay varied according to the form of the essay. Thus, the first essay is on a summary of a lecture or a seminar; the second concerns an argumentative essay and students can choose from two topics: Elderly people and mobile technologies or The teacher and ICT; the third essay is on Benefits and limitations of technologies for the teaching of English; the fourth essay focuses on Cognitive decline in dementia and the fifth is Writing an article for Wikipedia on the basis of students' own choice.

In the winter term of 2015, 11 students participated in the course. This number might seem small but correcting their essays every second week which were usually 350–500 words long on average imposes a significant burden on their teacher/tutor. Out of these 11 students, two were male students and nine were female students. In the end only ten students completed the course. The reason was the topic of the fourth essay on Cognitive decline and dementia which most of the students found difficult because it was not related to their field of study as in other cases. This was also confirmed by students in their self-reflective essays. The easiest was probably Assignment 1, which was only 1–2 paragraphs without writing any bibliography and Assignment 5 on which students work in pairs and they thoroughly enjoyed it although they had to use also their computer skills in order to edit and upload it into the English version of Wikipedia according to their requirements.

The worst grades were given for Assignment 3, in which students were learning how to write bibliography and references. These skills were new for students, and thus, they made mistakes. The most exploited items in the e-learning course were mainly content areas; my grades since students monitored their progress in writing essays; tools such as email or calendar, and announcements, which made students aware of some important changes in the course. They are illustrated in Fig. 1 below.

Since most of the students' activity was in the content areas, Fig. 2 below then specifies these areas which include three main fields: information about the course, assignments, and learning modules.

Furthermore, from the students' learning point of view, it is also important to notice the days and time students were spending on their studies. As Fig. 3 below indicates, most of the time on studying and uploading their assignments in the e-learning course

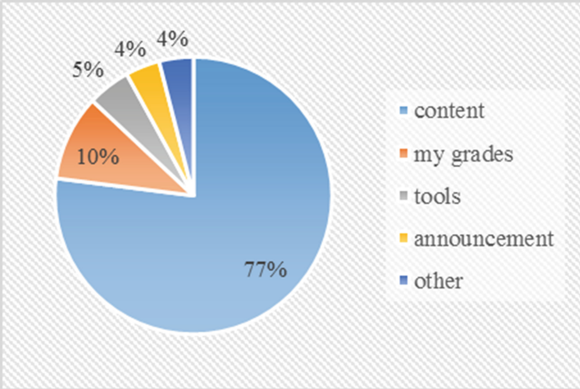


Fig. 1. Students' activity in the e-learning course, author's own processing based on the data from the e-learning course

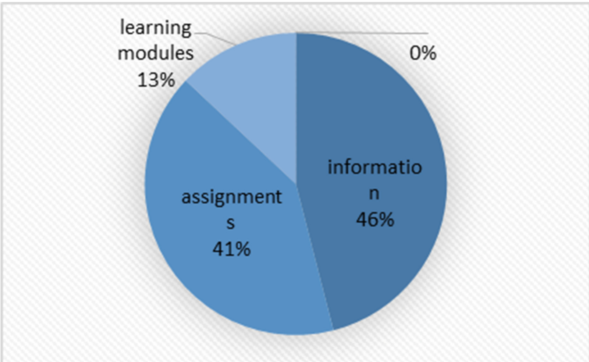


Fig. 2. Students' activity in the content areas, author's own processing based on the data from the e-learning course

was spent on Mondays and Tuesdays. The reason is that Tuesdays were the days of submitting their assignments and also the days of contact classes.

In addition, Fig. 4 below then shows that students were mostly active in the e-learning course between 12 and 1 in the afternoon and then 5 and 10 in the evening.

The author also looked at the number of student's hits in the e-learning course and compare it with their results on the assignments in order to discover any correlation between their study achievements and learning (Fig. 5). The average student's achievement was 398 points and the average number of student's hits was 78.

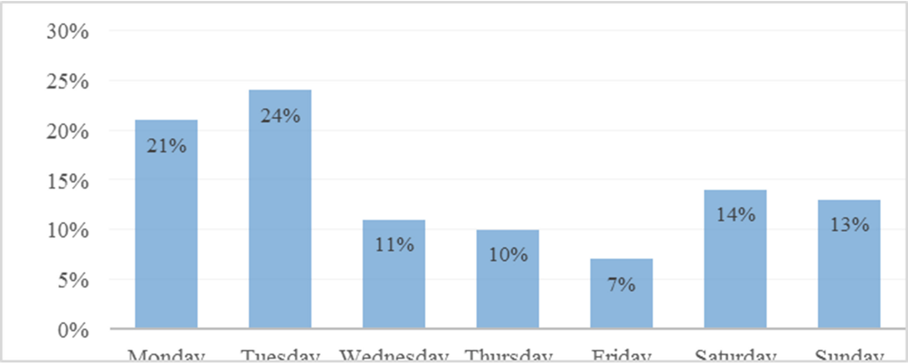


Fig. 3. Days of students' activity in the e-learning course, author's own processing based on the data from the e-learning course

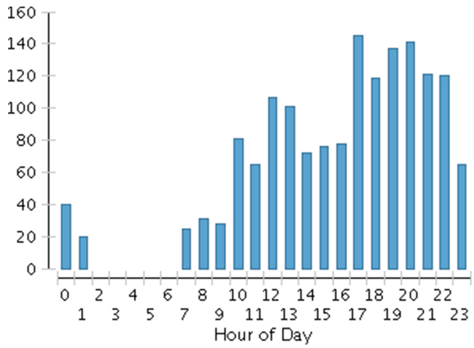


Fig. 4. Period of students' activity in the e-learning course per day [24]

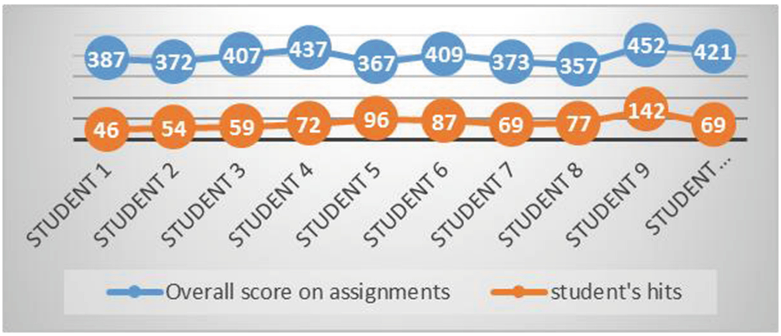


Fig. 5. Correlation between students' study achievements and students' hits in the e-learning course, author's own processing based on the data from the e-learning course

4 Discussion

The findings show that the most exploited tool in the e-learning course is the content areas. The reason is that it provides information on the course structure and subject matter of the course. It also gives more examples on the knowledge discussed during the face-to-face classes. Students also access the assignments of tasks which they have to do. Furthermore, students who cannot be present during the contact classes for various reasons can access the information in the e-learning course at home. In this way they also do not miss the deadline of their compulsory assignments. In addition, the findings reveal that students mainly learn and work when the deadline of their assignment is approaching. For example, student 10 confessed in his/her essay, s/he had had to persuade herself/himself to write the essay in the chosen time. The time period of their learning, however, indicates that students prefer to study between five and ten in the evening, i.e., when they finish their daily activities, calm down and have a more extended period for their academic work.

The correlation of students' study achievements and their hits in the e-learning course show the match only in two cases (Fig. 5), which means that students should study more and more systematically and intensively. Moreover, one drop out in the course indicates that more attention should focus on the encouragement of students' learning and a better choice of essay topics which should be more related to their field of study.

In addition, the teacher/tutor should run a discussion forum to enable students to express their opinions and share their learning difficulties in the learning process. Overall, it seems that the blended learning approach in this course is not effective enough, which contradicts with the research in this area (cf. [25]). The reason is that it focuses more on content delivery and less on social and relational aspects. Therefore more effort should be spent next years on promoting collaboration among students. The teacher/tutor must also attempt to deliver the course as effectively as possible: s/he has to prepare and be ready to modify the materials at any time according to students' learning needs [26]; s/he has to provide students with explicit and clear instructions and a study guide for the e-learning course; s/he has to constantly encourage students to achieve their learning objectives and thus, to promote their intrinsic motivation for self-directed learning; s/he has to provide a focused and almost immediate feedback on their performance; s/he has to offer and provide consultations for students at any time they have difficulties in learning in order to avoid potential learning conflicts and a consequent drop out; s/he has to promote co-operation and collaboration; and s/he has to nurture connections between fields, ideas, or concepts (cf. [27]).

5 Conclusion

In conclusion, the blended learning approach definitely brings many benefits such as personalized and independent learning, provides students with a lot of learning materials and examples, or enables flexibility. However, as the case study has shown, it must be implemented purposefully, consistently and systematically. In addition. the teacher has to focus on social aspects of this course and stimulate students to collaborate more. In fact, it is the teacher/tutor who is particularly responsible for the whole success of the course delivery and its methodology because as Sorden [7] states, blended learning is a combination of training methodologies, which uses the best delivery method for the successful achievement of the learning objective.

Acknowledgments. This work is supported by Excelence project 2016 and IGU project 2016 run at the Faculty of Informatics and Management in Hradec Kralove.

References

1. Herlo, D.: Improving efficiency of learning in education master programs. Procedia Soc. Behav. Sci. **191**, 1304–1309 (2015)
2. Blended learning, ScienceDirect (2015). http://www.sciencedirect.com/science?_ob=ArticleListURL&_method=list&_ArticleListID=-917229177&_sort=r&_st=13&view=c&md5=428cacf6f84901dad96f2e0f2f06126b&searchtype=a
3. Graham, C.R., et al.: Benefits and challenges of blended learning environments. In: Khosrow-Pour, M. (ed.) Encyclopedia of Information Science and Technology I-V. Idea Group Inc., Hershey (2003)
4. Bonk, C.J., Graham, C.R. (eds.): Handbook of Blended Learning: Global Perspectives. Local Designs. Pfeiffer Publishing, San Francisco (2005)
5. Whitelock, D., Jelfs, A.: An editorial: journal of educational media special issue on blended learning. J. Educ. Media **28**(3), 99–100 (2003)
6. Littlejohn, A., Pegler, C.: Preparing for Blended E-Learning. Routledge-Falmer, London (2007)
7. Sorden, S.: Emerging Trends in Foreign Language Teaching with Information and Communication Technologies (2012). http://www.slideshare.net/ssorden/emerging-trends-in-foreign-language-teaching-with-ict
8. Buran, A., Evseeva, A.: Prospects of blended learning implementation at technical university. Procedia Soc. Behav. Sci. **206**, 177–182 (2015)
9. Frydrychova Klimova, B.: Blended Learning, in A. In: Vilas, M. et al. (eds.) Research, Reflections and Innovations in Integrating ICT in Education, vol. 2, pp. 705–708. FORMATEX, Spain (2009)
10. Allen, I.E., Seaman, J.: Changing course: ten years of tracking online education in the United States, Oakland, Babson Survey Research Group and Quashog Research Group, LLC (2013)
11. Poulova, P., Simonova, I.: Flexible e-learning: online courses tailored to student's needs. In: Proceedings of the 9th International Scientific Conference on Distance Learning in Applied Informatics (DIVAI 2012), UKF, Nitra, pp. 251–260 (2012)
12. Hubackova, S., Semradova, I.: Comparison of on-line teaching and face-to-face teaching. Procedia Soc. Behav. Sci. **89**, 445–449 (2013)
13. Frydrychova-Klimova, B., Hubackova, S., Semradova, I.: Blended learning in a foreign language learning. Procedia Soc. Behav. Sci. **28**, 281–285 (2011)
14. Frydrychova Klimova, B., Poulova, P.: ICT in the teaching of academic writing. Lectures Notes in Management Science, vol. 11, pp. 33–38 (2013)
15. Klimova, B.: Assessment in smart learning environment – a case study approach. In: Uskov, V., Howlett, R.J., Jai, L.C. (eds.) Smart Innovation, Systems and Technologies, vol. 41, pp. 15–24 (2015)

16. Frydrychová Klímová, B., Poulova, P.: Pedagogical issues of online teaching: students' satisfaction with on-line study materials and their preferences for a certain type. In: Cao, Y., Väljataga, T., Tang, Jeff, K.,T., Leung, H., Laanpere, M. (eds.) ICWL 2014. LNCS, vol. 8699, pp. 187–194. Springer, Heidelberg (2014). doi:10.1007/978-3-319-13296-9_21
17. Sophonhiranraka, S., Suwannatthachoteb, P., Ngudgratokec, S.: Factors affecting creative problem solving in the blended learning environment: A review of the literature. Procedia Soc. Behav. Sci. **174**, 2130–2136 (2015)
18. Mustapa, M.A.S., Ibrahim, M., Yusoff, A.: Engaging vocational college students through blended learning: Improving class attendance and participation. Procedia Soc. Behav. Sci. **204**, 127–135 (2015)
19. Porter, W.W., Graham, C.R., Spring, K.A., Welch, K.R.: Blended learning in higher education: Institutional adoption and implementation. Comput. Educ. **75**(6), 185–193 (2013)
20. Simonova, I.: Information literacy: research reflecting individual learning styles. In: Proceedings of the 10th International Conference on Efficiency and Responsibility in Education (ERIE 2013), Prague, pp. 550–556 (2013)
21. Klimova, B., Simonova, I., Poulova, P., Truhlarova, Z., Kuca, K. Older people and their attitude to the use of information and communication technologies – A review study with special focus on the Czech Republic (Older people and their attitude to ICT). Educational Gerontology (2015). doi:10.1080/03601277.2015.1122447
22. Yin, R.K.: Case Study Research: Design and Methods. Newbury Park, Sage (1984)
23. Frydrychova Klimova, B., Poulova, P.: Forms of instructions and students´ preferences – a comparative study. hybrid learning. theory and practice. In: Proceedings of the 7th International Conference (ICHL 2014), pp. 220–231. Springer, Heidelberg (2014)
24. E-learning course on Academic Writing (2015). http://bboard.uhk.cz/
25. Garrison, D.R., Kanuka, H.: Blended learning: uncovering its transformative potential in higher education. Internet High. Educ. **7**(2), 95–105 (2004)
26. Reid, E.: Multimedia used in development of intercultural competences (ICC). In: CALL and Foreign Language Education: E-Textbook for Foreign Language Teachers, Nitra, UKF, pp. 83–92 (2014)
27. Frydrychova Klimova, B., Poulova, P.: ICT as an effective tool for learning English. In: The Third International Conference on Digital Information Processing (ICDIPC 2013), USA, The Society of Digital Information and Wireless Communications (SDIWC), pp. 569–573 (2013)

Private Cloud with e-Learning for Resources Sharing in University Environment

K.P.N Jayasena[1,2] and Huazhu Song[1(✉)]

[1] School of Computer Science and Technology, Wuhan University of Technology, Wuhan, People's Republic of China
shuaz@whut.edu.cn
[2] Department of Computing and Information Systems, Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka
pubudu@appsc.sab.ac.lk

Abstract. Most existing e-Learning platforms are unable to share learning resources between cloud platform and public network, and normally need additional cost to deploy the environment. This paper presents a new e-Learning model based on the virtual private network and private cloud, which could help the student to easily setup and configure his own e-Learning environment with less cost for efficiently sharing resources in universities. Firstly this paper describes the academic private cloud tool that offers a simple environment to experiment cloud computing concepts. Based on this private cloud, e-Learning system can be easily installed by using standard local computing resources, without the need of different hardware or external resources. Hence, this paper illustrates the framework of VPN and Private Cloud Integration, aiming at resource sharing in the university environment. The e-Learning platform is also scalable and capable to interconnect other multi-platform developed in different locations. This proposed framework solves the various challenges faced by e-Learning, and increases the availability, reliability and scalability of cloud based e-Learning systems.

Keywords: e-Learning infrastructure · Private cloud · Virtual learning environments · Virtual Private Networking (VPN) · Virtualization · Resource sharing

1 Introduction

Cloud computing technology is an emerging internet based computing for delivering computing services that are delivered as a service over a network (typically the Internet). The e-Learning solution is one of the technologies which implement the cloud power in its existing systems to enhance the functionalities providing to students.

In this research, we propose to build a framework to utilize the clouds' features in the teaching process in campus network. Since there are several of cloud types and services, we identify the courses that could apply cloud computing

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 169–180, 2017.
DOI: 10.1007/978-3-319-49625-2_21

to their teaching processes. The main contribution of this research is to building private cloud using open source software and combined it with e-Learning system. Private cloud provides universities a secure platform to run e-Learning services; so many industries are planning to implement private cloud. Most cloud based e-Learning platforms unable to share e-Learning services directly on the public university network. We will provide a flexible, efficient infrastructure for the students in campus with the shared resource, and could let the students easily setup, access and use the resource by private cloud. The presented platform is based on virtual private network (VPN) technology. The VPN based private e-Learning platform is scalable and capable to interconnect other working platform developed in university network domain.

The research is organized as follows: Sect. 1 gives background about cloud computing and e-Learning. Section 2 provides cloud adaption in Education and issues in existing e-Learning systems, and introduces challenges of cloud based e-Learning system. Section 3 illustrates the proposed private cloud framework for e-Learning system and finally discusses the how VPN technology integrates in to current e-Learning system.

2 Background

2.1 e-Learning

e-Learning is a hot topic in education field and has been growing fast since the first web based courses in the mid to late 1990s. e-Learning comprises all forms of electronically supported learning and teaching. The 2013 ECAR study of e-Learning discovered that nearly all institutions (98%) have at least some departments, units, or programs with a major interest in e-Learning [1,2].

There are two ways of e-Learning, synchronous e-Learning and asynchronous e-Learning [3]. Synchronous e-Learning contains technology such as video conferencing and electronic white boards requiring students to be present at the time of content delivery. Asynchronous mode includes programmed instruction and tutorials that permit students to work through the screens at their own place and at their own time. Most of the courses available on the network asynchronous model e-Learning system [4,5].

Based on the literature review, some of the benefits of e-Learning are, it allows students to access material when needed and study at their own preferred place, low delivery cost, learners are required to critically engage with the lot of information available, shared learning by allowing interaction among learners from diverse backgrounds and freedom of speech [6].

LMS (Learning Management system), e-portfolios, and e-Learning social networks use more than one-quarter. Eighty-one percent of institutions provide e-Learning course deliver internally, and 87 % provide tech support in-house [7–9].

There is an emergent trend regarding the research of e-Learning or virtual e-Learning platform [10]. There are several education institutes some examples are the Khan Academy Virtual Learning Center of Granada University, the Open University of Catalonia, the MIT Open Course Ware, and free online courses of Stanford University virtual courses, which are clearly supported by the e-Learning approach. EdX is a joint partnership between the Massachusetts Institute of Technology (MIT) and Harvard University provide online learning to millions of people in the world. EdX will offer Harvard and MIT classes online for free. Harvard Extension School offers many courses for credit over the Internet. The Internet is used to deliver course lectures with video, audio, and multimedia. Live lectures are recorded and made available on demand through "streaming video" technology. Students use technologies to work on exams and homework assignments and to communicate with the instructor and other students in the class [11,12]. Currently, e-Learning systems face lot of challenges. The main challenge is the massive data in e-Learning system. With the growth of resources, the overhead of resource management becomes a key problem with unacceptable increasing costs. e-Learning system needs scalable storage capacity. Cloud computing has been an emergent topic of information technology paradigm. Cloud computing offers dynamically scalable infrastructure supplying computation, storage and communication capabilities as services it can provide tremendous values to e-Learning [13].

2.2 Cloud Computing Based e-Learning

Cloud computing is an emerging technology that have changed the way applications are developed and accessed. They are aimed at computing resources (hardware and software) that are delivered as a service over a network on a scalable infrastructure. According to the definition of National Institute of Standards and Technology (NIST) [14] "Cloud Computing" is a model for enabling convenient; on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) which can be quickly released with minimal management power or service provider collaboration. On-demand self-service, broad network access, resource pooling, rapid elastic or expansion, and measured service are the main characteristics of cloud computing [15,16].

Many Universities are moving to cloud based e-Learning system in a highly efficient way. Cloud based e-Learning system combined with power of Big Data and it offers a powerful and smart system [17,18]. The e-Learning systems can benefit from cloud computing as the follows [19,25]:

[1] Infrastructure: use an e-Learning solution on the provider's infrastructure.
[2] Platform: use and develop an e-Learning solution based on the provider's development interface.
[3] Services: use the e-Learning solution given by the provider.

It allows researchers search and find models and make discoveries fast. The universities can open their technology infrastructures to private, public sectors for research advancements. The efficiencies of cloud computing can help universities keep place with ever growing resource requirements and energy costs. Students expect their personal mobile devices to connect to campus services for education. Faculty members are asking for efficient access and flexibility when integrating technology into their classes. Researchers want instant access to high performance computing services, without them [20].

Massive Open Online Course (MOOC) is a recent development that is powered by Cloud Computing technology. MOOC promoters (such as 'Coursera' which is known as the 'Amazon of education') offer a wide range of educational programs from leading universities online for free.

Cloud Computing based e-Learning applications that can use IaaS for dynamic storage and compute resources were proposed by Bo Dong. That research describes a general and simple architecture with monitoring, policy and provision modules. Xian Jiaotong University develops BlueSky cloud framework enables physical machines to be virtualized and assigned on-demand for e-Learning systems [2] BlueSky cloud framework combines with load balancing and data caching middleware functions to assist for e-Learning systems [1,11,21,22].

2.3 Private Cloud for Education

Public cloud has been the best solutions for many industries, even today; there are lot of challenges with a public cloud. In a public cloud environment computing resources,services, and applications are delivered to the customer at a pay-per-use scheme. Amazon Web Services and Google Apps are well-known examples of this cloud deployment model. Private cloud offers the security, customization and efficiency for industries while providing scalability and agility in different processes. However public cloud, a private cloud is a dedicated cloud infrastructure that is customized to deliver different services for a specific institute. The computing resources are available only to the specific institute, whether managed internally or externally.

Here are some advantages presented by the private cloud to the education sector. Lower total cost ownership is a clear advantage. Implementation of a private cloud for efficient allocation of resources as every department in the organization flexibly utilizes resources. Universities have to purchase different software products that become resources of the institute. The product might come to its end-of-life then it becomes no value to the institution or is too complex to install and use. In a private cloud environment, only software that is essential for the university is subscribed and used.

2.4 VPN and Private Cloud Integration

In this section, the research focus on providing networking support for enterprise cloud platforms with VPNs. In private cloud architecture allows different cloud services to connect to each other easily. Here, we discuss how can introduce VPN into the inter-cloud computing architecture.

VPN is a virtual private network that uses a public network (usually the internet) to connect remote sites or users together and built on top of existing physical networks that can provide secure mechanism for data and IP information transmitted between networks. VPN can be used over existing networks, such as the Internet, it can enable the secure transfer of sensitive data across untrusted public networks, such as intra-cloud and inter-cloud in our private cloud e-Learning infrastructure.

3 Methodology

Before implement the cloud based e-learning system first we outline the goals and requirements. When the course is made in e-learning system it should be available more globally and extend educational reach. The users must have a possibility to access educational resources in the private campus domain through private cloud infrastructure. Campus network infrastructure implement in a different network domain and our private cloud framework deploy in another network domain but these two networks must have a flexible and secure communication path. It will provide a flexible, efficient infrastructure for the students and could let the students easily setup, access and use the resource by private cloud.

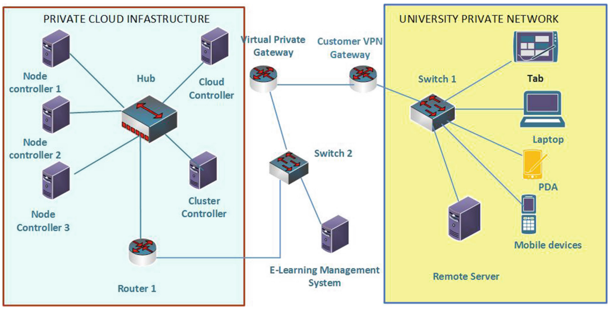


Fig. 1. The overall architecture of the system

The Fig. 1. Illustrates the overall architecture of the system. Overall architecture contains mainly two parts. Most of the e-Learning based researches focus only the private cloud infrastructure.

However in our research we are not going to discuss the private cloud infrastructure other than that we mainly elaborate the virtual private network integration part. Private cloud infrastructure connects with private campus network through VPN technology. In this section first explains the implementation procedure of the Eucalyptus private cloud. The key features of the implemented private cloud include: services for connect to a virtual environment, services for resource management, and services for user account management and a virtual infrastructure management system. These features let for an efficient work with virtual machines. In this virtualization environment students and teachers have their own storage space in private cloud and they are available for later reference. Students can launch virtual machines instances based on different virtual lab practical. Those instances stored in node controllers private cloud infrastructure. The students are unable to misuse the internet bandwidth as each VM (Virtual Machine) instances is allocated a fixed amount of bandwidth. So this proposed method solve lot of problems arise in existing university infrastructure.

3.1 Implement Private cloud Infrastructure

The main objective of this project is to build a private cloud for the purpose of creating infrastructures and running e-Learning applications. The proposed architecture that builds on top of an existing hardware infrastructure. Implement Infrastructure for virtual e-Learning system, It consists of three layers.

[1] The physical layer: The private cloud architecture is built on top of an existing hardware infrastructure. In this way, all hosts and services can be visualized and managed through a web browser, displaying real-time data about the virtual infrastructure including performance, configuration and storage.
[2] The virtualization layer: In order to allow multiple operating systems to share a single hardware host, a hypervisor is needed.
[3] The service layer: This layer is the interface with the cloud environment, and provides software for supporting the PaaS and the SaaS the cloud users need. In this case, virtual machines are created by choosing base images and software packages. Then students simply access the required VM using the client.

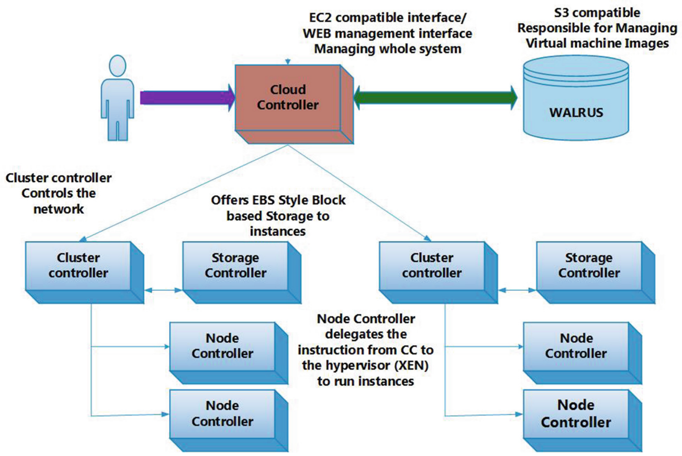


Fig. 2. The overview architecture of the Eucalyptus cloud

The basic architecture of private cloud consists of a front end which runs one or more Cloud Controller (CLC), Cluster Controller (CC), Walrus (WS3), Storage Controller (SC) and one or more nodes. The architecture of the proposed system is shown in the Fig. 2. The CLC manages the whole cloud and includes multiple CCs. There will be a WS3 attached to a CLC. The CC can contain multiple NCs and SCs. Ultimately the VMs will be running in the NC making use of its physical resource [23, 24].

3.2 Implementation of Virtual e-Learning System

In this section mainly consists of three steps, and the virtual e-Learning system is as shown in the Fig. 3.

Create the Virtual Machines. The Eucalyptus Machine Image (EMI) is a combination of a virtual disk image(s), kernel and ramdisk images as well as an xml containing metadata about the image. These images reside on WS3 and are used as templates for creating instances. An instance is a virtual machine deployed from an EMI (Eucalyptus Machine Image). An instance then, is simply a running copy of an EMI. In this research we developed hadoop images for big data analyzing practices for students.

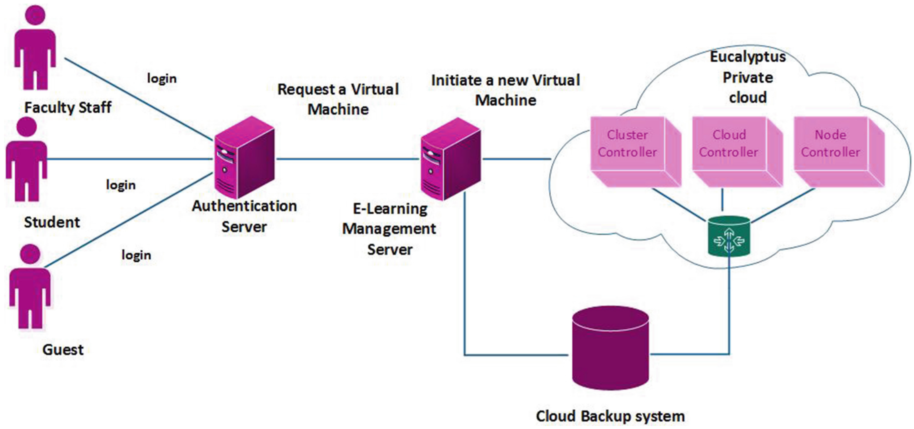


Fig. 3. The virtual e-Learning system

Students lab exercises and practical projects involve hardware with specific software requirements for student projects. Instead of allocating servers and desktop PCs to practical exercises, proposed infrastructure provides virtual machines. For example big data analyzing exercises like Hadoop-based practical sessions each group needs powerful PCs to complete the exercise. Then VMs are most appropriate solution for this purpose. These virtual machines need to be created, managed and monitored automatically. VM created using minimal operating system (OS) images and insert software packages. This system allows students to reserve any of the enabled VMs for course for which they are registered. In this way, VMs will be available to students during the desired period. VMs with all the necessary software have been geared to students needs depending on the course the student attends. Students can use this software on any computer with an Internet connection and a web browser. After a successful login, the student is shown a list of available VMs, depending on the courses they enrolled. The student can make a reservation for a VM, and choose the date and time when the VM will be used. The reserved VM can be used in the desired time, from any location and any device with an Internet connection and a web browser. It consists of better utilization of existing hardware because the maximum possible number of VMs can be higher than physical hardware exists.

Design the User Interface Layer. This layer will offer all the functionalities that can be used by the different users include teacher, student, administrative staff and others. In this layer we have provided the different learning objects. The main components of this complex application include a set of web services and a web application. Via the web application, the user can review, reserve and use VM placed in the cloud infrastructure. Students can connect to the system from anywhere to work on their practical assignments through different platforms. For teachers improves their works and they can track their students progress and they can create laboratories that can be used any subject.

Managing the Users. User accounts are stored in centralized database implemented using Lightweight Directory Access Protocol (LDAP). LDAP also enables integration with University Information System. Use role based access control (RBAC) to manage user access and permission for that implement LDAP server. A role can be defined as a set of access control grants that can be attributed to an account in the system (e.g. Student, teacher and administrative staff). RBAC system has two phases in assigning a privilege to a user. In the first phase the user (student, teacher) is assigned one or more roles and in the second phase the roles are checked against the requested operations.

Implement the Backup System. In every production system, it is important to be able to restore the system to a working state after an incident resulting in loss of data. The virtual machines can be backed up using the snapshot feature in Eucalyptus. The process of proposed private cloud e-learning solution is shown in the activity diagram in Fig. 4.

4 Implementation of VPN Based Private Cloud e-Learning System

We are developing a system which attempts to meet the requirements of an enterprise ready cloud computing environment using virtual private clouds. This system forces existing virtualization technologies at the server, router, and network levels to create dynamic resource pools that can be connected to enterprises.

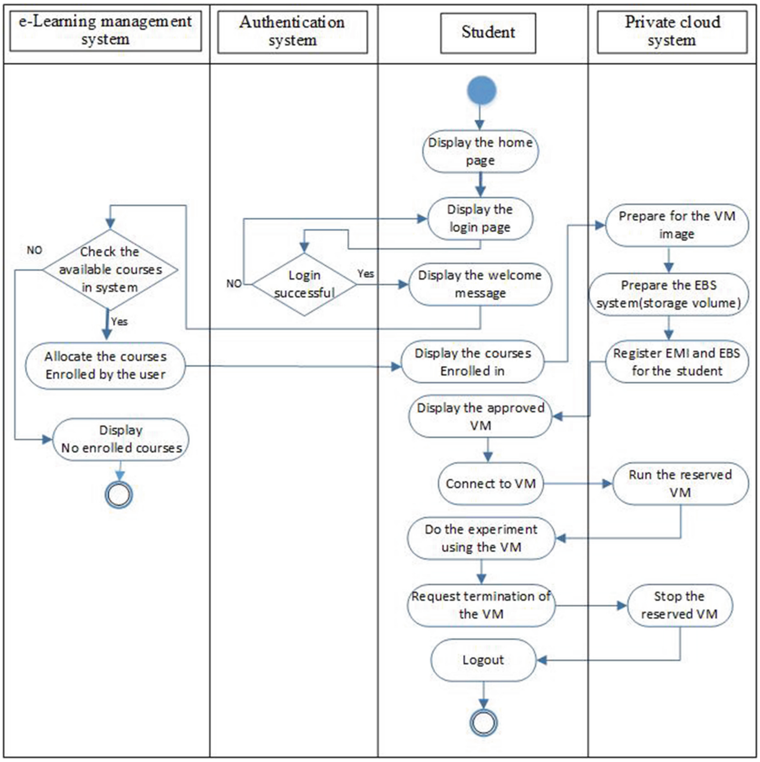


Fig. 4. The activity diagram for the process in the proposed private cloud e-Learning solution

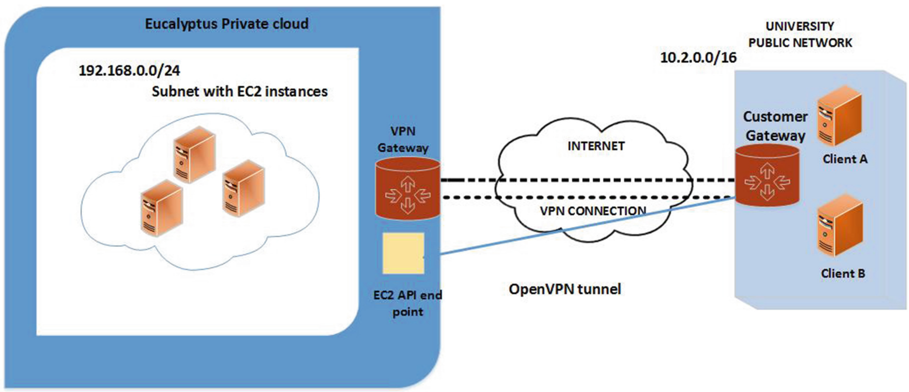


Fig. 5. The VPN architecture in the system

The Fig. 5. Shows the proposed network, the customer gateway, the VPN connection that goes to the virtual private gateway, and the Eucalyptus private cloud. There is a connection between the customer gateway and virtual private gateway. Eucalyptus private cloud contains the EC2 instances, it provides an accurate virtual computing platform which can be created and managed by different users through web service interfaces. Such a virtual environment is used by the students as the platform to achieve all the four lab experiments that designed in the e-Learning environment. It contains VPN server located in the private cloud infrastructure and all the components located in the same network domain. In the above situation private cloud network resides in 192.168.0.0 network domain. The university public network separated from Eucalyptus private cloud network domain. It is situated in 10.2.0.0/16 network domain. Some of the mobile users also located in the university network. The university public network contains customer gateway all the data traffics go through this gateway from private cloud infrastructure. In this section presents a simple setup that allows to an inter communication between local area network to a VPC hosted on Eucalyptus with a private VPN tunnel. The tunneling technology used is OpenVPN. To implement this configuration will need Eucalyptus web services account, Linux server running CentOS on the LAN, one internet connection. Finally we will be able to extend the local area network to a virtual private cloud and interconnect the internal systems with the Eucalyptus cloud instances.

5 Conclusion

The system has established a private cloud-based system for e-Learning, resource-sharing and support for education teachers and students. Private cloud platform that allows large number of distributed resources to become sharable and to be used for e-Learning. IT provides effective and scalable e-Learning services, especially suitable for educational institutions that teach computer science or similar subjects.

In this research, the current status of e-Learning system was discussed and highlights the limitations and determines how we could improve the e-Learning environment for campus environment. After identifying the challenges and limitations, the research showed that Cloud Computing can overcome most of these limitations and challenges to improve the virtual e-Learning environment. The primary focus of this research is to utilize the existing infrastructure which would enable the student to develop and deploy experiment in a real distributed environment, thereby enhancing the students learning outcomes and knowledge base. This cloud based e-Learning system is different from other cloud computing systems, It will connect private cloud server in to local network and access public resources such as objects stored in S3 using public IP address space, and private resources. It provides a flexible, efficient infrastructure for the students in campus with the shared resource, and could let the students easily setup, access and use the resource by private cloud. Students can access the private cloud system through different platforms such as computer and mobile devices. For that we implement VPN and private cloud integration into e-Learning system. With an increasing growth in the number of users, services, educational contents and resources, the system described in this paper can be used as a model for developing a scalable and flexible infrastructure for e-Learning. The model can easily be adjusted and applied in other educational institutions.

Acknowledgments. The research project is supported by the Education Reform Project(No: w2015043) in Wuhan University of Technology.

References

1. Masud, M.A.H.: A novel approach for adopting cloud-based e-Learning system. In: 2012 IEEE/ACIS 11th International Conference on Computer, Information Science, pp. 37–42, May 2012. http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=6211074
2. Dong, B., Zheng, Q., Qiao, M., Shu, J., Yang, J.: Bluesky cloud framework: an e-Learning framework embracing cloud computing. In: Jaatun, M.G., Zhao, G., Rong, C. (eds.) CloudCom 2009. LNCS, vol. 5931, pp. 577–582. Springer, Heidelberg (2009). doi:10.1007/978-3-642-10665-1_55
3. Alshwaier, A., Youssef, A., Emam, A.: A new trend for e-Learning in KSA using educational clouds. Adv. Comput. Int. J. (ACIJ) **3**(1), 81–97 (2012)
4. Boja, C., Pocatilu, P., Toma, C.: The economics of cloud computing on educational services. Procedia Soc. Behav. Sci. **93**, 1050–1054 (2013). http://linkinghub.elsevier.com/retrieve/pii/S1877042813034319
5. Devipriya, C., Lavanya, K., Priya, M.S., George, S.M.: E-Brainstorm: using PaaS model of cloud for e-Learning. Int. J. Emerg. Technol. Adv. Eng. **4**(2), 368–372 (2014)
6. Madhumathi, C., Ganapathy, G.: An academic cloud framework for adapting e-Learning in universities. Int. J. Adv. Res. Comput. Commun. Eng. **2**(11), 4480–4484 (2013)
7. S. I. Faculty: Cloud-based education, Part 1: E-learning strategy for instructors Concepts, tools, and methods, pp. 1–11 (2011)
8. Benta, D., Bologa, G., Dzitac, I.: e-Learning platforms in higher education. case study. Procedia Comput. Sci. **31**, 1170–1176 (2014). http://linkinghub.elsevier.com/retrieve/pii/S187705091400550X
9. Stantchev, V., Colomo-Palacios, R., Soto-Acosta, P., Misra, S.: Learning management systems, cloud file hosting services: a study on students acceptance. Comput. Hum. Behav. **31**, 612–619 (2014). http://linkinghub.elsevier.com/retrieve/pii/S0747563213002409
10. Button, D., Harrington, A., Belan, I.: E-learning & information communication technology (ICT) in nursing education: a review of the literature. Nurse Educ. Today **34**(10), 1311–1323 (2013). http://www.ncbi.nlm.nih.gov/pubmed/23786869
11. Wang, C.-C., Yen, N.Y.: A sharable e-Learning platform based on cloud computing. In: 2011 3rd International Conference on Computer Research and Development (ICCRD) (2011)
12. Palanivel, K., Kuppuswami, S.: Architecture solutions to e-Learning systems using service-oriented cloud computing reference architecture. Int. J. Appl. Eng. Manag. (IJAIEM) **3**(3), 547–559 (2014)

13. Shahzad, F.: State-of-the-art survey on cloud computing security challenges, approaches, solutions. Procedia Comput. Sci. **37**, 357–362 (2014). http://linkinghub.elsevier.com/retrieve/pii/S1877050914010187
14. Mell, P., Grance, T.: The NIST Definition of Cloud Computing, Recommendations of the National Institute of Standards and Technology (2011)
15. Buyya, R., Vecchiola, C., Selvi, S.T.: Mastering Cloud Computing. Elsevier, New York (2013). http://www.sciencedirect.com/science/article/pii/B9780124114548000103
16. Fox, G., Pallickara, S.: Recent work in utility, cloud computing. Future Gener. Comput. Syst. **29**(4), 986–987 (2013). http://linkinghub.elsevier.com/retrieve/pii/S0167739X13000071
17. Dukhanov, A., Karpova, M., Bochenina, K.: Design virtual learning labs for courses in computational science with use of cloud computing technologies. Procedia Comput. Sci. **29**, 2472–2482 (2014). http://linkinghub.elsevier.com/retrieve/pii/S1877050914004086
18. Ezenwoke, A., Omoregbe, N., Ayo, C.K., Sanjay, M.: NIGEDU CLOUD: model of a national e-education cloud for developing countries. IERI Procedia **4**, 74–80 (2013). http://linkinghub.elsevier.com/retrieve/pii/S2212667813000154
19. Chao, K.-M., James, A.E., Nanos, A.G., Chen, J.-H., Stan, S.-D., Muntean, I., Figliolini, G., Rea, P., Bouzgarrou, C.B., Vitliemov, P., Cooper, J., van Capelle, J.: Cloud e-Learning for mechatronics: CLEM. Future Gener. Comput. Syst. **48**, 46–59 (2014). http://linkinghub.elsevier.com/retrieve/pii/S0167739X14002271
20. Chen, L.-P., Lin, J.-A., Li, K.-C., Hsu, C.-H., Chen, Z.-X.: A scalable blackbox-oriented e-learning system based on desktop grid over private cloud. Future Gener. Comput. Syst. **38**, 1–10 (2014). http://linkinghub.elsevier.com/retrieve/pii/S0167739X14000429
21. Cayirci, E., Rong, C., Huiskamp, W., Verkoelen, C.: Snow leopard cloud: a multi-national education training and experimentation cloud and its security challenges. In: Jaatun, M.G., Zhao, G., Rong, C. (eds.) CloudCom 2009. LNCS, vol. 5931, pp. 57–68. Springer, Heidelberg (2009). doi:10.1007/978-3-642-10665-1_6
22. Honghui, N., Xiaojun, M.: Research of e-Learning system based on SOA. In: 2010 Second International Conference on Multimedia, Information Technology, pp. 148–150 (2010). http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=5474255
23. E. Systems, Eucalyptus 4. 1 User Guide (2015)
24. Togawa, S., Kanenishi, K.: Private cloud cooperation framework of e-Learning environment for disaster recovery. In: 2013 IEEE International Conference on Systems, Man, Cybernetics, pp. 4104–4109, October 2013. http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=6722453
25. Despotović-Zrakić, M., Simić, K., Labus, A., Milić, A., Jovanić, B.: Scaffolding environment for e-Learning through cloud computing. Educ. Technol. Soc. **16**(3), 301–314 (2013)

Research and Trends in the Studies of Collective Intelligence from 2012 to 2015

Francisca Grimon[1(✉)], Jaime Meza[2], Mónica Vaca-Cardenas[3], and Josep M. Monguet[2]

[1] Universidad de Carabobo, Valencia, Venezuela
fgrimon@uc.edu.ve
[2] Universitat Politècnica de Catalunya, Barcelona, Spain
jaime.meza@estudiant.upc.edu, jm.monguet@gmail.com
[3] Kansas State University, Manhattan, KS, USA
monivcec@ksu.edu

Abstract. The interaction between groups of people and machines supports the transfer of knowledge and strengthen Collective Intelligence (CI) making it robust. The CI with the support of technology progresses through platforms and computer systems including ontology, clusters, agents and Web intelligence among others. This research consists of a content analysis of recent studies 2012-2015 on CI. After an extensive search of publications on electronic databases, two hundred and fifteen one papers were selected and exposed to a document analysis following the approach of Zott. In this research we identified three categories to consider: learning, technology and decision-making. The analysis revealed that CI is strongly related with technology, supporting the processes of training people and promoting collaborative learning as a new form of literacy. Another result of the analysis of literature indicates that the methods of decision-making and consensus foster collaboration and competition between individuals in order to achieve better results. Our review of the literature provides a contribution in the area of CI.

Keywords: Collective intelligence · Teaching/learning strategies · Computing · Domain · Knowledge · Decision-making

1 Introduction

The scientific communication is the main practice of the discussion forum for the research community and allows the generation of knowledge and progress of societies. CI, investigated for several years, is currently taking momentum with the use of technologies that impressively supports collaboration between individuals. Between 2012 and 2015 there have been published in scientific journals a number of papers related to CI.

CI encompasses a variety of domains, interaction and collaboration within groups in order to perform a variety of jobs, sharing knowledge and strengthening decision-making in problem solving [1].

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 181–187, 2017.
DOI: 10.1007/978-3-319-49625-2_22

We hope that the current study contributes to CI and increase understanding about current trends in it; we conducted a content analysis of published papers on the subject.

The rest of this paper is organized as follows: Sect. 2 contains the methods, referring to the analysis of content in selected research papers; Sect. 3 contains the results of the selected research papers reviewed and coded according to the method; Sect. 4 contains some concluding remarks and road map for future research and Sect. 5 contains some limitations.

2 Methods

Analysis of content published in scientific journal allows to assess the level of development of a particular discipline and to appreciate its research trends [2, 3]. According to [4], content analysis is a method that separate large amounts of information regarding specific purposes. The content analysis involves comparing, contrasting, and categorizing a set of data. Method has been used to analyze collections of papers [5]. According to [6] content analysis has proven to be an effective research method; they also referenced the following authors: [7] in distance education, [8] in educational technology and [9] in science education. Finally, [10] has used the method in the investigation into blended learning in higher education.

Content analysis was selected because of its potential to classify text material [11]. The literature exemplifies content analysis as a methodology for analyzing and observing the trends of published articles in journals [12].

2.1 Data Collection

The selection of papers regarding to the literature of CI was done in: Science Direct, Web of Science, SpringerLink and Wiley. The searches for the CI were limited to articles in journals, full-text, all language and all sciences. The term of "collective intelligence" was used in all parts of the article, and it locates a total of 1724 papers published from 2012 to 2015.

According to [13] the title of a scientific article describes with few words the content of this article and the abstract can be considered a miniature version of the article. In addition, the American National Standards Institute referencing [13] states that "a well-prepared abstract enables readers to quickly identify and exactly the content of a document, determine its relevance to their interests and decide if they have to read the work in its entirety." Finally, [13] considers that keywords label the scientific article. Refining the search with the term "collective intelligence" appearing in keyword, title or abstract the previous 1724 papers were limited to a set of 215.

Next, the set of papers was refined again following the approach of [14] limiting the final list of papers. Over this final list a content analysis was implemented to interpret the contents of the papers classifying and/or encoding the various elements of text in categories [15].

Following [14] the final inclusion criteria of papers is based on the fact that the issue of CI is addressed on a nontrivial manner.

It is the focus of the paper and usually appears in the title.
It appears at least in two of three: title, abstract and key words.
It appears in the abstract, in the keywords, and it is clear that the paper is a contribution to IC.

At the end, a final list of 119 papers resulted as relevant and was analyzed for this research.

2.2 Analysis

To perform content analysis, categories must be established according to the focus of each particular research. Categories are intended to group together sets of pieces of information which refer to the same aspect [10]. The categories applied to analyze the attributes of texts in the list of papers of this research are shown in Table 1:

Table 1. Category

Category	Words	Group
Learning	Learning, e-learning, u-learning, b-learning, training, knowledge, teaching, formation, education, pedagogy, pedagogical instruction	C1
Technology	Technology platform, system, Web, tools, software, ICT, authoring tool, computing	C2
Decision-making	Decision-making methods, Delphi, consensus, models	C3

The papers of this research have been coded according to the previous categories.

3 Results and Discussions

The results of the research are presented in different subsections:

3.1 Category

The frequency of the categories previously defined in Table 1 and their associated words are shown in Fig. 1.

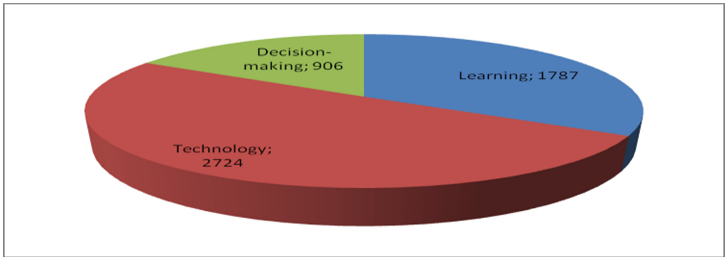


Fig. 1. Category and frequency

3.1.1 Collective Intelligence and Learning

Knowledge and CI have been several investigations, including [16] applied a CI framework to characterize education in the context of a web based tool for teachers, called Instructional Architect (IA). It allows teachers to find, create and share instructional activities for students using online learning resources. Other research is that of [17] entitled "Knowledge Acquisition for Medical Diagnosis Using Collective Intelligence" indicates that using the wisdom of crowds can get new biomedical knowledge. These researchers exhibit a scheme to collect diagnostic information Diagnosis Decision Support Systems; they are based on consensus and CI.

[18] Proposes CorpWiki, self-regulation of the wiki system, allowing the acquisition of high-quality knowledge. This will develop CI organizations make efficient use of the intelligence of its employees and the facilities provided by technology, such as Web 2.0. That way you can create and evaluate knowledge that is timely and assured quality.

Regarding to learning, [19] referenced [20] reports online communities provide a learning space to build CI. They are communities where each member has the potential to contribute and participate in the discussions, which increases the possibility to solve complex problems. Also, education and the use of technologies, [21] reports in his article that Web 2.0 provides a framework for education on the Web, allowing students to experience CI and creativity.

There is evidence in the literature that papers dealing with CI enable collaboration between groups, affecting all areas, especially education. Studies indicate that teachers and students are committed to CI. They can help to create, share and reuse new content or they can be consumers by displaying other content. Also, the use of software tools enhances the IC, both in the generation of knowledge and the administrative aspect of education.

3.1.2 Collective Intelligence and Technology

In research literature linking CI and technology investigations are published in the scientific literature, including one has to [22] proposed in their research a framework of CI based narrative reasoning and natural language processing. It exhibits a hybrid model that combines the Narrative Knowledge Representation Language (NKRL) and HARMS (Humans, software Agents, Robots, Machines and Sensors).

Other research includes the Web is to [23] reported project called "Open Geometry Textbook" whose objective was to develop a web-based platform to gain knowledge on the subject of geometry and create a textbook through CI involving Internet users. According to [24] Semantic Web aims to exchange structured information and formal knowledge to achieve CI on the Web. The Semantic Web enables the distribution of data and interconnection to provide information to users. It also allows the sharing of knowledge, collaboration and cooperation.

Technological systems with Web 2.0 evolve in e-learning and CI strengthens. In the investigation of [25] propose an adaptive learning system centered on the user based on the CI of users and employs item response theory. The results indicate that students are more satisfied and learn efficiently. In the publication of [26] reports the effects of application of information technologies and communication ICT from the perspective of the CI. They refer to the CI, as the exchange of information through specific tools.

Regarding to technological tools several are described in scientific databases, including [27] entitled "Aprendis: a tool for formal learning in Health Informatics", which aims to harness the CI of professionals, students, teachers, clients and institutions interested in the area of Health Informatics, specifically the Portuguese-speaking community.

Finally, [28] CI indicates that arises from the following: (1) data, information, knowledge; (2) software, hardware and (3) experts and stake-holders which produce knowledge through their input and feedback from them.

CI must rely on systems and software tools to develop new collective knowledge. Human and computer tools must be integrated into all domains of knowledge allowing the development of CI.

3.1.3 Collective Intelligence and Decision-Making

According to several authors, CI appears in a variety of forms of collective knowledge, and it is the result of consensus decision-making in different processes [29]. Investigation of [17] lets you collect diagnostic information Diagnosis Decision Support Systems methods based on consensus and CI, the objective of the research was to apply the CI to share medical knowledge and build a knowledge base on using consensus methods, achieving results make better medical diagnosis.

[28] research in the CI, creating an information system to support the Egyptian Academy of Scientific Research and Technology, in the Millennium Project The system organizes information from experts, scientists, leaders and the general public, aided by the software. It improves decision-making, civic participation and social cohesion.

According to [30] the objective of recommendation systems is to support the decision-making process of the user. They propose in their research use the CI and recommendation systems to improve decision-making.

The objective of recommendation systems is to support the decision-making process of the user. [30] propose in their research to use the CI and recommendation systems to improve decision-making.

Research in the area of CI is opening opportunities for research in the area of decision-making. The literature indicates the need to make quick decisions, to deal with this situation, it is better to use new models and tools incorporating IC.

4 Conclusions

Researchers can locate a variety of peer reviewed scientific documentation, taking the problem to handle a large wealth of information. To resolve this problem there are methods and techniques, for example the analysis of content [31].

Our study was conducted in articles published in high impact journals; the focus of our investigation was learning, technology and decision-making. We found that the CI is exhibit in works to enhance learning. The decisions of individuals and groups benefit from the use of technologies to process large amounts of information. We believe that the CI provides an alternative to the creation of knowledge, using technologies and helping decision making.

The choice of the analyses, which are more suitable for the data in this type of study, can be used for other researchers in future studies. The repetition of this type of research allows other scientists to be better informed and will keep people updated on trends on IC.

5 Limitations

The study has some limitations; the sample was obtained from literature search in four databases. This work could be extended by reviewing literature from other sources. Despite of the attempt of scientific rigor, some sources may have been lost during the sample analysis and the identification of issues and their classification is subjective, we recommend that further similar research on CI are made.

References

1. Gregg, F.: Developing a collective intelligence application for special education. Decis. Support Syst. **47**, 455–465 (2009)
2. Julien, H., Pecoskie, J., Reed, K.: Trends in information behavior research, 1999–2008: a content analysis. Libr. Inf. Sci. Res. **33**, 19–24 (2011)
3. Capó-Vicedo, J., Martínez-Fernández, M., Vallet-Bellmunt, T., Expósito-Langa, M.: Análisis de contenido de las Publicaciones sobre Clusters y Distritos Industriales en las Revistas Españolas de Económia. Investigaciones Europeas de Dirección y Economía de la Empresa **17**(2), 119–141 (2011). ISSN: 1135-2523
4. Krippendorff, K.: Content Analysis: An Introduction to Its Methodology. Sage Publication, New York (2004)
5. Kucuk, S., Aydemir, M., Yildirim, G., Arpacik, O., Goktas, Y.: Educational technology research trends in Turkey from 1990 to 2011. Comput. Educ. **68**, 42–50 (2013)
6. Sheu, F., Chen, N.: Taking a signal: a review of gesture-based computing research. Comput. Educ. **78**, 268–277 (2014)
7. Rourke, L., Szabo, M.: A content analysis of the “journal of distance education” 1986e2001. J. Distance Educ. **17**(1), 63–74 (2002)
8. Shih, M., Feng, J., Tsai, C.: Research and trends in the field of e-learning from 2001 to 2005: a content analysis of cognitive studies in selected journals. Comput. Educ. **51**(2), 955–967 (2008)
9. Tsai, C., Wen, L.: Research and trends in science education from 1998 to 2002: a content analysis of publication in selected journals. Int. J. Sci. Educ. **27**(1), 3–14 (2005)
10. Grimón, F.: Modelo para la gestión de dominios de contenido en sistemas hipermedia adaptativos aplicados a entornos de educación superior semipresencial. Tesis Doctoral Universidad Politécnica de Cataluña, España (2008)
11. Burla, L., Knierim, B., Barth, J., Liewald, K., Duetz, M., Abel, T.: From text to codings: intercoder reliability assessment in qualitative content analysis. Nurs. Res. **57**(2), 113–117 (2008)
12. Polit, D., Hungler, B.: Nursing Research: Principles and Methods, 6th edn. Lippincott, Philadelphia (1999)
13. Day, R.: Cómo escribir y publicar trabajos científicos. Tercera edición en español. Publicación Científica y Técnica No. 598 (2005). ISBN 92 75 31598 1

14. Zott, C., Amit, R., Massa, L.: The business model: recent developments and future research. J. Manag. **37**, 1019–1042 (2011)
15. Gómez, M.: Análisis de contenido cualitativo y cuantitativo: Definición, clasificación y metodología. Revista de Ciencias Humanas, 20 (2000)
16. Recker, M., Yuan, M., Ye, L.: Crowdteaching: supporting teaching as designing in collective intelligence communities. Int. Rev. Res. Open Distance Learn. **15**(4), 138–159 (2014)
17. Hernández-Chan, G., Rodríguez-González, A., Alor-Hernández, G., Gómez-Berbís, J., Mayer-Pujadas, M., Posada-Gómez, R.: Knowledge acquisition for medical diagnosis using collective intelligence. J. Med. Syst. **36**(Suppl 1), S5–S9 (2012)
18. Lykourentzou, I., Papadaki, K., Vergados, D., Polemi, D., Loumos, V.: CorpWiki: a self-regulating wiki to promote corporate collective intelligence through expert peer matching. Inf. Sci. **180**, 18–38 (2010)
19. Davidson, C.N.: 'Collective IQ', HASTAC (2010). http://www.hastac.org/blogs/cathy-davidson/collective-iq
20. Singletary, K.: Interdisciplinary intellect HASTAC and the commitment to encourage collective intelligence. Arts Humanit. High. Educ. **11**(1–2), 109–119 (2011)
21. Tsai, W., Li, W., Elston, J., Chen, Y.: Collaborative learning using wiki web sites for computer science undergraduate education: a case study. IEEE Trans. Educ. **54**(1), 114–124 (2011)
22. Ayari, N., Chibani, A., Amirat, Y., Matson, E.: A semantic approach for enhancing assistive services in ubiquitous robotics. Robot. Auton. Syst. **75**, 17–27 (2015)
23. Chen, X., Li, W., Luo, J., Wang, D.: Open geometry textbook: a case study of knowledge acquisition via collective intelligence. In: Jeuring, J., Campbell, J.A., Carette, J., Reis, G., Sojka, P., Wenzel, M., Sorge, V. (eds.) CICM 2012. LNCS (LNAI), vol. 7362, pp. 432–437. Springer, Heidelberg (2012). doi:10.1007/978-3-642-31374-5_31
24. Janik, M., Scherp, A., Staab, S.: The semantic web: collective intelligence on the web. Informatik Spektrum **34**(5), 469–483 (2011). Springer
25. Huang, S., Shiu, J.: A user-centric adaptive learning system for e-learning 2.0 a user-centric adaptive learning system for e-learning 2.0. Educ. Technol. Soc. **15**(3), 214–225 (2012)
26. Saba, M., De Rémurb, D., Gerbaix, S.: ICT implementation. Going beyond expectations? An essay of interpretation through competitive intelligence. Int. Strateg. Manage. Rev. **2**, 46–55 (2014)
27. Cruz-Correia, R.: AprendIS: a tool for (in)formal learning in health informatics. Procedia Technol. **16**, 1367–1373 (2014)
28. Glenn, J.: Collective intelligence and an application by the millennium project. Technol. Forecast. Soc. Chang. **97**(2015), 7–14 (2013)
29. Maleszka, M., Nguyen, N.: Integration computing and collective intelligence. Expert Syst. Appl. **42**, 332–340 (2015)
30. Perez-Gallardo, Y., Alor-Hernandez, G., Cortes-Robles, G.: Collective intelligence as mechanism of medical diagnosis: the iPixel approach. Expert Syst. Appl. **40**(2013), 2726–2737 (2013)
31. Fernández, F.: El análisis de contenido como ayuda metodológica para la investigación. Ciencias Sociales **96**, 35–53 (2002)

Student Track

Comparative Study of the Mobile Learning Architectures

Sameh Baccari[1,2](✉), Florence Mendes[1,2], Christophe Nicolle[1,2], Fayrouz Soualah-Alila[1,2], and Mahmoud Neji[1,2]

[1] MIRACL, University of Sfax, Sfax, Tunisia
sameh_baccari@yahoo.fr, {florence.mendes, fayrouz.soualah-alila}@checksem.fr, cnicolle@u-bourgogne.fr, Mahmoud.neji@fsegs.rnu.tn
[2] LE2I, UMR CNRS 6306, University of Bourgogne, Dijon, France

Abstract. With the emergence of mobile devices (Smart Phone, PDA, UMPC, game consoles, etc.), and the growth of offers and needs of a company under formation in motion, multiply the work to identify relevant new learning platforms to improve and facilitate the process of distance learning. The next stage of distance learning is naturally the port of e-learning to new mobile systems. This is called m-learning (mobile learning). Because of the mobility feature, m-learning courses have to be adapted dynamically to the learner's context. Several researches addressed this issue and implemented a mobile learning environment. In this paper, we compare a list of mobile learning architectures with methods presented in the literature. The evaluation presents a set of criteria specifically identified to qualify m-learning architectures dedicated to the context-change management.

Keywords: Mobile technology · E-Learning · M-learning · Context-change management · Learning method

1 Introduction

The introduction of mobility in a learning process induces new practices and uses which change the conception paradigm of a learning courses. This paradigm was implicitly based on the unity of place. With a mobile learning systems, the learner can continue his education out of a classroom, move during the learning process and changed place using a mobile device whether a Smartphone or a tablet. This mobility led to the appearance of a new paradigm where the learning process has to be dynamically adapted according to the change of the learner's context.

M-learning objects can take many forms, such as text, audio or video documents organized into comprehensive training programs adapted to mobile devices. While there are a large number of courses available on mobile devices, this type of training is still at an early stage. In fact, it is sometimes difficult to adapt of the mobile devices to the available contents in e-Learning. For instance, the problems to migrate e-learning training course to mobile learning systems are not only limited to technical issue, such as the limitation of screen size and the bandwidth, but also to the management of

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 191–200, 2017.
DOI: 10.1007/978-3-319-49625-2_23

change within the context and its impact on the training course. In addition, even if some contents, such as audio and video media course materials, are ideally suitable for mobile use, the existing systems are still unsatisfactory for the users' needs. Our goal is to identify how the existing mobile-learning methods resolve the technical heterogeneity and bridge the gap change management during the mobile learning process.

The remainder of this article is organized as follows: In Sect. 2, we give a brief definition of the mobile learning. The context and the opportunities of context-aware applications are described in more detail in Sect. 3. Then, in Sect. 4, some existing works in the literature are presented. Then, a comparison between the different architectures proposed in these works is made using a list of significant criteria. Finally, we end up our paper with a conclusion.

2 M-learning

M-learning is described by the use of mobile and wireless technologies allowing anyone to access information and learning materials at any time regardless of the place. Some approaches consider that mobile learning is simply an extension of the E-learning. However, they do not take into account the mobile device limitations, the particular circumstances of mobile learning and the added value of mobility, such as informal learning, learning on demand, in context, through contexts, etc. Mobile learning has been defined as the process of learning and teaching that occurs with the use of mobile devices providing flexible on-demand access (without time and device constraints) to educational resources, experts, peers and services from any place [1].

This evolution of learning can be characterized by the following changes: distance in e-learning and the consideration of mobility with m-learning and omnipresence with the ubiquity ubiquitous learning (ubiquitous learning, pervasive learning). These changes reflect the impact of computer technology, such as mobile and ubiquitous computing, on the learning process.

The shift from e-learning to mobile learning has given rise to much debate among researchers. For instance, Sharma noticed that the shift from e-learning to mobile learning is accompanied by a change in the terminology [2] as shown in Table 1.

Table 1. Comparison of e-learning terminology and m-learning (according to [3])

E-learning	M-learning
Computer	Mobile
Bandwidth	GPRS, 3G, Bluetooth
Multimedia	Objects
Interactive	Spontaneous
Hyperlinked	Connected
Distance learning	Situated learning
More formal	Informal
Simulated situation	Realistic situation
Hyper learning	Constructivism, situationism, collaborative

The main benefits of mobile learning for education and learning are reported as follows [4]: (a) it enables on-demand access to learning resources and services as well as instant delivery of notifications and reminders, (b) it offers new learning opportunities that extend beyond the traditional teacher-led activities and classroom-based ones, (c) it encourages learners to participate more actively in the learning process by engaging them to authentic and situated learning embedded in real-life context and (d) supports on-demand access, communication and exchange of knowledge with experts, peers and communities of practice.

The major difference between learning somewhere on a stationary desktop computer and learning with mobile devices is the context. In fact, mobile devices feature some functionality to capture some background information that can be helpful to personalize the learning experience. When considering mobility from the learner's point of view rather than the technology's, it is more important to say that m-learning is about people moving through environments, their learning as they go, using electronic devices that enables connectivity to information sources and communicating while they are able to change their physical location. In short, our new definition of mobile learning is "context-aware in mobile learning" which discussed in more detail in the next sections.

3 Context-Aware in Mobile Learning

In a mobile learning experience, each learner has to be treated in a different way according to the current situation in which he is learning, e.g. his pre-knowledge or the specifications of the device he is using. Those different conditions are called the context in which the learner is situated.

As mobility is related to mobile learning, mobile devices, capacity, connectivity, user and the environment can all change over time and place. That is to say the set of learning exchange or the learning context can change all the time. A mobile learning's challenge is to exploit applications that can dynamically adapt to different learning situations. M-learning makes learning across contexts: "mobile learning is not just about learning using mobile devices, intended learning across contexts" [5]. Here the focus is on how learners are formed through places and transitions between different contexts.

It should not be a break in learning between the face-and outside. Learning is based on the business continuity through space and time interacting with mobile and fixed technologies. Learning should not be limited to certain environments, but should increase the mobility of the learner through these. With the emergence and evolution of new mobile technologies, adaptation to context has become an indispensable nature of new computer systems for mobile use. It is therefore necessary in the case of an adaptation to the context in learning, determined by the context of the learner what content to send, how, on what tool, etc. The whole learning process has to adapt to these changes in context. On the other hand, learning through contexts requires a series of organized activities, that is to say that learning takes place in a particular context depends on those who were before. This requires that the system takes into account the history of learning to provide the learner with meaningful learning activities and thus to monitor its activities through contexts.

4 Previous Works

In this section, we will review the work existing in the literature by introducing representative approaches and mobile learning platforms. We are interested in the adaptation management which is a very important parameter in managing and customizing the learning resources to the learners. We will focus, also, on the context, which is a central core of all the mobile learning systems.

MOBILearn is a European research and development project which aims at exploring the use of mobile environments to foster informal learning, learning through problem solving and learning at work. As part of this project, a new architecture for mobile learning was constructed. It can help generate contents and services to accompany a learner during his learning activities in a gallery or a museum [6]. In this context, Learning is backed by a set of activities at the museums. Being placed in front of a painting, the visitors can, then, use a PDA or Smartphone to get the relevant information while observing the painting in order to learn. A learner visiting a museum, for the second time, can acquire information related to his previous visit.

E-Bag (virtual bag) is part of the iSchool project for nomadic and mobile learning [7] for which mobility and context are two key elements. Briefly, the iSchool project vision is used to develop a software infrastructure, graphical interfaces and spatial concepts in an interactive environment. The idea behind eBag is the creation of a “virtual school bag” for each student to help him learn through contexts by moving to specific locations (classrooms, laboratories, workshops, libraries, museums, cities, clubs and home). Therefore, the objective of the system is to serve as a “personal and digital warehouse” in which all the resources (texts, photos, videos, etc.) can be stored for internal and external use of the school environment.

The MoULe project (Mobile and Ubiquitous Learning) aims at allowing pupils to use mobile devices in order to build up collaborative knowledge and incorporate learning activities in the classroom and laboratory for situation learning. The MoULe is an environment that helps the users edit and share documents and concept maps using desktop computers and smart phones equipped with GPS. These tools enable students to collect textual content, images, videos and audio recordings while visiting an outside site during their learning activities. Besides, the system allows them to comment on the media they collect and classify it, so that their research and the re-use of the information in collaborative activities will be easier [8].

The mCALS project (mobile Context-aware and Adaptive Learning Schedule) is a context-aware mobile learning system developed for supporting Java programming learning. The goal of the system is to select appropriate learning objects for learners based on their current context and preferences. User context attributes include their location, and user preference attributes include their knowledge level for the topic (in this case Java) and their available time. The system is made up of three layers: Learner Model Layer, Adaptation Layer and Learning Objects (LO) Layer. Learner model layer collects, organizes and manages the learner’s context, which can characterize the learning situation for learning objects adaptation. Adaptation layer is in charge of selecting appropriate learning objects based on the learner’s current context with a series of adaptation mechanisms. Learning objects layer stores and manages learning objects in a learning object repository, with which learners are provided during their learning [9].

Nguyen Pham and Ho present CAMLES (Context-Aware Mobile Learning English System) to help students learn English as a foreign language to prepare them for TOEFL test by suggesting topics they need to learn on the basis of their test results. The test provides an adaptive content for different learners in context including location, time and the learner's knowledge. The system architecture of CAMLES includes three layers: Context Detection Layer, Database Layer and Adaptive Layer. The Context Detection Layer identifies the context factors such as location, time interval, manner of learning and learner's knowledge that impact selection of adapted learning contents for different learners. The Database Layer consists of context data, content data, the learner's profile and test. The Adaptive Layer includes an adaptive engine which selects learning contents according to the learner's learning context based on a set of if-then rules stored in the rules repository [10].

Chuantao YIN proposed the design for a contextual mobile learning system known as SAMCCO (French abbreviation for "contextual and collaborative mobile learning system for professional fields") [11]. It is based on EPSS (Electronic Performance Support System) whose goal is to group storage of technical, working and learning data in order to provide not only just-in-time and just enough training, but also information as well as tools and help mastering or repairing equipment, appliances or products disseminated in the smart city environment. This system is able to bring relevant information designed to maintain or ensure appropriate performance of smart city users whenever and wherever needed, thereby enhancing the performance of the industry and the company as a whole. EPSS is used to store and deliver plant reference materials including: training documents, operating procedures and historical maintenance information. SAMCCO edits and organizes learning contents stored in the EPSS information database, which is an essential professional learning resource offering abundant and well-structured learning contents.

In 2013, Soualah Alila et al. [12] proposed an approach for context-based adaptation for m-earning known as CAMLearn (Context-Aware Mobile Learning), making use of learning practices already deployed in e-learning systems and adopting them in m-learning. This system is built around an ontology that both defines the learning domain and supports context-awareness. The use of this ontology facilitates context acquisition and enables a standard-based learning object metadata annotation. It, also, uses a set of ontological rules to achieve personalized context-aware learning objects by exploiting knowledge embedded in the ontology. The future adaptive system will offer an optimized panel of learning objects matching with the learner's current context. CAMLearn consists of two parts: the first part consists of a knowledge server where data and business processes are modeled by evolutionary ontology and business rules, and the second part is based on metaheuristics algorithms allowing analyzing business rules and ontology to allow a good combination of learning content.

The UoLmP project (Units of Learning mobile Player) Project [13] is intended to present an adaptive, personalized and context sensitive mobile learning system which aims to support the semi-automatic adaptation of the learning activities. This is about the accommodations to: (a) the interconnection of the learning activities (i.e. the learning flow) and (b) the educational resources, tools and services that support the learning activities. The initial results of the assessment of the UoLmP use provide evidence that UoLmP can successfully be adapted to the learning flow of a pedagogical scenario and the provision of educational resources, tools and service that support the learning activities. This project includes three parts: capture/retrieval part, adaptation process part, and delivery/adjustment part. The Capture/retrieval part captures or senses the current situation properties for filtering learning contents, and detects current device capabilities for presenting the filtered contents polymorphically. The Adaptation process part executes the adaptation mechanisms, including the filtering mechanism and the polymorphic presentation mechanism, based on the IMS Learning Design Specification (IMS-LD). The Delivery/adjustment part delivers the adapted learning contents and learning activities to learners.

Some of them will, then, be analyzed in the mobile learning systems that have been performed to show the mobile learning features mentioned in the previous section.

5 Comparative Study

In this section, we give a comparative study of the different approaches and architectures of mobile learning that we have presented in the previous section.

This comparison is based on some significant criteria and features. We are particularly interested in:

1. *Device mobile support*: this is due to the fact that all the mobile devices used in the previous architectures are of personal/portable type (PDA, Smartphone, PC, Tablet, etc.).
2. *Heterogeneity support*: the various hardware sensors, actuators, mobile devices with powerful servers, various network interfaces and different programming languages must be supported.
3. *Protection of privacy act:* flows of contextual information between system components must be controlled according to the needs and requirements of protection of users' privacy.
4. *Learning as a collaborative process.*
5. *The integration of formal and informal learning*.
6. *Learning as a set of activities in context*: it is to foster mobile technology in specific contexts to help carry out learning activities.
7. *Learning context-aware:* it is to help shift the monitoring of learning activities from one context to another in a mobile environment.
8. *Adaptability:* components that treated the context and communication protocols must adapt sufficiently in systems with a variable number of sensors, triggers and application components.
9. *Traceability and control*: the conditions of the system components and the flow of information between the components must be open to inspection so as to provide the users with adequate understanding and a control system.

10. *Tolerance at chess*: sensors or other components can possibly fail in the ordinary operation of a system. Disconnections may also arrive. The system should continue operations without demanding excessive resources, and detect failures.
11. *Deployment and configuration:* the hardware and software of the system must be easily deployed and configured to meet the requirements of users or environments, even for non-experts.

The result of this comparison is presented in Table 2. This table summarizes the capabilities of these architectures of context-aware systems. In fact, we find that none of the presented architectures fulfills all the criteria required for the implementation of a system sensitive to the context. The architectures layers (CAMLES and mCALS) and architecture of MoULe can be considered as models for system designers, but they still lack solutions to support privacy and tolerance failures. It is the same for architecture of eBag, which in addition does not support heterogeneity and traceability. The architecture of MOBIlearn has not context management. Learning as a set of activities in context is more important in the case of projects CMLearn and UoLmP in the other. Collaborative learning is most developed in the SAMCCO project in terms of participants' roles, pedagogical intention (collaborative missions) and supports. SAMCCO is based on the AM-LOM (Appliance Mastering LOM) metadata that is an extension of the LOM (Learning Object Metadata) metadata. AM-LOM the use of educational resources for indexing will allow several semantic ambiguity problems of some elements of the LOM and interpretation problems. For this, in our work we propose to use ontology for indexing educational resources based on LOM will allow a better understanding of the elements and securities offered and consequently facilitate their descriptions.

Table 2. Comparative Study of the mobile learning architectures

Criterion	Approaches							
	MOBILearn	E-Bag	MoULe	mCALS	CAMLES	SAMCCO	CAMLearn	UoLmP
(1)	√	√	√	√	√	√	√	√
(2)	√	–	√	–	–	√	√	√
(3)	–	–	–	–	–	√	√	√
(4)	–	–	√	–	√	√	–	–
(5)	–	–	–	–	–	–	–	–
(6)	–	–	–	–	√	–	√	–
(7)	√	–	–	–	–	√	√	√
(8)	√	√	√	√	√	√	√	√
(9)	–	–	√	√	√	√	√	√
(10)	–	–	–	–	–	√	√	√
(11)	√	√	√	√	√	√	√	√

Most approaches do not enable the adaptation of the content to the learner's profiles. Context-aware approaches have the advantage of providing the user with the appropriate learning resources depending on the context. It is, therefore, essential to determine, depending on the context, how, when, and on which interface the resources should be sent. However, Learning Through contextualization is not easy to achieve.

In fact, the development of mobile technologies and the dynamics in the mobile environments have complicated the process of contextualization.

Today, mobile computing (user mobility, terminal mobility, and network mobility) is characterized by a permanent change in context (connected or disconnected, low or high bandwidth, change of location, widescreen or small screen, varying input devices, etc.). Thus, it has become very complex to consider many and various aspects when designing such application.

It is worth-noting that mobile learning is very important, particularly in education, and the major utilization of mobile devices is in the field of medicine. In fact, medical students are placed in hospital/clinical environment require in their training an access to course information while on the move. In addition, the work of the postgraduates and the physicians involves a high degree of mobility between distributed sites and instant communications within work environments. Distributed sites, where physicians are working and in which students are placed, are often in remote and rural areas. The technological advances can be capitalized to promote and facilitate situated learning and collaborative.

In fact, because of the considerable growth of data, the heterogeneity of roles and needs as well as the rapid development of mobile systems, it becomes important to introduce a new system able to provide the users with a pertinent training adapted to their needs. We seek to develop an m-learning system of which the main issues are: (i) learning seen as "a collaborative process" that connects learners to communities of people through situations. Learners are not formed by a single teacher but by a learning community. (ii) Learning seen as "a process context-aware", the learning process must adapt to these changes in context: consideration of context aware and adaptation. This implies that the apprenticeship system is able to explore the environment to determine the current context and conduct learning activities in a particular context. Also, it is adapting learning resources (content, services, etc.) select the proper way to perform according to the current context activities.

In our work, a learning system named CCMLS (Context-aware and Collaborative Mobile Learning System) has been proposed. This system requires a context-aware architecture with mechanism that considers the change within the context. This architecture must take into account the users' different characteristics as well as all the contextual situations that influence their behavior when interacting with the mobile learning system. This system allows to share, to build, to collaborate with others remotely via collaborative tools (wiki, chat, forum, blog, etc.) or social networks of Universities, of Hospitals, etc.

The learner is only recipient of knowledge provided by the trainer but it becomes actor of the learning platform. He is involved in their own learning and working with the trainer and other learners. Finally, he shares his knowledge and expertise. We talk about learning community. Furthermore, the objectives of CCMLS can be specified as follows:

- To take not only learning objects, but also knowledgeable people as learning resources.
- The information about a role and individual role members should be used to help a learner to find appropriate knowledgeable people: such people may be a domain

expert, teacher and even a co-learner when the learner needs to learn how to perform an activity.
- To integrate necessary communication tools.
- To classify the learning contents into learning objects, and to describe learning objects with metadata.
- To enable a learner to get the right learning objects at the right time.
- To enable a learner to contact the right people at the right time with the proper communication tool.
- To assist the learner to access the extensive knowledge artifacts' with which the learner could better understand the just learned knowledge or skills and also extend his learning area.

Through analysis of the relative work stated in previous section, three essential elements of a context-aware mobile learning system are: the context model, the learning units, and the adaptation engine with designed learning strategies. According to this structure, we state the overall architecture of the CCMLS system. This architecture consists of three layers: Learning Context Layer, Learning Adaptation Layer and Learning Application Layer. The context layer contains various physical and visual sensors to sense the learning context values defined in the context model. The goal of the Learning Adaptation Layer is to provide appropriate learning supports, including learning objects, learning community and learning activities, in relation with the current learning context. The learning application layer is in charge of interacting with learners, such as: collecting their information and requirements, displaying to them the adaptive learning objects, building the appropriate communication platforms between them and the selected learning community, helping them to complete proper learning activities, etc.

To realize and validate our proposals, a prototype of the system has been developed to facilitate the management of reusability and discovery of resources and services to deal with a dynamic environment. This prototype implemented with the PHP, Java, Jena, OWL, XML and MySQL technologies, using the development and running tools Eclipse, JDK, Protégé.

6 Conclusions

In this article, we have presented and compared the list of mobile learning architectures according to a set of features. All the presented architectures are not able to detect the mobile learning environment or to get information about it. Therefore, they cannot be adapted. Our work is an extension of one of the presented m-learning approaches in which we propose the context management, the adaptation and the learning without a break through contexts. Our goal is to design a mobile learning architecture that supports the features of mobility and context in order to enhance the learning experience in the field of education, specifically in medical field.

References

1. Sharples, M., Roschelle, J.: Guest editorial: special issue on mobile and ubiquitous technologies for learning. IEEE Trans. Learn. Technol. **3**(1), 4–5 (2010)
2. Sharma, S.K., Kitchens, F.L.: Web services architecture for M-Learning. Electron. J. eLearning **2**(1), 203–216 (2004)
3. Laouris, Y.: We need an educationally relevant definition of mobile learning. In: 4th World Conference on mLearning, MLearn2005, Cape Town, South Africa (2005)
4. Lam, J., Yau, J., Cheung, S.K.S.: A review of mobile learning in the mobile age. In: Tsang, P., Cheung, S.K.S., Lee, V.S.K., Huang, R. (eds.) ICHL 2010. LNCS, vol. 6248, pp. 306–315. Springer, Heidelberg (2010). doi:10.1007/978-3-642-14657-2_28
5. Sharples, M.: How can we address the conflicts between personal informal learning and traditional classroom education? In: Big Issues in Mobile Learning, Report of a Workshop by the Kaleidoscope Network of Excellence. Mobile Learning Initiative, pp. 21–24. University of Nottingham (2006)
6. Lonsdale, P., Beale, R.: Towards a dynamic process model of context. In: Proceedings of Ubicomp 2004 Workshop on Advanced Context Modeling, Reasoning and Manage (2004, to appear)
7. Brodersen, C., Christensen, B.G., Gronboek, K., Dindler, C., Sundararajah, B.: eBag: a ubiquitous web infrastructure for nomadic learning. In: Paper Presented at the Proceedings of the 14th International Conference on World Wide Web (2005)
8. Arrigo, M., Giuseppe, O.D., Fulantelli, G., Gentile, M., Novara, G., Seta, L., et al.: A collaborative M-Learning environment. In: Paper Presented at the 6th Annual International Conference on Mobile Learning, Melbourne, Australia (2007)
9. Yau, J.K., Joy, M.S.: A self-regulated learning approach: a mobile context-aware and adaptive learning schedule (mCALS) tool. Int. J. Interact. Mob. Technol. **2**(3), 52–57 (2008)
10. Nguyen, V.A., Pham, V.C., Ho, S.D.: A context - aware mobile learning adaptive system for supporting foreigner learning english. In: 2010 IEEE RIVF International Conference on Computing and Communication Technologies, Research, Innovation, and Vision for the Future (RIVF), pp 1–6 (2010)
11. Yin, C.: SAMCCO: a system of contextual and collaborative mobile learning in the professional situations (in French), Thesis of Ecole Centrale de Lyon, Computer Science Department, 25 January 2010
12. SoualahAlila, F., Mendes, F., Nicolle, C.: A context-based adaptation in mobile learning. In: IEEE Computer Society Technical Committee on Learning Technology (TCLT), vol. 15, no. 4, 5 p (2013)
13. Gómez, S., Zervas, P., Sampson, D., Fabregat, R.: Context-aware adaptive and personalized mobile learning delivery supported by UoLmP. J. King Saud Univ. – Comput. Inf. Sci. **26**, 47–61 (2014)

Social Microlearning Motivates Learners to Pursue Higher-Level Cognitive Objectives

Bernhard Göschlberger[1,2](✉)

[1] Research Studios Austria FG, Linz, Austria
bernhard.goeschlberger@researchstudio.at
[2] Johannes Kepler University, Linz, Austria

Abstract. With the advent of the smart phone, technology enhanced learning ultimately became mobile. The combination of small devices and ubiquitous availability promoted a certain type of informal learning called microlearning. Unfortunately, micro-learners tend to focus on the lower level cognitive objectives remembering and understanding. Social microlearning seeks to engage the learners in activities of higher cognitive levels – such as analyzing, evaluating and creating – by using successful strategies of social software. Early results confirm the assumption that learners' activities evolve towards higher cognitive levels over time spent on a particular subject in a social microlearning environment. Consequently, social micro-learners gain deeper insights by progressing through an upwards spiral of competence development.

Keywords: Microlearning · Social learning · Question posing

1 Introduction

Microlearning focuses on short-term and informal learning activities using small, but self-explanatory learning resources [1] that are available on the Internet and often accessible through a single definitive URL or permalink [2]. Micro-learners are often driven by a particular knowledge gap they want to close immediately [3]. Therefore they tend to consume information on a factual level and solely for the sake of remembering. Microlearning implementations often use learning activities similar to flash cards (e.g. Mobler Cards [4, 5], KnowledgePulse [6]) as they provide a good format for compressed factual knowledge. In Bloom's revised taxonomy [7] the act of learning a flash card (in drill mode) is an act of remembering. To promote understanding - a higher-level learning objective - the aforementioned microlearning implementations advanced the traditional flash cards enriching them with explanation, insight and/or feedback. Further, they implement a variety of features aimed at engaging students in higher order cognitive tasks such as reflection, self-regulation, content evaluation and content creation. However, there is a significant gap between remembering factual knowledge and creating new knowledge. In order to evaluate and create learning content the learner already needs a good understanding of the subject. It is a challenge for microlearning systems to accompany a learner's progress throughout the different cognitive levels of educational objectives. The micro-learner's immediate need to fill a knowledge gap (cf. [3]) might be sufficiently served, the moment he or she

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 201–208, 2017.
DOI: 10.1007/978-3-319-49625-2_24

remembers the specific facts. Therefore the system must be designed in a way to attract further interaction and ultimately leading to a deeper insight. Based on findings in related work described in Sect. 2 and Baumgartner's learning model described in Sect. 3 we will argue that characteristics and strategies of social software – described in Sect. 4 – can attract micro-learners to pursue higher-level cognitive learning objectives. In Sect. 5 we describe a first empirical evaluation and the results, before we conclude and outline intended future work.

2 Related Work

The pedagogical value of encouraging students to contribute educational resources via online systems has been demonstrated by many researchers. Several systems with a focus on online question posing or assessment item creation have been presented. Among the first systems was QSIA (Questions Sharing and Interactive Assignments) [8], which aimed to merge assessment and knowledge sharing (by recommendation). In experimental settings students had to take self-assessment followed by peer assessment and finally achievement assessment. Thus students should be led to reflection and deeper learning. The researchers found a statistical significant correlation between students' contribution quality and their exam grades.

Another approach was the QPPA (Question Posing and Peer Assessment) [9] system. It provided question-posing, peer-assessment, item-viewing, and drill-exercise capabilities. The research mainly focused on the difficulty of question posing for different subjects in higher grades of elementary school, but also showed that the task of posing questions promoted students' cognitive ability and motivation.

PeerWise is arguably the system providing the most empirical evidence on the effects of having students create and share their own assessment questions [10, 11]. The results of a study on 854 students during the academic year session 2011/12 across subjects showed a significant correlation between PeerWise activities and final exam grades. Although, providing evidence for the effectiveness of the pedagogical approach, it has to be noted, that PeerWise is designed for formal settings. Students log into a course specific space and are formally constrained to the topic.

All of the aforementioned systems have a narrow focus on multiple-choice questions and assessment items. Conversely Concerto II [12, 13] and Concerto III [14] allow additional types of questions. Their results support that students contributing questions perform better at exams and that the quality of the contributions is also positively correlated to exam scores. Another interesting finding is that students claim to be more motivated using the online question-posing system.

In recent work (unpublished) Karataev and Zadorozhny presented the SALT-framework [15]. Their work focuses on crowdsourcing of lesslets. A lesslet is a mini-lesson, constrained to a certain form and could well be considered as a certain type of micro-content. The focus on crowdsourcing by nature implies informal learning scenarios and therefore a close relation to our work. However, the research focus is clearly on crowdsourcing and scalability issues as (1) how to group/cluster students, (2) ideal learning pathways of individuals and groups, and (3) content recommendation using collaborative filtering.

All of the presented related research is driven by the intention to engage students in more metacognitive work and deeper and into a richer learning experience. Even though Bloom's cognitive domain model influenced all mentioned works, each one has a slightly different view on the learning process. The following section presents the educational model our social microlearning approach is based on.

3 Learning Model

The underlying learning model for this work is derived from Baumgartner's model of a micro-learner [16]. Whilst other authors (e.g. [1, 6]) focused on the use of microlearning principles for formal learning and its didactics, Baumgartner's Model focusses on informal learning and the learners themselves. It has evolved from his earlier work on a teaching model that focuses on the students competence development in a certain subject or topic [17]. He argues that the role of the teacher transforms as the students competences develop. According to Baumgartner a teacher initially needs to transfer factual-knowledge (Teaching I). Subsequently students may apply the transferred knowledge and the teacher's role changes to tutoring (Teaching II). The teacher can continuously reduce guidance and the teaching process becomes an act of cooperation between students and teacher (Teaching III). In the context of microlearning Baumgartner adapts his model and describes the perspective of an informal learner. He argues that a student has to absorb basic knowledge about a topic or subject in a first step (Learning I), before being able to actively acquire knowledge about that topic in a self-determined manner (Learning II) and finally being able to construct knowledge in a third step (Learning III). With the learner continuing to learn more advanced concepts this process is repeated on a higher level (Learning I+) – leading to an upwards competence spiral. Baumgartner remarks relations between Learning I and behaviorism, Learning II and cognitivism, and Learning III and constructivism.

Whereas typical microlearning systems have proven valuable especially in the Learning I phase, the key challenge social microlearning tries to address is to motivate students to enter the following phases. Each phase demands different levels of guidance and requires the learning system to play a different role. The system needs to adapt accordingly and act like the teacher described in Baumgartner's earlier model. Learning I requires the software to provide strict guidance and reduce complexity by limiting the degree of freedom. In Learning II phase the learner takes control over his learning process. The system should enable the user to freely navigate through and choose learning resources. Guidance is reduced to recommendation. Learning III phase includes the construction of new knowledge. Therefore the system needs to support students to contribute, evaluate and discuss. The following section will focus on strategies and features of social software and derive a key set of functionality social microlearning systems need to address students' needs throughout all three phases, and therefore remains attractive to micro-learners beyond the objective to remember factual knowledge.

4 Social Software for Microlearning

The evolution of the Internet towards a space of more democratic information exchange has ultimately led to its society-changing success. The term social web has been coined to reflect the social nature of the process of creating and sharing information resources on the web. Accordingly the term social software describes software that enables groups to form and self-organize in a bottom-up manner and typical functionalities have been identified (cf. [18, 19]):

- Support for conversational interaction between individuals or groups
- Support for social feedback
- Support for social networks

Wikis and Weblogs were first popular types of social software and are still very commonplace. However, as of today social network sites (SNS) are the predominant form of social software on the web. Two success factors for SNS are the simplicity and immediate graspability of its content artifacts. Twitter – considering itself as micro-blogging service earlier – became more popular than any other blogging service as it restricted its content artifacts to 140 characters. This restriction reduced the cognitive load per artifact for both creators and consumers and lowers the barrier to initiate social interaction. On the other hand it also enables the consumers to quickly decide whether content is relevant to them. Similarly, Facebook only views the first view lines of a post in the timeline, forcing posters to indicate the essence of their post in the first lines in order to arouse a reader's interest. Hence, micro-content artifacts as understood by microlearning are especially suited for SNS or social online learning environments.

A social microlearning system has to follow the premises for microlearning. It has to be available on the Web, optimized for mobile devices and should support the different phases of learning model. Therefore it has to at least enable learners to:

1. interact with and solve learning activities
2. tag, collect, evaluate, rate, comment and improve content
3. create and share content

4.1 Interact and Solve

Learners in Learning I phase try to remember and understand the factual knowledge they are provided with. They interact with the provided micro-content. In the case of multiple-choice questions, for example, this would mean to check and uncheck options. Once they decided on an answer they can submit and resolve. Learners in Learning I phase need to be able to repeat and practice a particular activity. Learners in Learning II or Learning III phase interact with and solve learning activities differently. Rather than repeating the activity to remember factual knowledge, they reflect, analyze and evaluate the activity and hence the content. They are more likely to tag, collect, evaluate, rate, comment and improve the content subsequently.

4.2 Tag, Collect, Evaluate, Rate and Comment

Learners in Learning II phase are able to organize content as they have the ability to understand the basic principles and structure inherent to the topic. To organize existing learning content relevant to them, they tag items or add them to their collections. In Learning II, learners are also able to compare and evaluate content and hence provide content ratings or express their thoughts on particular content items by commenting. As comments themselves are content it should be possible to rate them as well.

4.3 Create, Share and Improve

Learners in Learning III phase create and share micro learning content. They synthesize their acquired knowledge into new variations of that knowledge. If challenged, they will justify their point of view through commenting. They will engage in debates and edit and improve shared content. As in most social software a version history should be provided to document the evolution of content.

5 Experimental Setting and Results

Based on the criteria outlined above a social microlearning platform has been implemented (described in [20]). To verify the underlying educational model a cohort of 100 students was asked to use the system accompanying a specific university course. The course consisted of five distinct topics covered during the semester. The topics were covered sequentially in the course.

Our hypotheses were that (1) students would progress through the learning phases (Learning I, Learning II, and Learning III) for each topic, and that (2) in each learning phase students prefer the associated type of activity. The students were not instructed how they were expected to use the system, but were able to earn bonus points for their final exam for actively using the system. Activity was assigned to the course topics and students were able to earn up to three bonus points per topic. The exam itself totaled 100 points. The actions outlined in the previous section were logged using xAPI and analyzed for patterns of evolution in the students' types of activities over time per topic. To provide content students could interact with, the instructor created initial learning cards at the beginning of the experiment.

The data was investigated in two ways: (a) by thorough statistical analysis of the tracked interaction data and (b) by analyzing the textual content items and comments. The statistical analysis so far supports the learning model presented in Sect. 3 as we found the following patterns:

- most students started with activities associated with Learning I (interacting with existing content)
- first movers contributed content for new topics right away
- after about two weeks of interaction, other students contributed content themselves
- although the bonus points were already awarded, the highest activity was tracked in the last days before the exam

Figure 1 illustrates the found patterns. It highlights the timespan of two weeks between contributions of first movers and other students for the modules “mediatype text” and “multimedia systems”.

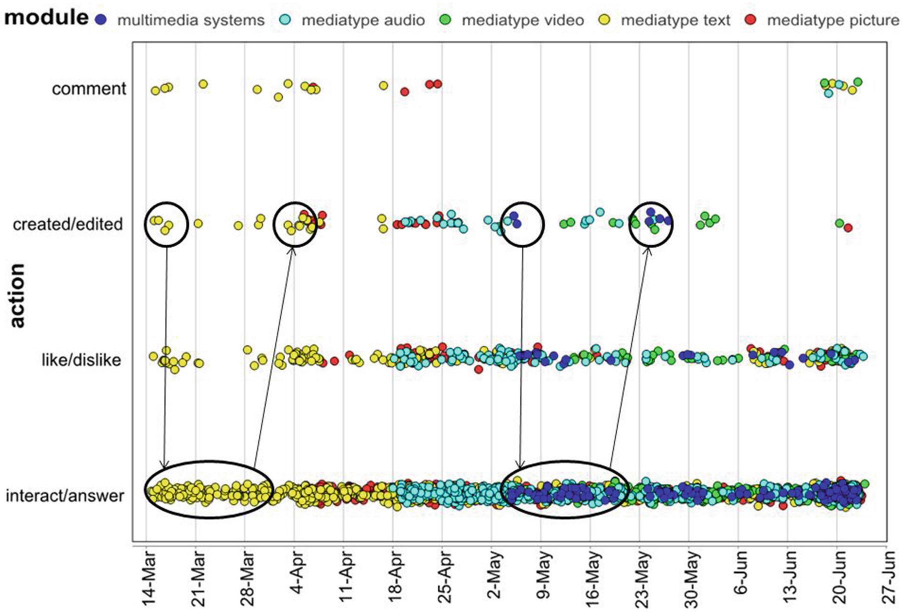


Fig. 1. Student activities. Reoccurring pattern: First movers create content. Majority of students consumes content for two weeks before contributing content themselves.

The analysis of the textual content showed that students were demonstrating clear signs of critical analysis and reflection, such as discussions on the correctness of content or inquiries about content improvement directed at the content creator. Linking these findings with the statistical data we found that especially students who had interacted with content of the specific module prior showed these signs of higher order cognitive thinking.

6 Conclusions and Future Work

The experiment demonstrated that patterns of the competence development spiral can be identified throughout all topics. The results of our analysis supports our hypotheses, as clear signs of Learning III appeared towards the end of each topic and were preceded by tasks that are related to Learning I. However, the current prototype provided no appropriate way to organize content. The tagging-feature was hardly used and therefore Learning II could not be observed as desired.

We plan to report on the students' exam performances in relation to this experiment in future work. As related research suggests we expect that (1) students using the system will outperform students not using the system, and that (2) students that showed signs of Learning II and Learning III will outperform other students.

Future work will have to incorporate further strategies of social software such as reputation management, recommendation or information filtering. The Concerto II-research showed that students' motivation to use a system and the amount of contribution can be improved enormously by considering user feedback. Therefore we will survey students about their experience and potential improvements and adjust our development priorities accordingly.

Acknowledgements. This research is part of a PhD project, funded by the Austrian Funding Agency (FFG) as part of the Industrial PhD Programme. The project started in July 2015 and will be completed by December 2017.

References

1. Hug, T.: Micro learning and narration: exploring possibilities of utilization of narrations and storytelling for the design of "micro units" and didactical micro-learning arrangements. In: Proceedings of Media in Transition (2005)
2. Buchem, I., Hamelmann, H.: Microlearning: a strategy for ongoing professional development. eLearning Pap. **21**(7) (2010)
3. Kovachev, D., Cao, Y., Klamma, R., Jarke, M.: Learn-as-you-go: new ways of cloud-based micro-learning for the mobile web. In: Leung, H., Popescu, E., Cao, Y., Lau, R.W.H., Nejdl, W. (eds.) ICWL 2011. LNCS, vol. 7048, pp. 51–61. Springer, Heidelberg (2011). doi:10.1007/978-3-642-25813-8_6
4. Glahn, C.: Supporting learner mobility in SCORM-compliant learning environments with ISN mobler cards. Connections Q. J. **12**(1) (2012)
5. Glahn, C.: Using the adl experience api for mobile learning, sensing, informing, encouraging, orchestrating. In: 2013 Seventh International Conference on Next Generation Mobile Apps, Services and Technologies (NGMAST). IEEE (2013)
6. Bruck, P.A., Motiwalla, L., Foerster, F.: Mobile learning with micro-content: a framework and evaluation. In: Bled eConference, 25th Bled eConference eDependability: Reliable and Trustworthy eStructures, eProcesses, eOperations and eServices for the Future, pp. 17–20 (2012)
7. Anderson, L.W., Krathwohl, D.R., Bloom, B.S.: A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives. Longman, New York (2001)
8. Barak, M., Rafaeli, S.: On-line question-posing and peer-assessment as means for web-based knowledge sharing in learning. Int. J. Hum Comput Stud. **61**(1), 84–103 (2004)
9. Yu, F.Y., Liu, Y.H., Chan, T.W.: A web-based learning system for question-posing and peer assessment. Innovations Educ. Teach. Int. **42**(4), 337–348 (2005)
10. Denny, P., Luxton-Reilly, A., Hamer, J.: The PeerWise system of student contributed assessment questions. In: Proceedings of the Tenth Conference on Australasian Computing Education, vol. 78. Australian Computer Society, Inc. (2008)
11. Hardy, J., et al.: Student-generated content: enhancing learning through sharing multiple-choice questions. Int. J. Sci. Educ. **36**(13), 2180–2194 (2014)

12. Hazeyama, A., Hirai, Y.: Concerto II: a collaborative learning support system based on question posing (2009)
13. Hazeyama, A., Hirai, Y.: Concerto ii: a learning community support system based on question-posing. In: Seventh IEEE International Conference on Advanced Learning Technologies, ICALT 2007. IEEE (2007)
14. Hirai, Y., Hazeyama, A., Inoue, T.: Assessment of learning in concerto III: a collaborative learning support system based on question-posing. In: Proceedings of Computers and Advanced Technology in Education, Calgary, Canada, pp. 36–43. ACTA Press (2009)
15. Karataev, E., Zadorozhny, V.: Adaptive social learning based on crowdsourcing. IEEE Trans. Learn. Technol. **PP**(99), 1 (2016)
16. Baumgartner, P.: Educational dimensions of microlearning–towards a taxonomy for microlearning. In: Designing Microlearning Experiences–Building Up Knowledge in Organisations and Companies. Innsbruck University Press, Innsbruck (2013)
17. Baumgartner, P.: The zen art of teaching-communication and interactions in eEducation. In: Proceedings of the International Workshop ICL2004, Villach/Austria (2004)
18. Ziovas, S., Grigoriadou, M., Samarakou, M.: Supporting Learning in Online Communities With Social Software: An Overview of Community Driven Technologies. INTECH Open Access Publisher, Rijeka (2009)
19. Boyd, S.: Are you ready for social software? Darwin Magazine (2003)
20. Göschlberger, B.: A platform for social microlearning. In: Verbert, K., Sharples, M., Klobučar, T. (eds.) EC-TEL 2016. LNCS, vol. 9891, pp. 513–516. Springer, Heidelberg (2016). doi:10.1007/978-3-319-45153-4_52

Strategy Simulation Games: The Student Perspective and an Investigation of Employability Competencies Gained Through the Use of Strategy Simulations in Higher Education

Anne Crowley[1(✉)], Margaret Farren[2], and Gearóid Ó. Súilleabháin[3]

[1] Department of Organisation and Professional Development, Cork Institute of Technology, Cork, Ireland
anne.crowley@cit.ie
[2] School of Education Studies, Dublin City University, Dublin, Ireland
margaret.farren@dcu.ie
[3] Department of Technology Enhanced Learning, Cork Institute of Technology, Cork, Ireland
gearoid.osuilleabhain@cit.ie

Abstract. The use of business simulations continues to grow in higher education business schools. The perspective of a key stakeholder, the student, is presented in this paper. A key to student buy-in is evidence of the competencies acquired through the use of simulations. The Higher Education institutions, the lecturers, the students and the future employers are all seeking enhanced student employability competencies; a demonstrable link between the use of simulations and key employability competencies would present a win for all stakeholders. The second phase of research presented is the students view on employability competencies currently achieved via a case study assessment. Finally this paper presents a high level overview of the proposed research to assess if the use of a strategy simulation in the teaching of strategic management enhances student employability competencies.

Keywords: Strategy simulation · Business simulation · Simulation game · Serious game · Employability competencies · Strategic management

1 Introduction

The current generation of students in our higher education institutions have grown up with the widespread use of technology in their classrooms. These digital natives, through their use of games and technology have developed a more visual, interactive and problem solving learning style to previous generations [1]. One might therefore assume that these students will welcome the use of technology in their teaching and assessment, however it is only by asking that we will really understand their views. It is only through an understanding of their perspectives and addressing their concerns that the commitment of these important stakeholders will be achieved.

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 209–221, 2017.
DOI: 10.1007/978-3-319-49625-2_25

Since the earliest use of simulation in higher education in the 1950s adoption of business simulation has grown significantly in recent years [2, 3]. When a new technology or teaching format is introduced to the classroom, there are many stakeholders; including the teacher, the institution and the student. The students' perspective of the use of strategy simulations is presented in this paper.

The importance of graduate employability skills are discussed throughout academia around the world as well as in the UK [4, p. 262, 5, p. 3]. The Irish Higher Education Authority is also part of this discussion and in their 2012 pilot study identified the concerns of future employers regarding these employability skills, particularly in our business and humanities graduates [6]. These findings are supported by the research of the Association of Higher Education Careers Services in Ireland, which recommends the inclusion of a module addressing these skills in all undergraduate programmes [7].

Our graduates will search for jobs and evidence of employability competences is an important part of the employers selection process [8]. Higher level education institutions therefore need to define these competences and if indeed these skills can be taught and learnt, then institutions need to develop undergraduate and postgraduate programmes that enable their students to acquire these skills. Identification of these employability skills is not straight-forward, mainly due to the many and varied definitions [9–11]. Whilst the definitions vary and often consider the term from the viewpoints of the different stakeholders, student, employer and higher level institution there are common themes across all definitions. Knight and Yorke's [12] definition reflects these common themes, with a broad definition of employability as:

> "a set of achievements, understandings and personal attributes that make individuals more likely to gain employment and be successful in their chosen occupations."

This paper presents the students' perspective on Strategy Simulations in higher education, in particular the concerns raised by students relating to the use of simulation in the teaching of a strategic management module. Further research is then presented of the students view on competencies gained via the current traditional case study assessment. Finally, this paper proposes a research design to understand the benefits of using strategy simulations with a particular focus on the student employability competences that may be enhanced through the use of Strategy Simulations in the teaching of Strategic Management.

2 Literature Review

The key types of value delivered by a business school are given by Hay as: the academic value delivered through research and dissemination; the personal value achieved through knowledge, skill and the foundations of a successful future career and thirdly, the social contribution delivered through graduates and alumni contributing positively to their communities [13]. Employability skills are part of each of these three types of value creation. The role of the business school has long been questioned and challenged. In their 1984 article in the Harvard Business Review, Behrman and Levin [14] listed criticisms of business schools including: the over reliance on imparting theory; the lack of a long term perspective; emphasis on quantitative rather than qualitative factors; emphasis on traditional management rather than entrepreneurial management; lack of attention to interpersonal relationships and risk adverse behaviour. It is clear therefore that in order to remain relevant schools of business need to continually assess the skills and competencies of the graduates they are creating.

Strategic Management is often the capstone module on degree programmes from business schools, however the difficulty teaching and assessing this module is under researched [15]. The teaching of strategic management, based on delivering theory through lectures, can develop an understanding of strategic management concepts, but it does not demonstrate the complexities of strategic decisions in the real world. Students taught in this way, are unable to see the impact of decisions across the functions of the organisation and the complexities of the decisions necessary to implement strategy in an organization [16].

A long recognised method of dealing with the complexity of strategic management theory and the importance of putting the theory in context is the discussion and understanding of case studies. Since its introduction in Harvard at the start of the last century; the case study has become an essential part of business school teaching across the globe [17]. The case study method has always had its detractors including those from within Harvard itself [18]. The fast changing business environment of today has brought renewed criticism of the static and historical nature of traditional case studies [19]. Current lecturers of strategic management are looking for solutions that allow students apply the theory, but also allow adjustment to reflect changing business environments. Technology advances have enabled the development of business simulations that can achieve this and institutions have been implementing business simulation teaching methods in increasing numbers [20]. Similar to how the case study approach was often central to the definition of an institutions educational practice [21]; institutions are now looking to incorporate business simulations into their teaching methods.

In recent years business simulations have been used in educational environments to give students participative interactive and applied environments in which to learn. In the discussion of games and simulations in education, authors use different terms and definitions. For the purpose of this paper and research, the term business simulation will be used with the definition of simulation as presented by Thavikulwat [22] that "a simulation is an exercise involving reality of function in an artificial environment, a case study but with the participants inside".

It is clear that all higher education institutions exist in order to assist students learn, however to define student learning is in itself an elusive concept based on the underlying pedagogical theories [23]. The characteristics of deep and surface approaches to learning are much researched [24–26]. Experience based or experiential learning is suggested as one of the elements that encourages students to critically analyse and link learning, to ensure better understanding and retention of the material. Although detractors of experiential learning are acknowledged, the wealth of research in support of this learning model lends weight to its validity as a method of creating behaviour, attitudinal and knowledge change. Keys & Wolfe [27, p. 4] outline how the rise in experienced based learning, which occurred in the middle of the last century, contributed to the growth of the business simulation movement.

Experiential learning theory stresses the importance of direct experience and reflective observation. Simulations support this model as they are experiential exercises allowing students to interact with a knowledge domain [28, p. 522]. Business Simulations require students to understand and interpret information in order to make decisions. The consequences of these decisions are then communicated to the students and further decisions are then required – forcing students to live with the consequences of prior decisions [24, p. 24].

There is research which challenges the effectiveness of simulations [2, 29], however there is also much research demonstrating their effectiveness [27]. This research proposes to investigate the perceptions of the students, one of the key stakeholders in the strategic management classroom and to design further research into whether the use of strategy simulations enhances a student's employability competences.

3 The Research

The research for this study was conducted in three independent phases with connected themes:

1. The first phase consisted of a survey and group interview with final year higher education business students to understand their perspectives of the use of strategy simulations in the teaching of strategic management. This research is complete and a summary of the results are presented here.
2. The second phase was a survey of strategic management students to assess their view of the employability skills gained through the traditional strategic management case study assessment method.
3. The final phase of this research is still under design and proposes to assess the students employability competencies gained through a mixed method research study incorporating delivery of a strategic management module using a strategy simulation.

3.1 Phase One: Understanding Student Perspectives of the Use of Business Simulation in the Teaching of Strategic Management

A sample of full-time and part-time students in their final year of study at a higher education institution in Ireland was surveyed to identify their views on the possibility of using strategy simulations in the teaching and assessing of a strategic management module. The key characteristics of business simulations were identified following an extensive literature review and the students were surveyed on their opinions of simulations. Excluding the demographic questions, the questionnaire comprised of seven structured questions using Likert scales and other structured formats as well as three unstructured questions to generate some qualitative data. The questionnaire was prepared using Google Forms and was distributed via e-mail, it is attached as Appendix 1.

The survey data was analysed and a number of discussion themes were identified, such as, findings from the survey that contradicted the literature or findings that would benefit from further detail. The group interview volunteers were given ground rules and introduced to a simulation and were then guided to the discussion themes. The interview contributed a more in-depth understanding of the students views on the themes identified from the survey.

The research discovered that while the students recognised many of the benefits associated with business simulations and are open to the simulation experience, they had reservations in relation to the adoption of simulations in the teaching of strategic management. These reservations can be categorised under a number of headings:

Student Concerns Regarding a New Learning Environment. Students are familiar with the traditional lecture and exams and as a result they know what to expect. Despite students' recognition of the benefits of business simulations coming from both the questionnaire and interview findings, students are still slow to undertake a new mode of learning.

Students recognise the limitations of exams and all participants in the group interview conceded that they do better in continuous assessment assignments than exams, however when faced with a new or unknown method of assessment, the tried and trusted methods are preferred, particularly in final year.

It is necessary therefore to reassure these students of the benefits of business simulations as well as allay their fears toward the new format. This could be achieved by demonstration and exposure to the format in earlier years of their degree programme where the stakes are somewhat lower. Additionally trial/low stakes assessments can be conducted to introduce the concepts.

Student Concerns Regarding Group Work. On joining the workforce all students will need to work in teams, very few will find a career that sees them work independently without the need to co-ordinate and communicate with others. Educators have a duty to prepare graduates for the rigours of the workplace which includes the skills necessary for working in teams [30].

It follows therefore that the success of group work should not be left to chance. Davies [31, p. 564] clearly outlines the numerous benefits of group work and whilst recognising the problems with group work recommendations on setting up and implementing groups include: consideration of the purpose of the group work, allocation of sufficient time to allow groups socialise, support for students in creating ground rules and team contracts along with proposed assessment mechanisms that support constructive contributions to the work of the team and the identification of team members that are not contributing.

It is only in the context of these supports for group work that a strategy simulation could be introduced. If the problems of group work are ignored the simulation will suffer therefore adequate attention should be paid to how groups will be supported and developed through the simulation process.

Student Concerns on the Time Consuming Nature of Business Simulations. The most common concern raised by students in the interview and questionnaire was related to the possible time consuming nature of business simulations. This concern can be addressed by incorporating the business simulations into the existing strategic management modules and replacing existing assessments so that the business simulation does not add to assessment workload. This would also be supporting the principles of assessment for learning as outlined by Race [32]. By using the assessment to drive the student learning the time invested in the simulation would be seen to give the student a return on their investment.

Additionally the time needed to familiarise students with the simulation and the time to prepare and run the simulation should be designed into class time and tutorial time. The students will then benefit from the learning without seeing increased demands on their time; this will go further to address their concerns.

Students also need to be shown that the effort is worthwhile. Clarke [33, p. 450] summarises the learning outcomes and transferrable skills attained from business simulation based on previous studies. These transferrable skills will be of interest to potential employers. The important step is for the higher education institution and its graduates to market these skills and thereby generate an interest from potential employers. If the transferrable and professional skills developed by the business simulation are valued by potential employers this will convince students that it is worth the associated effort.

Before investing in a business simulation it would be important to ensure that the competences required by the potential employers of graduates are included in the assessment process. This alignment between employability skills and the learning outcomes of the business simulations would make it a worthwhile investment of the students' time. This represents the basis behind the second and third phases of this research.

3.2 Phase Two: Student Perception of Employability Competences Gained Through the Use of Case Study in the Teaching of Strategic Management

Currently one of the strategic management modules is part assessed using a written case study. The students are encouraged to analyse the case study in teams or pairs and submit an individual written report on the case. In the light of the importance of employability competences for our graduates, a brief survey of the strategic management students was carried out to assess if the current case study assessment method was seen to enhance employability competences.

A list of employability competences was taken from the meta-analysis prepared by Jackson [34] and the students were surveyed to identify if they felt these competencies were developed using the strategic management case study assessment.

Table 1. Student perception of competences developed via case study assessment

Top 10 competences "Not at all" or "Slightly" developed by case study assessment	Top 10 competences "Reasonably" or "Significantly" developed by case study assessment
Project management	Business acumen
Stress tolerance	Understanding an organisation's culture
Meeting management	Critical thinking
Self-efficacy	Attention to detail
Coaching	Decision management
Oral communication	Ethics and responsibility
Political skill/Negotiation	Research & Information retrieval skills
Leadership skills	Initiative
Team-working	Problem solving
Adaptability & change management	Written communication

A survey was prepared using Google Forms and was undertaken by students at the start of a computer laboratory session – this resulted in a high response rate of 84%. The students were presented with a list of employability competences as identified by Jackson [34] and were asked to rate the degree to which these competencies were developed by their strategic management case study assignment.

It is recognized that this survey represented only the students' perceptions on whether these competences were developed and that the student may not be the best judge of their competency development. It was however noted that further investigation was merited regarding whether the important competences such as those in the left-hand column of Table 1 could be developed. The outcome of this brief survey prompted the more detailed third phase of research to assess whether the implementation of a strategy simulation might enhance student employability competences.

3.3 Phase Three: Design of a Mixed Methods, Action Research, Case Study Exploring the Connection Between Teaching Higher Education Business Students Using Strategy Simulation Games and the Development of Key Employability Competences

The central hypothesis of this study will be that Business students who undertake a strategic management module using a business simulation assessment will acquire key employability competences. This will be established through observation in the classroom, analysis of student assessment submissions and student feedback.

The specific Aims of this proposed study are as follows:

- Analysis of literature, interview with employers and higher level institutions to identify key employability competencies for business graduates.
- Review of strategic management assessment methods to establish benefits of business simulation over alternatives.

- Use of key employability competences and other relevant criteria to select appropriate strategy simulation.
- Implement strategy simulation and assess competencies gained by students through observation, analysis of assessment submissions and student survey.

The aim of this study is that it will deliver benefits to all stakeholders. It is intended that lecturer and students will experience an improved teaching and learning experience. Students will be better equipped for the workplace with key employability skills desired by employers. The institution will be able to demonstrate that it is providing graduates with the necessary skills for their future careers and prospective employers can hire graduates with the skillset needed to make early and significant contributions to their organizations.

4 Conclusion

This paper has presented a three phase investigation into strategy simulation games. Initially, as a key stakeholder the student perspective on simulations was sought and their key concerns identified. A method of overcoming the students' concerns was to identify the key benefits of strategy simulations which is the enhancement of student employability competences. In the students own view, the existing case study assessment method was found wanting in respect of many of these employability competences so a detailed study is proposed to analyse the connection between the use of strategy simulation games and the enhancement of student employability competences.

Appendix 1: Phase One Questionnaire

Student Perceptions of the use of Business Simulation in teaching Strategic Management

This research is being undertaken as part of my MA in Teaching and Learning in Higher Education.

I am writing a research paper on the perceptions of students on the use of business simulation in teaching strategic management.

Your responses to this questionnaire are completely confidential.

The responses remain anonymous unless you choose to disclose your contact information.

Student Background

1) Please choose your programme of study

- Bachelor of Business (Honours)
- Bachelor of Business (Honours) in Accounting
- Other: ______

2) Please select your mode of study

- Full-time student
- Part-time student
- Other: ______

3) Please select your age range below.

- 25 or younger
- 26 - 40 years old
- 41 or older

A Simulation

A Simulation is a representation of a real world scenario. The student can make decisions and see the impact of these decisions.The student receives feedback on the outcomes based on their decisions. The process can be completed as an individual or as a group.

4) Have you used simulations as part of your learning before

- Yes - At Third level
- Yes - At Second level
- Yes - At Primary level
- No - I have never used simulations as part of my learning
- Other: ______

5) If you have used simulations for learning before, please indicate on the scale what you thought about the learning experience

Skip this question if you have never used simulation for learning before

	1	2	3	4	5	
Negative Learning Experience	○	○	○	○	○	Positive Learning Experience

6) Please explain why you felt that your previous use of simulation was a positive or negative learning experience

Skip this question if you have never used simulation for learning before

A Business Simulation

A Business Simulation is a representation of a real world business scenario.

7) If business simulations were part of your strategic management modules, please indicate on the scale what you think the learning experience would be like

	1	2	3	4	5	
Negative Learning Experience	○	○	○	○	○	Positive Learning Experience

8) Please explain why you feel that the use of business simulations as part of your strategic management modules would be a positive or negative learning experience

9) If business simulations were incorporated into your strategic management modules, please rate the likely learning experience against the following headings

	Not at all	Slightly	Reasonably	Extremely	No opinion
Engaging	◯	◯	◯	◯	◯
Motivating	◯	◯	◯	◯	◯
Relevant	◯	◯	◯	◯	◯
Complex	◯	◯	◯	◯	◯
Challenging	◯	◯	◯	◯	◯
Time Comsuming	◯	◯	◯	◯	◯

10) Please select from the list the characteristics of a business simulation, which in your opinion would give a positive learning experience

Please select all that apply in your opinion

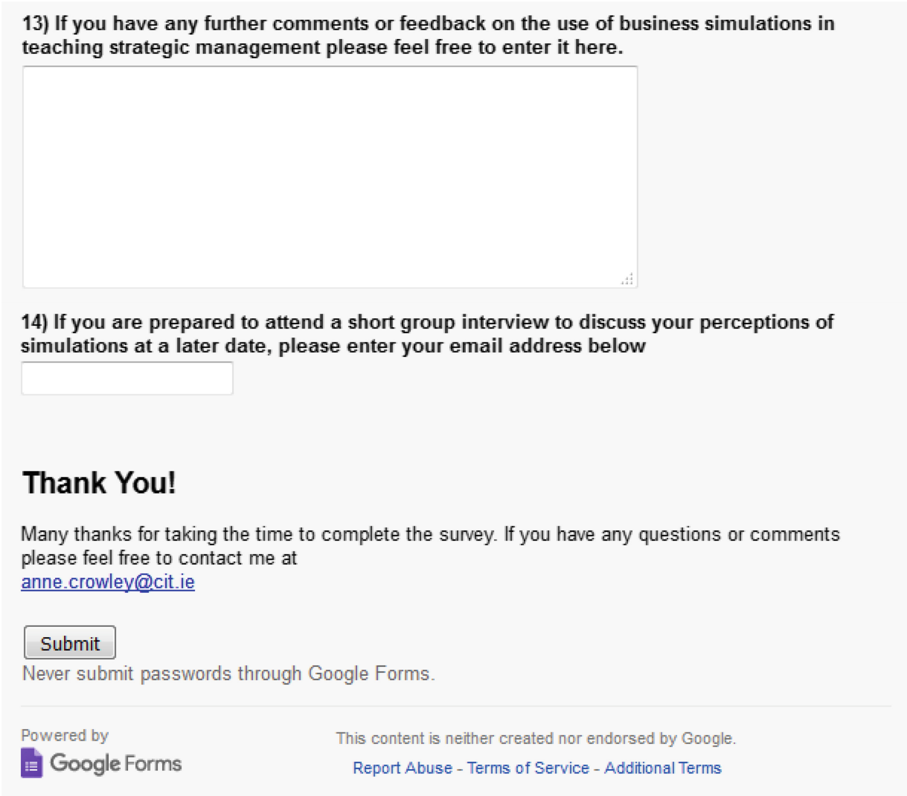
- ☐ Fidelity to a real world scenario
- ☐ Media rich
- ☐ Interactive
- ☐ Ease of use
- ☐ Authentic
- ☐ Challenging
- ☐ Social
- ☐ Other: ____________

11) If business simulations were part of your module would you be prepared to do the simulation as

- ◯ An Individual
- ◯ A Group
- ◯ Either an individual or a group
- ◯ No opinion

12) Would you be happy to have a business simulation as some or all of your assessment in your strategic management module

- ◯ Yes - as the full assessment
- ◯ Yes - as partial assessment
- ◯ No - would not like it as an assessment method
- ◯ No opinion



13) If you have any further comments or feedback on the use of business simulations in teaching strategic management please feel free to enter it here.

14) If you are prepared to attend a short group interview to discuss your perceptions of simulations at a later date, please enter your email address below

Thank You!

Many thanks for taking the time to complete the survey. If you have any questions or comments please feel free to contact me at
anne.crowley@cit.ie

Submit

Never submit passwords through Google Forms.

Powered by
Google Forms

This content is neither created nor endorsed by Google.
Report Abuse - Terms of Service - Additional Terms

References

1. Pasin, F., Giroux, H.: The impact of a simulation game on operations management education. Comput. Educ. **57**(1), 1240–1254 (2011)
2. Faria, A.J.: Business simulation games: current usage levels–an update. Simul. Gaming **29** (3), 295–308 (1998)
3. Chin, J., Dukes, R., Gamson, W.: Assessment in simulation and gaming. Simul. Gaming **40**, 553–568 (2009)
4. Barrie, S.C.: A research-based approach to generic graduate attributes policy. High. Educ. Res. Dev. **23**(3), 261–275 (2004)
5. Yorke, M.: Employability and higher education: what it is – what it is not. New Dir. Inst. Res. **2005**, 41–58 (2005)
6. Higher Education Authority: National survey of employers' views of Irish higher education outcomes (2012)
7. Association of Higher Education Careers Services: AHECS the voice of higher education career services (2013)

8. Raybould, J., Sheedy, V.: Are graduates equipped with the right skills in the employability stakes? Ind. Commercial Training **37**(5), 259–263 (2005)
9. Andrews, J., Higson, H.: Graduate employability, 'Soft skills' versus 'Hard' business knowledge: a European study. High. Educ. Europe **33**(4), 411–422 (2008)
10. Lees, D.: Graduate employability - literature review. Lit. Rev., 1–23 (2002)
11. Tymon, A.: The student perspective on employability. Stud. High. Educ. **38**(6), 1–16 (2013)
12. Knight, P.T., Yorke, M.: Employability and good learning in higher education. Teach. High. Educ. **8**(1), 3–16 (2003)
13. Hay, M.: Business schools: a new sense of purpose. J. Manag. Dev. **27**(4), 371–378 (2008)
14. Behrman, J.N., Levin, R.I.: Are business schools doing their job? (1984)
15. Payne, S.L., Whitfield, M.J., Flynn, J.A.: Assessing the business capstone course through a method based on the SOTL and the stakeholder process. J. Educ. Bus. **78**(2), 69–74 (2002)
16. Arias-Aranda, D.: Simulating reality for teaching strategic management. Innov. Educ. Teach. Int. **44**(3), 273–286 (2007)
17. Alexander, L.D., O'Neill, H.M., Synder, N.H., Townsend, J.B.: How academy members teach the business policy/strategic management case course. J. Manag. Case Stud. **2**(3), 333–344 (1986)
18. Argyris, C.: Some limitations of the case method: experiences in a management development program. Acad. Manag. Rev. **2**, 291–298 (1980)
19. Jackson, G.: Rethinking the case method. J. Manag. Policy Pract. **12**(1), 142–165 (2011)
20. Avramenko, A.: Enhancing students' employability through business simulation. Educ. + Train. **54**(5), 355–367 (2012)
21. Burgoyne, J., Mumford, A.: Learning from the case method: a report to the European case clearing house. Eur. Case Clearing House **44**, 1–92 (2001)
22. Thavikulwat, P.: The architecture of computerized business gaming simulations. Simul. Gaming **35**(2), 242–269 (2004)
23. Entwistle, N.J., Peterson, E.R.: Conceptions of learning and knowledge in higher education: relationships with study behaviour and influences of learning environments. Int. J. Educ. Res. **41**(6), 407–428 (2004)
24. Biggs, W.D.: Chapter 3. Introduction to computerized business management simulations. Guide Bus. Gaming Experiential Learn. **1987**, 23–35 (1990)
25. Entwistle, N.J.: Teaching for Understanding at University. Palgrave Macmillan, UK (2009)
26. Ramsden, P.: Learning to Teach in Higher Education. RoutledgeFalmer, London (2003)
27. Keys, B., Wolfe, J.: The role of management games and simulation in education research. J. Manag. **16**(2), 307–336 (1990)
28. Gredler, M.E.: Educational games and simulations: a technology in search of a (research) paradigm. Handb. Res. Educ. Commun. Technol. **39**, 521–540 (1996)
29. Anderson, P.H., Lawton, L.: Business simulations and cognitive learning. Simul. Gaming **40**(2), 193–216 (2009)
30. Maguire, S., Edmondson, S.: Student evaluation and assessment of group projects. J. Geogr. High. Educ. **25**, 37–41 (2010)
31. Davies, W.M.: Groupwork as a form of assessment: common problems and recommended solutions. High. Educ. **58**(4), 563–584 (2009)
32. Race, P.: Towards assessment as learning. Assessment **1**(1), 1–11 (2009)
33. Clarke, E.: Learning outcomes from business simulation exercises - challenges for the implementation of learning technologies. Educ. + Train. **51**(5/6), 448–459 (2009)
34. Jackson, D.: An international profile of industry-relevant competencies and skill gaps in modern graduates. Int. J. Manag. Educ. **8**(3), 29–58 (2010)

Author Index