Lorna Uden
Dario Liberona
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Learning Technology for Education Challenges

7th International Workshop, LTEC 2018
Žilina, Slovakia, August 6–10, 2018
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Preface

The 7th International Workshop on Learning Technology for Education Challenges, (LTEC 2018): What Learning Professionals Should Know, was held at the University of Zilina, Slovakia, during August 6–10, 2018.

The conference was preceded by one day of free tutorials for participants who wished to learn about the state of the art of research relating to the topics of LTEC. The tutorials were held on August 6, 2018, while the conference commenced on August 7.

New technologies impact the ways we learn and teach. When mapping out strategies for the next few years, it is important to carefully consider the elements of technology, learning science, and societal influences to ensure that we have a strategy that is on target, scalable, and meets the needs of the learners to help them achieve organizational goals and objectives.

There are several technology-enabled learning trends that will help shape learning across universities and industries in the coming years. It is important to keep abreast with these technologies to ensure that students' skills are up to date and aligned with new realities.

Microlearning is the concept of delivering content to learners in small, specific bursts over time or just when needed. This has led to short how-to videos that last less than five minutes and to short text-message-based instruction. However, microlearning solutions require design and technology, which most existing platforms, authoring tools, and processes do not fully support. Another technology issue that we are witnessing is the use of smartphones and mobile devices for consumption of learning.

Game-based learning enhances motivation, engagement, and knowledge retention. Gamification and serious games are prominent corporate e-Learning trends. e-Learning games give students the rare opportunity to learn information without even realizing it. Besides game-based learning, curation of content is on the rise. We expect to see more carefully selected, user-focused e-Learning content, including blogs, forum threads, guides, videos, and articles. This will help organizations to create a modern and holistic set of learning content delivered via designed content or multiple resources that do not need to be made from scratch.

Using data can help us learn how to quickly see where we need to improve e-Learning content. Data offer a smart way to personalize learning content. The increased adoption of big data will allow e-Learning administrators to personalize learning content, provide timely motivation, and test the effectiveness of various learning theories and strategies.

Massive open online courses (MOOC) will continue to grow and it is important to look into how this method can be used as an effective tool for learning. Cloud-based learning is steadily gaining ground and the latest trend has seen learning management systems and authoring tools switch to cloud-based platforms. Crowd sourcing is vital in education today to extract a wide range of educational information that is available online. It has great benefits in developing the best practices in education for learning institutions and students. Virtual reality (VR) tools and Apps are used as tools of intelligence education that immerse the student in the lesson through hearing and visuals. VR learning tools enhance and create real learning experiences in fields such as science, biology, geology, literacy, history, and much more. VR tools used in classrooms create many educational possibilities and increase student engagement.

The use of technology in education will continue to rise. Learning methods could become entirely technology driven. It is predicted that more technology trends will continue to enhance modern learning. More students will use devices and gadgets to support learning in education. The Internet and technology-driven generation will continue to reform traditional learning systems to adaptable practices.

There is abundant research that shows learning technology has the potential to improve learning. Besides technologies, there are also new pedagogical advances in learning and teaching.

The 7th LTEC (2018) examined how these technologies and pedagogical advances can be used to change the way teachers teach and students learn while placing special emphasis on the pedagogically effective ways we can harness these new technologies in education. The conference seeks contributions that address theory, research, practice, and policy; especially those that can also be focused on particular approaches, technologies, and domains are most welcome. The aim is to provide a platform for research in the very broad area of educational technology that bridges theory, research, practice, and policy.

LTEC 2018 gathered together academic research and practical applications of education from all areas, seeking to bring top research and proven best practices together in one location, for the purposes of helping practitioners find ways to put research into practice, and for researchers to gain an understanding of additional real-world problems.

The proceedings consist of 25 papers covering various aspects of technologies for learning including:

Gamification and learning
Learning and knowledge transfer
Learning technologies applications
Mobile learning and MOOCs
Virtual learning environments

The authors of the papers come from many different countries, including Austria, Brazil, China, Colombia, Estonia, Finland, France, Germany, Greece, Guatemala, Slovenia, Slovakia, Spain, Switzerland, Taiwan, UK, and USA. We would like to thank our authors, reviewers, and Program Committee for their contributions and the University of Žilina for hosting the conference. Special thanks to the authors and participants at the conference. Without their efforts, there would be no conference or proceedings.

August 2018

Lorna Uden
Dario Liberona
Jozef Ristvej

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Contents

Gamification and Learning

Assessing Gamification Effects on E-learning Platforms: An Experimental Case

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Abstract. Many educational organizations have implemented E-learning platforms aiming to improve student learning performance. However, due to its self-learning nature, these platforms reveal high dropout rates. The use of gamification is presented as a solution to this problem, through the generation of play environments that provide a high interaction with more motivating ludic experiences, attractive, and creating a positive impact on pedagogical and psychological aspects of E-learning. This paper conducted an empirical analysis using gamification in an online teaching platform used by an experimental group of students. The impact on dropout rates and final grades were examined comparing the historical data with those obtained after implementing the games in the online platform. The results expose the direct positive relationship that gamification has on the efficiency of using online platforms.

Keywords: Gamification · E-learning · Desertion · Learning

1 Introduction

New information and communications technologies have changed the way of transmitting knowledge and learning. Easy access to the information has allowed knowledge to be conceived as universal and open. [1]. Owing to the emergence of E-learning, classes can be imparted virtually, and students can access to their training courses, at any time and from anywhere, providing a solution to overcoming place and time barriers for to learning [2].

E-learning is an electronic learning system based on independent learning, for this reason, its effectiveness largely depends on the creation of an environment that encourages participation, continuous activity, attentiveness, commitment and emotional motivation of students [3, 4]. It is argued that the use of games can have a positive impact on the psychological characteristics of students and their behavior towards learning [5]. Hence, including gamification in E-learning to generate

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interactive dynamics that boost competition, challenges, instant feedback, rewards and recognition, among others, might improve the interaction between students and platforms, and therefore, to promote better learning.

The term "gamification" denotes the use of elements (mechanical, dynamic and aesthetic) of games as a strategy of improvement in different environments or fields. The use of this term has been increasing exponentially during recent years, and its importance has been increasing as well, positioning itself as an innovative technology [6]. Previous studies have focused on demonstrating the positive effects of their application in several fields. However, in the education field, only a few researches include empirical studies, and those who do it focus on assessing the effect on the learner motivation. This study implements some gamification elements in the E-learning platform of a Distance/Virtual Higher Education Institution course, and assess its effects on desertion, average time of platform usage and the final grades of students, with a quantitative data analysis by making use of gamification and historical data.

2 E-learning

E-learning is a teaching and learning system based on the use of information and communication technologies that allows students learning without space and time restriction [7]. Its use has caused a transformation from traditional teaching to virtual teaching and learning environments incorporating self-training aspects related to collaborative learning.

The importance of virtual learning is due in large part to its advantages: (a) efficiency in transferring knowledge, (b) learning environment customization according to specific individual needs and learning styles, (c) adaptability for multiple forms of interactive learning, (d) promotion of dynamic-type capabilities in learning and innovative potential, (e) time flexibility, allowing pauses at specific points and, if necessary, repetition of specific parts, (f) enables autonomy development and eases self-evaluation processes, (g) allows having a greater number of students, without location or space limitations, as in the case of traditional or physical class attendance [7, 8]. For these reasons, many educational institutions and firms have incorporated vitrual platforms in their training processes. Since the success of E-learning on the education field must integrate a joint vision of technical, pedagogical and didactic processes, its use in the university context will include the application of models and methods to generate more effective learning results, this exploration demands more functions, flexibility, and changes in tutor's activity, leading to propose educational models of technological and methodological innovation.

One of the main challenges of the virtual education is to decrease the student dropout rate that reaches higher percentages than those ones in traditional classes. Several studies have been carried out in order to identify what are the variables and main determinants that may affect this phenomenon. According to a study carried out in the Open Learning Institute in British Columbia, the main dropout cause is due to individual motivation, followed by academic level and lastly previous social characteristics. The study concludes that the characteristics of the student such as age and gender influence 11% in their continuity in virtual courses [9]. Other studies indicate that women have a slightly higher tendency to remain in distance courses [10].

The acceptance degree and success level of an E-learning, to a large extent, is due to the student's continuity, that depends on two general factors: the characteristics of the course (the Web, platform or specific technology employed, the content and methodology of the course) and, on the other hand, personal impressions or sensations from the student such as the will to do, the enjoyment, which are variables that influence individual motivation [11–13].

With the purpose of increasing student's individual motivations in virtual courses and the success of this learning modality, gamification is employed.

3 Gamification in E-learning

Gamification is defined as the application of game elements in not game related contexts [14] with the purpose of generating a greater commitment and ownership in tasks execution. Several studies have shown that gamification has a positive impact on personal motivation [15–19]. By using the dynamics, mechanics, and aesthetics of games, the students feel motivated, allowing them to increase their responsibility for distance learning, and strengthen their link with the content and the tasks proposed.

In overall terms, gamification in the education field has been used to foster desired learning behaviors and to encourage participation, interest, and commitment of students in the learning activities by allowing a greater immersion in the learning environment. The former is derived from the self-determination theory (SDT) proposed by Deci and Ryan [20], which exposes the way in which videogames, games and therefore gamification satisfy the psychological needs of players or participants. This theory distinguishes two types of motivation: intrinsic (where people continue to participate because they have fun, satisfaction, and taste) and extrinsic (external rewards) [20].

Games are intrinsically motivating, the gamified environments must address three psychological needs: autonomy (providing freedom of choice), competition (providing challenges, once achieved them make players feel recognition, competence, and efficiency) and finally the collaboration and relationship with others to promote social connections, hence, gamification in education motivate students by creating a better learning experience [20].

In E-learning, the general game designs are based on three areas: (1) the cognitive area: make complex systems where the student gradually progresses in obtaining achievements based on established rules; (2) Emotional area: elements that create appropriation and positive emotions; (3) Social area: generates mechanisms of interaction and competence [21]. Moreover, gamification impacts four aspects of motivation, boosting interest and stimulating the student: the cognitive, which improves attention, reaction time, and permanence; the social, which leads to transfer the acquired knowledge; and the emotional that regulates positive emotions and behaviors [22]. This study implements these game elements. Thus, an virtual course is gamified to measure its impact on the dropout rates, the average time on the platform and the final results of the course (Grading), inferring variables such as age and gender of the group of students who made use of the new gamified platform.

4 Description of the Study

This study was developed in a Distance/Virtual Higher Education Institutions in Colombia. Several gamification strategies were implemented in the course titled 'Foundations for Integral Management' due to (1) it belongs to one of the academic programs with the highest dropout rates, and (2) it reports a low academic performance. This course belongs to the administration and economic area, and has developed a methodology based on tasks and theoretical content.

The first semester is the period where the curriculum assigns the course, and it has a value of 3 academic credits. The course content includes 3 units and evaluates from 0.0 to 5.0; being the minimum and maximum score respectively, 6 tasks or products. Students must reach a grade equal to or greater than 3.0 to approve the course.

During one academic semester gamification was implemented on the E-learning platform. The course was taught to a total of 236 students with ages between 19 and 35 years old, and around (72%) of the students were males.

4.1 Gamification Implemented in the E-learning Platform

Moodle 2.7 (Modular Object-Oriented Dynamic Learning Environment) is the platform used by the research course, currently, the module has linear access to content, forums, and students can create their own profile, upload their profile picture, personal data such as age and a brief description of themselves.

The content of the training material in the course remains the same, i.e. the videos made by the tutor, assignments, exams, documents and forums were not modified, only six gamification components were added to the platform (See Table 1).

Table 1. Gamification strategies implemented in the course

Gamification element	Need to satisfy
Custom account	Sense of identity, personality, own style
Progress bar	Progress sensation in the achievement of goals
Levels (Titles) - scores	Competence, achievement, recognition, status
Score table	Recognition, social environment, competition
Instant feedback	To be informed about self-performance, Recognition
Battles	Competence

1. Custom Account

At the beginning of the course, the platform allows each student to design their own avatar, creating a unique and personal representation that generates identity [7]. In this case the avatar is improved according to the level obtained by the student, this level is reached based on the scores accumulated. The avatar goes together with the corresponding title of the level reached.

2. Progress Bar

The platform displayed the progress bar with the respective avatar at the bottom left-hand side of the screen. Hence, the student was able to know what was the path he took during the content of the course, the different tasks performed, and what remained to complete the goal. This tool is important due to allowing the player to feel an autonomous improvement [8].

3. Titles - Levels

Titles and levels evidenced the acquisition of skills and the mastery of knowledge within the classroom. The levels are also indicators of the degree of progress. In this case there were 4 levels of experience according to the number of points accumulated by the students (See Table 2).

Table 2. The Game levels

Student level	Acumulated score
Expert	>300
Advanced	201–300
Intermediate	101–200
Beginner	0–100

Scores are numerical values that are achieved in gamified systems after carrying out one or a set of actions. Each action that a player makes is associated with a reward, in this case, a certain amount of known points. Points are an important attraction, the mechanism used both to gain them and to preserve them can increase the motivation of the students [9].

Scores were obtained according to the fulfillment and the quality of the tasks and activities presented. The scores criteria were (a) having the highest score in a task, (b) delivering the activities on time, (c) participating in the forums, (d) winning battles with other participants, (e) When students upgraded their level (from first to intermediate, from intermediate to advanced and from advanced to expert).

4. The Score Table

Classification tables were used to display the position of each student in comparison with Others, at the bottom left-hand side of the screen always appeared the podium (the three first places). Therefore, students could track the complete list of positions occupied by each of them. A tab named "Ranking" was installed in the menu, there were three rankings to consult: Weekly Ranking (the students with the best scores of the week), Ranking by unit (the students with better scores in each unit) and the cumulative ranking (the students with the highest score accumulated during the course).

5. Instant Feedback

Feedback can be used to encourage or discourage certain behaviors, causing that the student becomes more involved in the learning process. Students like to be informed about how their performance is, and above all of that, to feel recognized when they are doing well, this generates an intrinsic motivation [8]. In this case, every time a student participated in a forum, performed the tasks in the established time, upgraded the ranking position, won a battle, and so forth, the system displayed motivational phrases to keep improving.

6. Battles

The course previously contained a series of playful activities such as crossword puzzles, and alphabet soups. Once gamification elements were implemented, the platform allowed students to perform these activities in the form of "battles" by challenging another student. The battles had a time restriction and the winner was the player with more triumphs. At the end, the platform assigned the respective score. Battles are usually used to satisfy the feeling of overcoming or recognition and encouraging competition.

5 Results

The course presents an average historical dropout of 42%. Each semester, the total students enrolled remains the same (236). During the experimental semester, 65 students abandoned the course, representing a dropout rate of 27.5% (See Fig. 1), this shows a significant decrease, evidencing that the implementation of the gamification has a considerable positive impact on student's continuity. This decrease in the dropout rate had a greater tendency among male students (26%), whilst the variation in the dropout among female students is negligible (1%) (See Fig. 2). The greatest decrease in dropout compared to the previous semester occurred in students with ages between 23 and 26 (See Fig. 3).

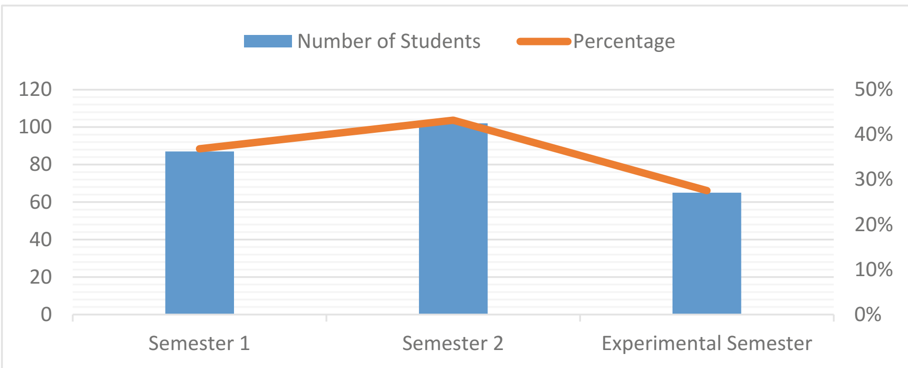

Fig. 1. Dropout percentage of the course

Figure 1 displays a decrease in the dropout percentage 14.5% (37 less students) with respect to the previous semester.

Men shows a greater decrease in the percentage of dropout, going from 68 students in the previous semester to 41 students in the experimental semester (decrease of 39.7%); while women present a decrease of 29.4% with the implementation of gamification (See Fig. 2).

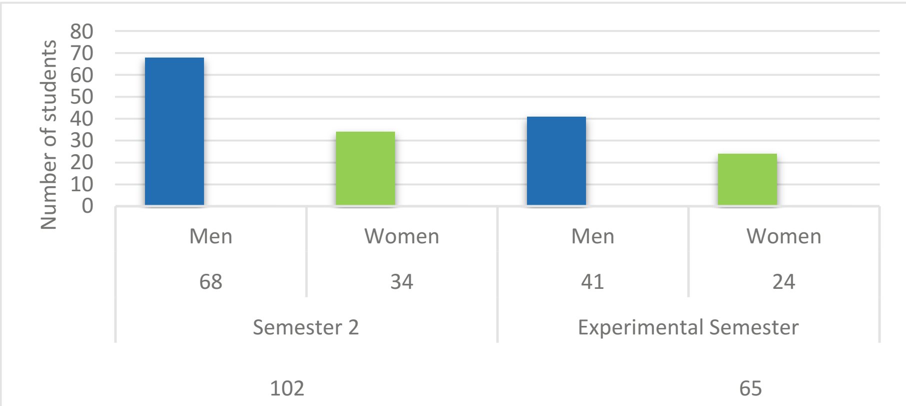

Fig. 2. Number of students deserting by gender

Students between 23 and 26 years old showed a lower dropout rate than students within the same age range in the preceding semester, although in the experimental semester there was a greater number of students in this age range taking the course (See Fig. 3).

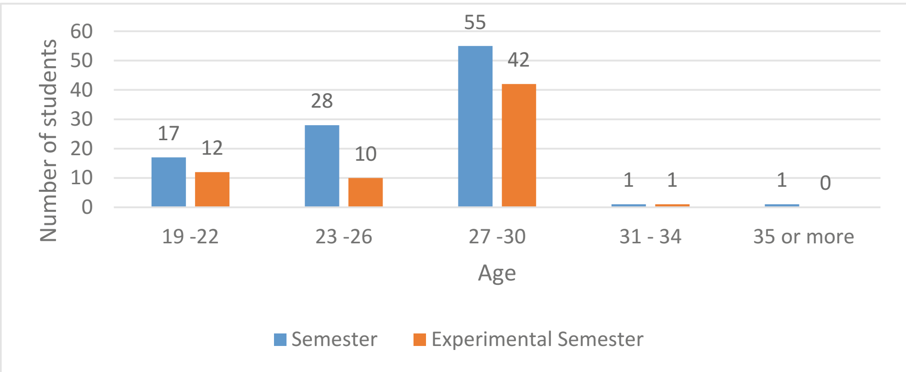

Fig. 3. Number of students deserting by age

The average time of the platform use increased more than three times, from 0:42 h to 1:48 daily hours. The average number of weekly entrances to the course per student also increased 55.5%, from 9 to 14. This findings indicate a greater interest, commitment and motivation of the students that leads them to invest more time in the learning process and, in general, in the platform of the course (See Figs. 4 and 5).

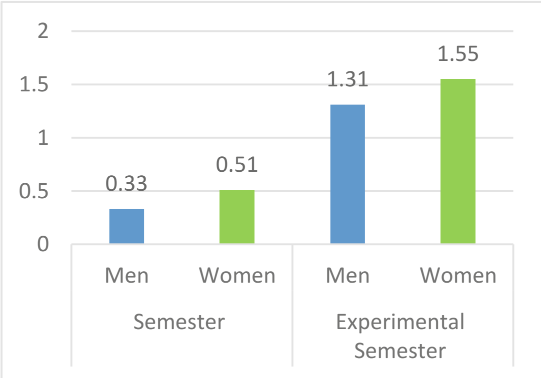

Fig. 4. The average time of daily use by gender

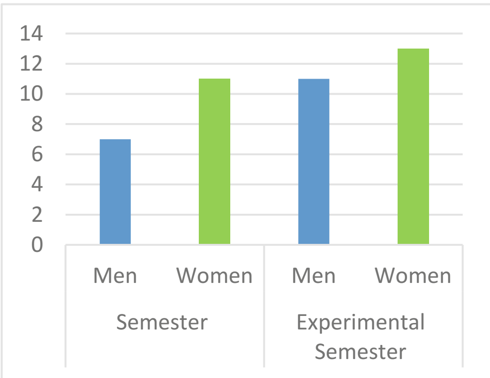

Fig. 5. Average number of weekly entrances by gender.

The average time of daily use in the platform increases 68% for women and 75% for men. The average weekly entrances increase 37% in men and 26% for women when gamification was implemented. There is evidence of a greater increase in men with respect to immersion in the platform and the content of the course when gamification is applied. However, women continue to have a higher average time of use and a higher number of weekly entrances than men.

It is important to mention that from the gamification activities implemented in the platform those that present the greatest number of visits or participation are the battles and the scoring tables respectively. Therefore, according to the theory it can be concluded that the profile of the student has a greater inclination towards competition, and these activities motivate students, as a consequence, there is a greater use of these gamification elements in the platform. It should be noted that women had a greater number of participation in the forums (See Table 3).

Table 3. Average weekly visits by gender to the implemented gamification elements in the course

Gamification element	No. of students	
	Man	Women
Battles	25	12
Score table	18	13
Forums	9	15
Avatar	3	3
Progress bar	3	5

On average 21% of the students failed the course, that is to say, they obtained a final grade lower than 3.0. The average grade is 3.36. The average of final grades when making use of gamification increased to 3.62 and the percentage of failed students decreases to 14%. The number of students who failed in the previous semester and in the experimental semester is similar. However, the percentage varies since the dropout was greater in the semester in which the platform has not been gamified, therefore, the number of students that ends the semester and gets final grade is lower.

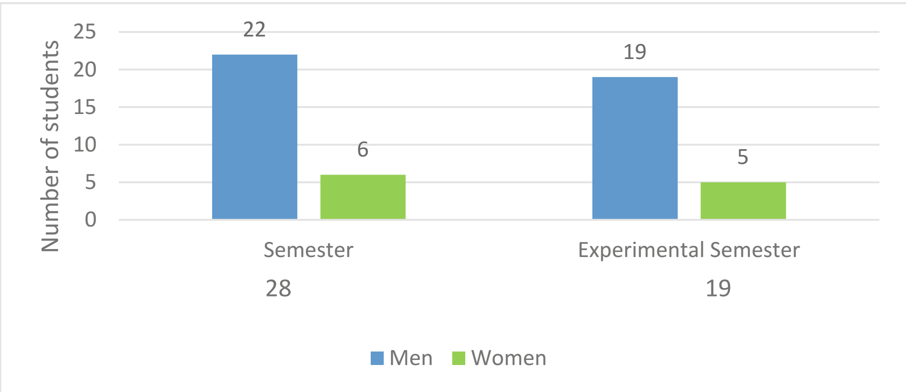

Fig. 6. Number of students failed the course by gender

Figure 6 shows that men had a greater decrease of failing the course with respect to women when implementing gamification. Regarding the improvement in the average of final grades, there is a greater increase in the average obtained by the ages of 19 to 22 years followed by the age range between 23 and 26, increasing 0.7 and 0.3 respectively (See Fig. 7).

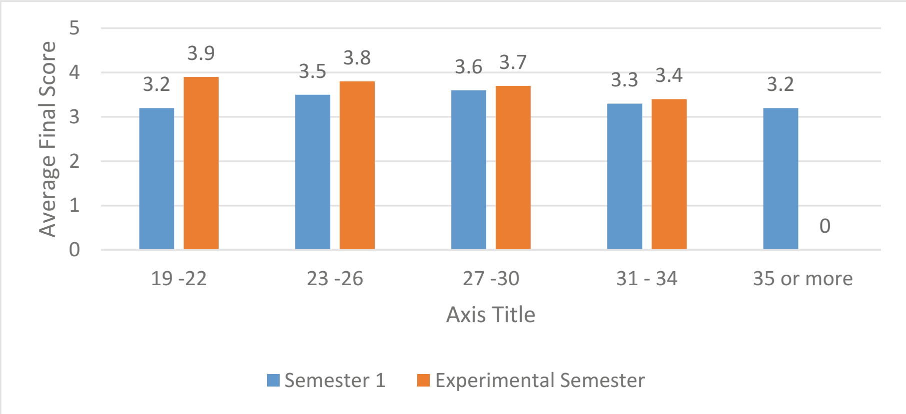

Fig. 7. Number of students failed the course by gender

6 Conclusions

According to the results, the implementation of gamification in the virtual course improved the educational effectiveness, causing a greater interest in the student learning process, which leads to a greater immersion in the contents of the course. Consequently, an increase of the average time of use and weekly number of entrance to the platform were observed. This interest also affected the continuity of students in the course, impacting and significantly decreasing the dropout rate. Moreover, an increase in the average final grade and the percentage of students that approved the course indicated a greater capture of the concepts and content of the course.

The study also showed that the participation frequency analysis in the gamification activities included in the platform could provide orientations towards the student's preferences, contributing in the definition of the player's profile who had a greater tendency of competition. This information provides guidelines for the improvement of gamification. Not all students got good results. One possible explanation is owed to personality, which directly affects the efficiency of gamification, due to the activities that motivate a certain group of students does not necessarily motivate the general group. Hence, a greater diversification of the elements can cause a greater effectiveness in the obtained results, as well as the use of surveys and tests could provide an early student's profile.

Lastly, the study showed that men between 23 and 26 years of age significantly improved their performance. A tentative interpretation might be that there was a greater affiliation among young people to the use and adaptation of technologies. The study showed that men had a greater motivation towards competition, while women showed greater participation in collaborative and social activities such as forums.

7 Discussion

The main empiric results from this study shows that gamification learning methods outperforms the conventional/non – gamification learning method in terms of: permanence of the students (continuity of the course), learner skills and immersion.

Another important result shows that the response from the user to the design prototype of the gamified course was positive, thus, in general terms the students accepted the new model.

In addition, the results of this study provided evidence that female college students were highly interested in playing computer games as male students. However, male generate a greater percentage improvement in each of the statistics evaluated as well as the group of students (male and female) between 23–26 years old. In this study case, the battles and rankings are among the gamification elements that have a major impact on enhancing students' inner motivation, this vary according to the player rol, who in this case had a greater inclination towards the competition. Therefore, it is crucial in this model that a feedback system includes challenges and positive reinforcement. Other than that, cooperation between students can be achieved by providing them with an interactive medium as the social fórum, enhancing social communications among learners, leading to a strong motivation and contribution of individuals in the social ambit.

The decreasing rate of students engagement while using virtual courses has been seen as an opportunity to explore gamification fields and using it to elaborate the online learning platform. Gamification will be serve as a motivation for all parties to participare actively in any virtual courses (educators and students).

References

1. Goodyear, P., Retalis, S.: Technology-Enhanced Learning, 1st edn. Sense Publishers, Rotterdam (2010)
2. Ethlers, U.D.: Web 2.0, E-learning 2.0, Quality for New Learning Cultures. In: Quality Assurance in Education, 3rd edn. Emerald Group Publishing, Bradford (2009)
3. Zhang, S., Zhan, Q., Du, H.: Research on the human computer interaction of e-learning. IEEE (2010)
4. Muntean, C.I.: Raising engagement in e-learning through gamification. In: 6th International Conference on Virtual Learning (2011)
5. Souza-Concilio, I.A., Pacheco, B.A.: Games and learning management systems: a discussion about motivational design and emotional engagement. In: SBGames (2013)

6. Gartner says by 2015, more than 50 percent of organizations that manage innovation processes will gamify those processes. Gartner Press Release, Egham (2011). www.gartner.com/it/page.jsp?id=1629214. Accessed 2 Jan 2018
7. Iris, R.Y., Vikas, A.: E-learning tecnologies: a key to dynamic capabilities. Comput. Hum. Behav. **27**, 1868–1874 (2011)
8. Wan, Z.Y., Haggerty, N.: Why people benefit from E-learning differently: the effects of psychological processes on E-learning outcomes. Inf. Manag. **45**, 513–521 (2008)
9. Tinto, V.: Leaving College: Rethinking the Causes and Cures of Student Attrition (2003)
10. Willging, P.A., Johnson, S.D.: Factors that influence students' decision to dropout of online courses. J. Asynchronous Learn. Netw. **8**, 105–118 (2004)
11. Roca, J.C., Gagné, M.: Understanding E-learning continuance intention in the workplace: a self-determination theory perspective. Comput. Hum. Behav. **24**, 1585–1604 (2008)
12. Hernandez, B., Montaner, T., Sese, F.J., Urquizu, P.: The role of social motivations in E-learning: How do they affect usage and success of ICT interactive tools? Comput. Hum. Behav. **27**, 2224–2232 (2011)
13. Lin, K., Lu, H.P.: Why people use networking sites: an empirical study interacting network externalities and motivation theory. Comput. Hum. Behav. **27**, 1152–1161 (2011)
14. Kapp, K.: The Gamification of Learning and Instruction: Game-Based Methods and Strategies for Training and Education. Wiley, San Francisco (2012)
15. Chang, J.W., Wei, H.Y.: Exploring engaging gamification mechanicsin massive online open courses. Educ. Technol. Soc. **19**(2), 177–203 (2016)
16. Shahdatunnaim, A., Noorminshah, A., Norasnita, A.: Attracting students' engagement in programming courses with gamification. In: IEEE Conference on e-Learning, e-Management and e-Services. Department of Information Systems, Universiti Teknologi Malaysia, Johor (2016)
17. Ilya, V., Latvija, A.: Study of gamification effectiveness in online e-learning systems. Int. J. Adv. Comput. Sci. Appl. **6**(2), 71–77 (2015)
18. Sinha, S.: Motivating Students and the Gamification of Learning, pp. 1–4. Huffingt Post (2012)
19. Leaning, M.: A study of the use of games and gamification to enhance student engagement, experience and achievement on a theory-based course of an undergraduate media degree. J. Media Pract. **16**, 155–170 (2015)
20. Ryan, R., Deci, E.: Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am. Psychol. **55**, 68–78 (2000)
21. 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 (2015)
22. Zichermann, G., Cunnigham, C.: Gamification by Design: Implementation Game Mechanics in Web and Mobile Apps. O'Reilly Media, Boston (2011)

Improving Business Process Management Competencies by Applying Gamification Aspects in Teaching Bachelor Students

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Abstract. Motivation can be named as one of the major drivers for learning. Besides motivation there is also experience, engagement and activity, which can improve the know-how on certain topics and speed-up knowledge transfer. Especially in practical education, the theoretical concepts are first presented and afterwards it is important to provide a setting for students, where they can learn based on their own experiences, building their own know-how. This is done by designing and executing the simulation as part of the business process management lecture by taking gamification aspects into consideration. This paper shows the positive impact of gamification aspects based on a study (N = 44) in a business process management bachelor class.

Keywords: Process management · Competency-based education
Gamification · Gameful design

1 Introduction

Competency-based education is state of the art in business and information systems engineering (BISE). BISE learning objectives are formulated for the German-speaking countries (DACH) by Jung and Lehrer [1]. The authors describe several job profiles in their guideline and outline the necessary objectives/learning outcomes. In this paper the authors report on applying some of these guidelines by using a game to teach a class of 44 students in the 2nd year bachelor (divided into four groups) business process management. The objectives given by the employed guidelines, sorted by relevance for bachelor students and their respective importance for process management are: (1) process modelling, (2) process analysis and mining, (3) process execution/monitoring and (4) process optimization/continuous improvement. More strategically aligned objectives, such as strategic process management or domain-specific reference models, will be trained as part of the master curriculum. The need for special social and personal skills was not taken into account by the game design, yet many such skills were observed [2] during the game.

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Normally, students go to university, learn what teachers present and find their motivation for all this in the grade they receive at the end of the term - this type of process relies entirely on extrinsic motivation, which seldom leads to high engagement [3]. One possibility to overcome missing engagement is gamification and especially the idea of gameful design [4].

There are several concepts about motivation, such as Maslow's popular hierarchy of needs [5], or the ARCS (attention, relevance, confidence, satisfaction) model of motivation designed for advice e-learning by Keller [6]. Vansteenkiste et al. [7] explored in a study that intrinsic goal framing based on enjoyment or fun increases the engagement in learning activities and show better conceptual learning compared to extrinsic goal framing. Especially the factor of fun is of high interest.

Based on these theoretical assumptions the authors focused on the following research question: *How can principal ideas of gamification be used to positively increase fun and know-how during a simulation?* In more detail, the following variables have to be elaborated during the study. The targets were set by the lead author before the first lecture in the planning phase of the course based on the curriculum, guidelines of our university and in accordance to didactic aspects measured on amount of students:

- *motivation and engagement* (target: more than 80%)
- *fun* (target: more than 80%)
- *knowledge increase based on the given objectives described in Sect.* 1 (target: more than 80% as expected)
- *practical transfer* (target: more than 90% as expected)

The measurement of the variables is explained in Sect. 4. Based on the given research question the structure of the paper is as follows. After the introduction which was just presented in Sect. 1, the following Sect. 2 explains the basic ideas of gamification in education and the relevant theoretical concepts. In Sect. 3, the case will be described and in Sect. 4, the methodology of data collection and gained results are discussed. Based on the results in Sect. 4, the discussion in Sect. 5 explains the outcomes and Sect. 6 closes the paper with limitations and a future outlook for ongoing improvement.

2 Gamification in Education

Gamification, the way it is explained by Deterding et al. [4], is the application of game design elements in a non-game context and should not be limited do digital technology. It is a promising approach to improve learners' motivation and engagement [8]. The term was coined by the gaming industry and is nowadays used to describe game situations in real world scenarios and for teaching environments outside the game industry [9].

The application of main gamification elements used in education have been proven by Dicheva et al. [10]. The authors found out that the following elements are of interest to be used in education: (1) freedom of choice/fail, (2) rapid feedback, (3) visible status and (4) social engagement. Explanations are given:

- *Freedom to fail* can be implemented by giving students the chance to rework on their activities as shown by O'Donovan et al. [11] and their re-take quizzes;
- *Rapid feedback* is about shortening the feedback cycles to increase the effectiveness of learning as highlighted by Kapp [12];
- *Visibility of the status* can trigger competitive motivation [13] and helps to engage the students into the game;
- Working on team projects or the cooperation and interaction with other students [14] can be seen in the element of *social engagement*. The idea of using badges based on the performance and fun [15] will be integrated in the study as a measurement but not as an element itself;

Based on the principles of gasification it is important to reflect on the gameful design, which can be seen as a potential alternative for gamification [4]. The gameful design meets the author's expectation, as it can be seen as an intrinsic motivator [8] and fits the planning of the game described in Sect. 3. Gameful design is about intentionally designing for gamefulness. The basic elements given by the dynamic model for gamification of learning are: (1) challenge, (2) curiosity, (3) fantasy and (4) control. How they are taken into consideration in the planning of the game will be described in the next section.

3 Game Description

The game, which was planned and implemented in the lecture by the lead author of this paper, is based on a simulation for building sailboats. Every sailboat consists of five different building blocks (PICASSO Tiles) with a high variety of assembling.

During the four production steps, which have to be fulfilled by students, the boats are produced and afterwards checked by internal quality management. For the logistics there is a separate position staffed with one student. Only logistics is allowed to move material within the production, from the supplier to production and from quality management in the last step to the customer. All parts are allocated by a dedicated supplier (one student) and the customer is also staffed with one student.

The simulation starts with assembling the needed physical setting in the classroom, briefing the customer in detail about the quality of the sailboats, and a rough introduction by a printed work instruction for each of the four production stages. Every production stage receives a starting set of building blocks. One round of the game is divided into ten cycles (each one minute) with a certain demand of ships given by the customer to the production (planned and written down on paper by the lecturer). Production starts producing, quality management checks the quality and logistics has to check the transportation of ships and raw materials.

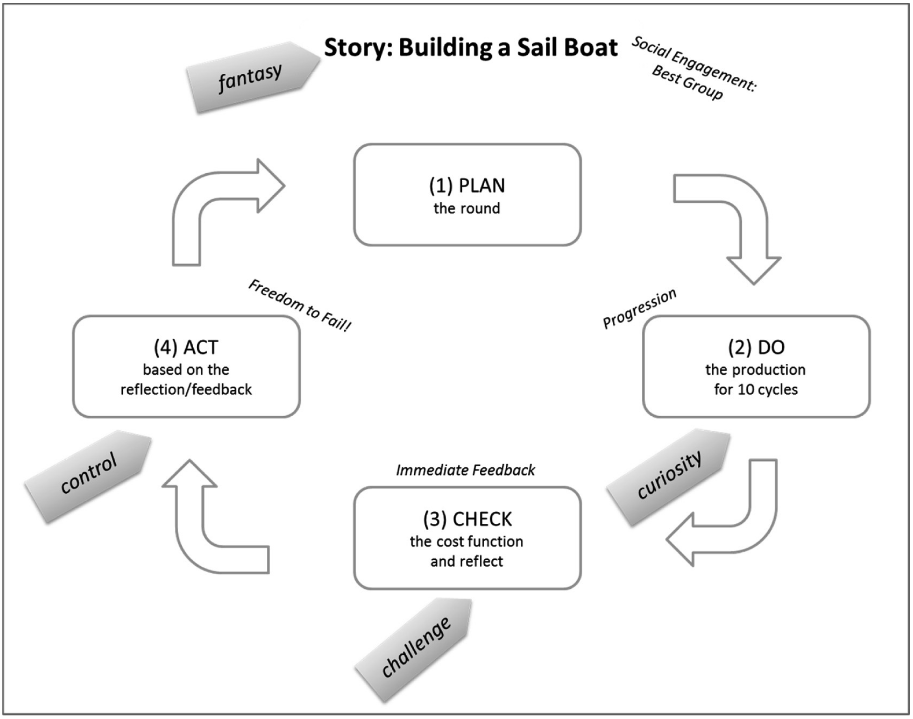


Fig. 1. Game structure with gamification and gameful design elements

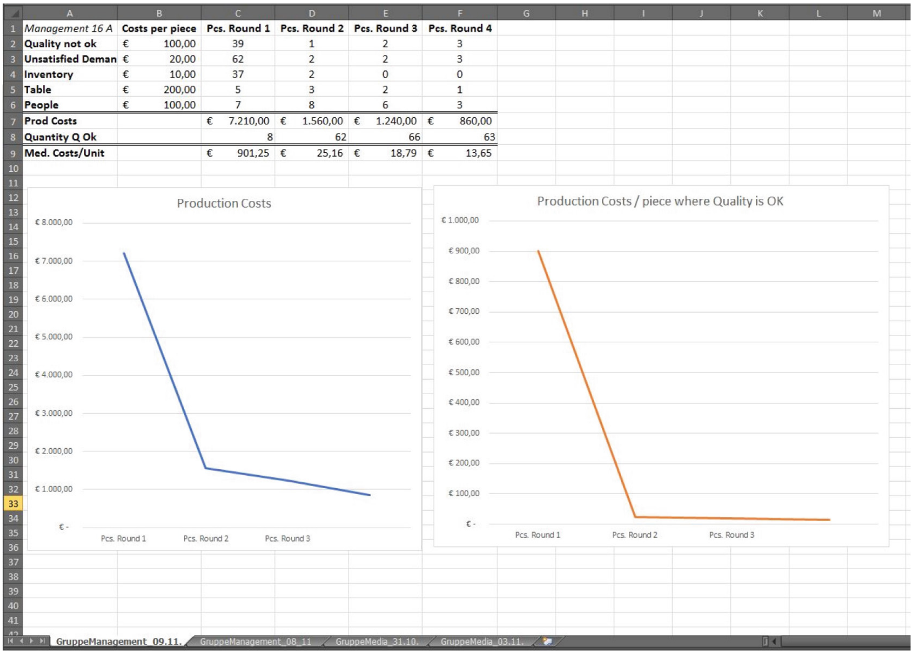
For calculation and comparison reasons a simple cost function is defined based on used resources, the quality and number of ships given to the customer.

As shown in Fig. 1, every round can be divided into four major steps: (1) **plan** the round, (2) **do** the production, (3) **check** the cost function and (4) **act** based on the reflection/feedback. So, to improve the motivation and engagement of the students, the authors tried to take the gameful design aspects into consideration, which are displayed in Fig. 1 as grey arrows. Additionally, the gamification elements are mentioned in italic text beside the process steps in Fig. 1.

The *first step* is about planning what to do in the next round. For the initial round it is easy, because students do more or less what is stated in the work instructions and what is explained by the lecturer. Upcoming chaos is based on rough information and provoked in the first round. For example normally only a small number of qualitative good products can be produced. Within the next rounds the planning of the workflows is done by the students themselves.

The *second step* is to produce the sailboats during the ten cycles based on the customer demand for each cycle. The element of *curiosity* carries out the thrill idea for the cycle time of one minute. In this time, all the participating roles in the game have a lot of work and focus on what they have to do. During this time, students are absolutely IN the game. It would be easy to give more time to the production cycles but the workload helps to grab the students' attention and shows them a lot of know-how about process analysis and workflow management.

The *third* step, after the tenth cycle, is where all participants come together and together with the lecturer calculate the costs per unit. This is done with an excel sheet illustrated shown on the projector (cf. Fig. 2) so that the information is immediately visible to all students. The way the cost function is integrated in the game is based on the element of *challenge*. The students try to decrease the production costs from round to round and potentially have less cost than the other three groups.



Management 16 A	Costs per piece	Pcs. Round 1	Pcs. Round 2	Pcs. Round 3	Pcs. Round 4
Quality not ok	€ 100,00	39	1	2	3
Unsatisfied Deman	€ 20,00	62	2	2	3
Inventory	€ 10,00	37	2	0	0
Table	€ 200,00	5	3	2	1
People	€ 100,00	7	8	6	3
Prod Costs		€ 7.210,00	€ 1.560,00	€ 1.240,00	€ 860,00
Quantity Q Ok		8	62	66	63
Med. Costs/Unit		€ 901,25	€ 25,16	€ 18,79	€ 13,65

Fig. 2. Cost function visible on beamer for feedback after each round

The *fourth and last step* in every round is the definition of changes and small improvements based on the feedback and students' reflections. This is one of the most important learnings during the game, thus students are given sufficient time to do this. Sometimes it happens that students conduct a trial run on their changes before going to the next round – it's absolutely under students' *control*, which means the clear borders between this and the planning step for the next round are blurred. Yet eventually the next round will start. In this step of planning the changes the students are also given some time to write down their individual perceptions during the game, which acts as a base for their follow-up reflection paper.

After four rounds students have time to discuss the game and the results together with the lecturer. Furthermore the students have to think about questions as part of an assignment. For example, they are asked about their expectations in the morning before the game started and how they felt after 5 h of playing. They have to design process models based on the Business Process Modeling Notation (BPMN) for every round, describe their changes and the achieved improvements and take the theoretical concepts from the theoretical inputs classes into consideration. By the last question they are asked to reflect on the practical transfer of the learned elements from theory and the game.

4 Methods and Data

The impact of the gameful design can be measured by the following variables, which are partially observed by the lead author during the lecture and partially taken from the written assignments handed in by every student after the lecture. The analysis of the variables follows the principles of (1) qualitative text analysis, (2) qualitative observation and (3) grading [16]. The combination of the three different data sources [17] follow the principles of data triangulation as mentioned by Denzin [18]:

- *motivation and engagement*: ranked by the lecturer during the game by **observation** and note taking, measured in percentage from “being part of the game” with less than 80%, “motivated” between 80 and 95% and “highly motivated” with more than 95%;
- *fun*: one part of the students reflection paper was to describe their personal view of how they experienced the game – this was taken for the measurement of fun (count 1 if they had “fun”), based on **text analysis**;
- *knowledge increase*: on the given objectives described in Sect. 1 **graded** by the lecturer based on the reflection paper – from, above expectations with more than 90%, as expected with 80–90% and under expectations with less than 80%;
- *practical transfer*: **graded** by the lecturer based on the separated section in the refection paper – from, above expectations with more than 90%, as expected with 80–90% and under expectations with less than 80%;

A basic method of qualitative research was used, which combined qualitative observation [19] with a text analysis of the students’ reflection papers [2]. Text fragments were coded and consequently ranked by occurrence [16]. Papers were first screened and coded regarding the aspect “fun”. The variables “knowledge increase” and “practical transfer” are relevant for the grading of the course - so they have been analyzed in detail, based on the expectations defined before the grading started. The variable “motivation and engagement” was observed by the lead author in all the four groups. Notes have been taken to paint a holistic picture of the four different groups and collect enough details of every student. In Fig. 3 the results are given in percentage as part of the whole group.

The interpretation of these numbers and their success with respect to the previously stated target values will be provided in the next section.

	highly motivated	61%
	motivated	23%
motivation	part of the game	16%
	had fun	86%
fun	had no fun	14%
	above expectations	39%
	as expected	59%
knowledge increase	under expectations	2%
	above expectations	20%
	as expected	68%
practical transfer	under expectations	11%

Fig. 3. Results of the variable calculation

5 Discussion of Results

As shown in Sect. 4, data are rather surprising concerning the basic assumptions to increase motivation and engagement/fun and consequently reach the set objectives described in the introduction, implementing gameful design aspects while planning the game based on gamification elements.

The motivation of all the 44 students has been moderate and all of them were at least part of the game. No 'free riders' have been detected during the whole day of gaming. The amount of motivated ones was at 23%, which is slightly less than a quarter. Surprisingly, 61% have been highly motivated. This high motivation was especially observed in one group where the lecturer asked them to have a break and they decided to think about ways of improving their process instead – something, which is not common with bachelor students. The expected target of more than 80% motivation was thus reached.

Many of the students had fun during the day of playing the four rounds of the game – that is, 86% did use words authors were able to link to the code "fun" when analyzing the reflection papers. Only 14% did not make use of any respective words. The target of reaching more than 80% of the students with the game was thus also reached.

The knowledge increase based on the objectives given by the paper from Jung and Lehrer [1] for BISE education and especially the role of a process manager were fulfilled as expected by 59% of the students. More than 35% were able to reach knowledge above the expectations and only two percent were rated under expectations. Hence, also for knowledge increase the target of 80% was reached.

Generally, students felt that practical knowledge was well transferred. However, many of them (11%) did not understand how this know-how may affect their future work and/or positions. Only few of them concentrated on one topic, which they additionally expanded their knowledge on by additionally reading current papers or books. Because the topic of knowledge transfer is of such high importance for the authors and also manifested in the curriculum of the course, the authors conclude that this factor is under estimations and has to be improved in future.

6 Limitations and Future Work

One limitation to this study is that it only involved 44 students during one term. In order to increase the sample size, the authors will use a similar setting during the next term in the process management masters course and will try to collect additional data from a lecturer which uses the simulation without implementing gamification aspects. In future it is planned to divide the course in two groups to get a control group for effect clarifications.

The meaningfulness of the reward or social statement for being the best group has to be improved and maybe a leaderboard of sailboat builders has to be established [20] and filled over the time, potentially communicating the best results which have to be beaten by the students.

Additionally, students' understanding of how this knowledge may affect their future work or positions has to be improved. We have to reflect on how this idea may be better transported to students and how the question should be adapted so that more of them are able to fulfill those expectations.

References

1. Jung, R., Lehrer, C.: Guidelines for education in business and information systems engineering at tertiary institutions. Bus. Inf. Syst. Eng. **59**, 189–203 (2017). https://doi.org/10.1007/s12599-017-0473-5
2. Berg, B.: Qualitative Research Methods for the Social Sciences. Allyn and Bacon, Boston (1989)
3. Lei, S.A.: Intrinsic and extrinsic motivation: evaluating benefits and drawbacks from college instructors. J. Instr. Psychol. **37**, 153 (2010)
4. Deterding, S., Dixon, D., Khaled, R., Nacke, L.: From game design elements to gamefulness. In: Proceedings of the 15th International Academic MindTrek Conference on Envisioning Future Media Environments - MindTrek 2011, p. 9 (2011)
5. Maslow, A.H.: A theory of human motivation. Psychol. Rev. **50**, 370–396 (1943)
6. Keller, J.M.: Motivational Design for Learning and Performance: The ARCS Model Approach. Springer Science & Business Media, Boston (2009). https://doi.org/10.1007/978-1-4419-1250-3
7. Vansteenkiste, M., Lens, W., Deci, E.L.: Intrinsic versus extrinsic goal contents in self-determination theory: another look at the quality of academic motivation. Educ. Psychol. **41**, 19–31 (2006). https://doi.org/10.1207/s15326985ep4101_4
8. Dichev, C., Dicheva, D., Angelova, G., Agre, G.: From gamification to gameful design and gameful experience in learning. Cybern. Inf. Technol. **14**, 80–100 (2014). https://doi.org/10.1515/cait-2014-0007
9. Helgason, D.: Trends 2010. Unity Technol. Blog (2010). http://goo.gl/AZ4vm

10. Dicheva, D., Dichev, C., Agre, G., et al.: Gamification in education: a systematic mapping study. Educ. Technol. Soc. **18**, 75–88 (2017)
11. O'Donovan, S., Gain, J., Marais, P.: A case study in the gamification of a university-level games development course. In: Proceedings of the South African Institute for Computer Scientists and Information Technologists Conference - SAICSIT 2013, p. 242 (2013). https://doi.org/10.1145/2513456.2513469
12. Kapp, K.: Games, gamification, and the quest for learner engagement. T + D **66**, 64–68 (2012)
13. Pirker, J., Riffnaller-Schiefer, M., Gütl, C.: Motivational active learning: engaging university students in computer science education. In: 2014 Innovation and Technology in Computer Science Education Conference ITICSE 2014, pp. 297–302 (2014). https://doi.org/10.1145/2591708.2591750
14. Landers, R.N., Callan, R.C.: Casual social games as serious games: the psychology of gamification in undergraduate education and employee training. In: Ma, M., Oikonomou, A., Jain, L. (eds.) Serious Games and Edutainment Applications, pp. 399–423. Springer, London (2011). https://doi.org/10.1007/978-1-4471-2161-9_20
15. Bartel, A., Hagel, G.: Engaging students with a mobile game-based learning system in university education. In: Kaynak, O., Auer, M., Llamas, M. (eds.) Proceedings of IEEE Global Engineering Education Conference, pp. 957–960 (2014)
16. Döring, N., Bortz, J.: Forschungsmethoden und Evaluation in den Sozial- und Humanwissenschaften. Springer, Heidelberg (2015). https://doi.org/10.1007/978-3-642-41089-5
17. Lamnek, S., Krell, C.: Qualitative Sozialforschung, 6th edn. Beltz, Weinheim (2016)
18. Denzin, N.: The Research Act: A Theoretical Introduction to Sociological Methods. McGraw-Hill, New York (1978)
19. Bryman, A., Bell, E.: Business Research Methods. Oxford University Press, Oxford (2015)
20. Van Hentenryck, P., Coffrin, C.: Teaching creative problem solving in a MOOC. In: Proceedings of the 45th ACM Technical Symposium on Computer Science Education - SIGCSE 2014, pp. 677–682 (2014). https://doi.org/10.1145/2538862.2538913

Student's Perceptions of Cyberbullying in the Context of Cyberbullying Criteria and Types: The Role of Age

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Abstract. The aim of the study was to describe how 12–13 and 15–16 years old Estonian students perceived cyberbullying, in the context of cyberbullying criteria and type of cyberbullying behaviour, and if any differences occurred between the age groups. The questionnaire sample consisted of 325 adolescents from two age groups: *12–13* (49%) *and 15–16* (51%) year olds. Data were analysed and statistical comparisons made between the two age groups. The results revealed that scenarios involving power imbalance criteria were labelled more as cyberbullying and were evaluated more severe among both age groups, than all the other cyberbullying criteria scenarios. Two criteria specific to the cyber context (publicity and anonymity) were not so important for students in order to label behaviour as cyberbullying. Impersonation and visual cyberbullying represented the cyberbullying construct better, with no differences between the two age groups, and were considered more serious than written–verbal behaviour and exclusion.

Keywords: Cyberbullying criteria · Cyberbullying types · Perception
Age differences

1 Introduction

One of the problems associated with the fast development of information and communication technologies, and the growth in the use of the internet, is cyberbullying. In many studies [1, 2], the definition of cyberbullying starts with Olweus' [3] definition of traditional bullying. According to Olweus [3], "*a student is being bullied or victimized when he or she is exposed, repeatedly and over time, to negative actions on the part of one or more other students*" (p. 10). As reported by Olweus [3], there are three important criteria that define bullying behaviour: intentionality; repetition; an imbalance of power. Many scholars [2, 4, 5] claim that regarding cyberbullying, there are additional criteria that are specific to communicating using new technologies: public vs. private; anonymous vs. known person.

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1.1 Criteria of Cyberbullying

According to Olweus [3], there are three important criteria that define bullying behaviour: intentionality; repetition; an imbalance of power. These criteria may acquire a different meaning in cyber context. For instance, some researchers [6, 7] claim that in the cyber environment, the repetition criterion acquires an additional dimension, because even one bullying incident in the cyberworld may result in continued humiliation for the victim owing to the public and permanent nature of the cyber environment resulting in new people seeing the insult as time passes. Many scholars [2, 4, 5] claim that with regard to cyberbullying, there are additional criteria that are specific to communicating using new technologies: public vs. private; anonymous vs. known person. Smith et al. [2] found that students differentiated traditional bullying from cyberbullying mainly owing to the anonymity the later usually entails, and in students' opinion cyberbullying can be more severe than traditional bullying, because of the larger audience the internet can involve. Anonymous bullies may foster feelings of insecurity in the victim [8], because it is hard to oppose someone you do not know, and they may even not know if it is one person or a group bullying them [9, 10].

Research on both traditional bullying [11, 12] and cyberbullying [13, 14] have shown that age may affect the way phenomena are perceived by students, and for this reason the aim of this paper was to find out if there were any age-related differences with the regard to how cyberbullying is perceived by Estonian students.

1.2 Types of Cyberbullying

There are several classifications of cyberbullying behaviour [5, 8, 9]. Drawing on previous studies, Nocentini et al. [5] created a classification based on the nature of the attack and summarised the different types of cyberbullying:

- written–verbal: involves bullying acts where written or verbal forms of communication are used (e.g. phone calls, text messages, emails, blogs, Skype, social networking sites);
- visual: involves visual forms of bullying, such as posting, sending, or sharing compromising pictures or videos on the internet or via mobile phones;
- impersonation: involves situations where the perpetrator gains access to the victim's account(s) and steals or reveals their personal information;
- exclusion: involves situations where someone is purposefully excluded from an online group (e.g. an online gaming environment, a buddy list).

1.3 Age Differences in Cyberbullying Behaviour

In the context of traditional bullying, Scheithauer et al. [15] found that bullying behaviour increases between early (6^{th} Grade) to middle adolescence (9^{th} Grade). Smith et al. [12] found in their cross-cultural research that children of different ages understand the concept of bullying differently. Although 8 years old students were able to distinguish between aggressive and non-aggressive behaviour, they did not differentiate between forms of bullying (verbal, physical, or relational), unlike children aged 14 years old [12]. This result is in line with Barlett and Coyne [16], who found that forms of aggression change as children mature; at first, physical forms of aggression are used in order to cope with stressful situations, but once verbal skills have developed during early childhood, the focus shifts from physical to verbal aggression. They claim that during childhood and adolescence, a person becomes more aware of the nature and complexity of human relationships, and this is also the period when relational or indirect forms of aggression emerge, including cyberbullying. Since cyberbullying requires a certain amount of technological skills and knowledge to hurt others, the phenomenon often emerges around late childhood to early adolescence [16].

The results of previous studies about relationships between age and cyberbullying behaviour are controversial. Some studies have found that older students are more likely to be involved in cyberbullying behaviour [2, 17–19]. The EuKids Online report [20] also indicated that older students encounter more online risks of all kinds. Conversely, some studies have indicated that the proportion of students participating in cyberbullying is lowest among older students [21, 22]. Other studies have found no significant differences based on the age of the students [23, 24]. Brighi et al. [4] found that younger victims were more likely to be traditionally bullied, but that age was not a predictor in the case of cyberbullying.

2 Aim and Hypothesis of the Current Study

Why have previous studies on age differences and cyberbullying shown contradictory results? One possible explanation might be that the items used in questionnaires or interviews were not equally well understood by all age groups. Perren and Gutzwiller-Helfenfinger [24] associated an understanding of cyberbullying activities with morality, and claimed that only in older adolescence is morality fully integrated into the self. Therefore, the aim of the present study was to describe how 12–13 and 15–16 years old Estonian students perceived cyberbullying, in the context of cyberbullying criteria (intentionality, an imbalance of power, repetition, public/private, and anonymity) and type of cyberbullying behaviour (written–verbal, visual, exclusion, and impersonation), and if any differences occurred between the age groups.

Two research questions were posed:

(1) Which age differences occur in labelling cyberbullying behaviour and in evaluations of severity of cyberbullying according to the criteria of cyberbullying?
(2) Which age differences occur in labelling cyberbullying behaviour and in evaluations of severity of cyberbullying according to the types of cyberbullying.

3 Method

3.1 Sample

Estonian students from two age groups, 12–13 (from grade six) and 15–16 (from grade nine), completed the questionnaire. The total number of participants was 336, however after harmonising the data set according to age and gender, the final sample size was

325 (12–13 year olds, n = 160 and 15–16 year olds, n = 165; 49% and 51% respectively). The mean age of all participants (N = 325) was 14.05 years (SD = 1.45), with 168 males (52%) and 157 females (48%). The data were collected from 12 schools (three in large towns, three in small towns, and six in countryside villages). The schools were selected using a convenience sampling method.

3.2 Instrument

Scenarios for questionnaire were developed in the European project COST ACTION IS0801 working group WG1. 32 scenarios were composed, where the presence and absence of the five cyberbullying criteria (intentionality, an imbalance of power, repetition, public/private, anonymous) were combined (see Table 1 and Appendix).

Table 1. The five cyberbullying criteria used in the scenarios

Criteria	Example of cyberbullying criteria in the scenarios
Intentionality	"To intentionally hurt" vs. "as a joke"
Imbalance of power	"C. was upset and didn't know how to defend himself/herself" vs. "C. didn't care"
Repetition	"Several times during the last month" vs. "once"
Public/private	"To other people to see" vs. "only to C"
Anonymity	"C., who didn't know him/her personally" vs. "to C., a familiar boy/girl"

Four types of cyberbullying behaviours (written–verbal, visual, exclusion, and impersonation, see Table 2) were combined with the 32 cyberbullying criteria presence/absence scenarios in such a way that a total of 128 scenarios were developed.

Table 2. The four types of cyberbullying behaviour

Type of behaviour	Example of the cyberbullying behaviour in the scenarios
Written–verbal	"M. sent to C. a nasty text message"
Visual	"M. sent to C. a compromising photo"
Exclusion	"M. took C. off their online group"
Impersonation	"M. has got access to C.'s password or private information"

Note: C = victim; M = bully.

Students were asked to evaluate each scenario based on whether they thought it cyberbullying or not, and if the answer was yes, then they were asked to evaluate the seriousness of the behaviour. As the number of scenarios was too large to evaluate by any one student, the scenarios were divided into four versions and thereby each student evaluated 32 scenarios. Each version was distributed to ten male and ten female students from each of the age groups (12–13 and 15–16 years old), thus each scenario was evaluated by 40 students.

To analyse the content validity of the instruments expert judgment of the items were obtained from European experts from COST ACTION. After that the instrument was translated into Estonian, and then translated back into English by another researcher and any discrepancies discussed with experts. The questionnaire was pre-tested to identify any ambiguities and difficult questions, to ensure that the instrument in Estonian was conceptually equivalent with the original version.

3.3 Procedure and Data Analysis

Students filled in a questionnaire during school time in their classroom. Questionnaires were distributed to the students by their teachers. Teachers were informed by the researcher on how to administer the questionnaire and provide help where needed. Participants were assured that participation was voluntary and their responses anonymous.

Percentages of "yes, it's cyberbullying" were calculated for each of the 32 scenarios per age group, and on the basis of these percentages, new variables were calculated. Five of these new variables were calculated as a percentage of scenarios by criteria labelled as cyberbullying and four of them were calculated as a percentage of scenarios by types labelled as cyberbullying by each respondent. Chi-square analysis and t-tests were performed to determine if any statistical differences between the two age groups occurred.

Five new variables were calculated as a median of the severity evaluation of each of the criteria of cyberbullying, and four new variables were calculated as the median of the severity evaluation of each type of cyberbullying by each respondent. To compare the severity of the scenarios, Mann-Whitney's U-test was used in the case of two independent groups and Wilcoxon's test was used in the case of two dependent groups.

4 Results

4.1 Criteria of Cyberbullying

Among both age groups (12–13 and 15–16 years old) scenarios involving the criteria of power imbalance were more likely to be labelled as cyberbullying, followed by scenarios involving the criteria intention and repetition (see Table 3). In both age groups the least labelled scenarios represented publicity and anonymity criteria.

The criteria power imbalance was more significant to the younger age group, who were more likely to label such scenarios as cyberbullying compared to the older students ($t = 2.01$, $p < .05$). There were no other statistically significant differences between the age groups in terms of scenarios representing the other criteria (in all cases $p > .05$).

Scenarios involving power imbalance criteria were perceived more severe than scenarios with other criteria among both age groups (Wilcoxon test, in all cases $p < 0.001$). Scenarios representing intention or repetition criteria were evaluated as the joint second most severe scenarios among both age groups. Furthermore, in the context of intention or repetition criteria there was difference from scenarios with all other

Table 3. Comparison in labelling questionnaire scenario as cyberbullying by criteria within the younger (12–13 years old) and older (15–16 years old) age groups using paired t-tests

Type	Mean percentage	t-statistic with intention	t-statistic with repetition	t-statistic with publicity	t-statistic with anonymity
Younger students					
Power imbalance	91.7	5.37***	8.32***	12.20***	11.88***
Intention	85.7		5.40***	8.08***	9.00***
Repetition	82.0			4.20**	5.14***
Publicity	78.6				1.83
Anonymity	77.0				
Older students					
Power imbalance	89.0	4.87***	7.09***	8.92***	10.17***
Intention	84.7		4.35***	6.60***	7.69***
Repetition	80.8			3.92***	4.88***
Publicity	76.4				0.57
Anonymity	76.7				

* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$

criteria in all cases ($p < 0.001$), but between intention and repetition criteria there was no statistically significant difference (among younger student $Z = -1.43$ and among older student $Z = -1.70$, $p > 0.05$ in both cases). As shown in Table 3 there was no statistically significant difference in labelling scenarios involving publicity and anonymity criteria as cyberbullying among either age group. There was no statistically significant difference also in the case of older students' evaluations of cyberbullying severity between these criteria ($Z = -0.07$, $p > 0.05$), but younger students perceived scenarios with a public aspect as more severe than those involving the criteria anonymity ($Z = -3.24$, $p < 0.001$). Younger students evaluated scenarios with a publicity criteria more severe than older students (Mann-Whitney U-test, $U = 11887.5$, $p < 0.05$). No other statistically significant differences in comparisons of the evaluations of the severity of cyberbullying criteria between the two age groups were found (in all cases, $p > 0.05$).

4.2 Typologies of Cyberbullying

Among the younger students (12–13 years old), scenarios representing the types 'visual' or 'impersonation' were more often labelled as cyberbullying compared to all other types (see Table 4). Among the older students (15–16 years old), the same two types were more often labelled as cyberbullying, but there was no statistically significant difference between impersonation and written–verbal types.

Table 4. Comparison in labelling questionnaire scenario as cyberbullying by type of behaviour within the younger (12–13 years old) and older (15–16 years old) age groups using paired t-tests

Type	Mean percentage	t-statistic with impersonation	t-statistic with written–verbal	t-statistic with exclusion
Younger students				
Visual	83.8	−0.31	2.29*	9.83***
Impersonation	84.2		2.82**	9.45***
Written–verbal	80.4			8.44***
Exclusion	62.7			
Older students				
Visual	85.2	1.68	3.7***	11.71***
Impersonation	82.6		1.61	11.15***
Written–verbal	79.8			9.43***
Exclusion	54.8			

*$p < 0.05$
**$p < 0.01$
***$p < 0.001$

Younger students marked exclusion as bullying more than older students ($t = 2.53$, $p < 0.05$) and perceived it more severe compared to older students ($U = 12033.5$, $p < 0.05$). In the case of other types there were not any statistically significant difference between younger and older students in labelling scenarios as cyberbullying and in evaluations of severity (in all cases, $p > 0.05$).

Results of Wilcoxon's sign test indicated that younger students perceived impersonation more severe compared to visual ($Z = -2.39$, $p < 0.05$) cyberbullying; older students' evaluations were vice versa, evaluating visual cyberbullying as more severe in comparison to impersonation ($Z = -2.19$; $p < 0.05$). Exclusion was perceived to be least serious by students in both age groups (in all cases, $p < 0.01$).

5 Discussion

The current study focused on researchers' operationalized criteria of cyberbullying and types of cyberbullying behaviour among students of two different age groups: 12–13 and 15–16 years old. In response to the first research questions regarding the criteria of cyberbullying, the results indicated that a power imbalance was the main criteria of cyberbullying for students: scenarios with power imbalance criteria were labelled more as cyberbullying and evaluated as the most severe among the scenarios. In terms of definition and instrumentation development this is an important outcome; Berne et al. [25] presented an overview about instruments designed to assess the prevalence of cyberbullying. They found that only 13 of the 44 definitions contained the criterion of imbalance of power. In the line with our results, Vaillancourt et al. [26] found that in a traditional bullying context, an imbalance of power was the most spontaneously mentioned criteria (by 26% of students) among others (intentionality and repetition). The criterion of a power imbalance has also emerged in previous cyberbullying studies [10, 27, 28]. Correspondingly to our previous study [10], one explanation may be that the direct effect on the victim's feelings in the scenario with the power imbalance criterion "*C. was upset and did not know how to defend himself/herself*", might have provoked empathic feelings in the students. Willard [8] claims that the key element for the prevention of violence and bullying is to ensure that students are empathically aware of the consequences of their behaviour towards other people and it also involves a sense of remorse for taking actions that caused hurt.

In the current study an imbalance of power was the most important criteria for both age groups, and in both a definitional and severity context it was followed by two other criteria that are considered to be definitional criteria in a traditional bullying context: intentionality and repetition. This result supports Olweus' [29] argument that to obtain an accurate assessment of the cyberbullying phenomenon, we cannot investigate it outside of the general context of traditional bullying. However, we still acknowledge Menesini's [28] arguments, together with the results of our previous study [10], which indicated that for Estonian students, anonymity was the second most relevant criteria for defining cyberbullying, that although the overlap between bullying and cyberbullying remains unclear, cyberbullying still has its specifiers that cannot be underestimated.

It must also be noted that although two criteria specific to the cyber context, publicity and anonymity, remained rather in the background among both age groups, it still seemed that these were more important to younger than older students. Younger students perceived scenarios with publicity criteria as more severe than scenarios with anonymity criteria. Furthermore, younger students evaluated public scenarios as more severe than the older students. This indicates that criteria specific to the cyber environment were perceived slightly different by the age groups. We agree with Sticca and Perren [30], who emphasize the need to distinguish between the actual and perceived severity of cyberbullying behaviour. It is necessary to increase adolescents' as well as teachers' and parents' awareness of the actual severity of public and anonymous cyberbullying in order to make them more caution and aware of the dangers of online communication [30]. Also we conclude similarly to Nocentini et al. [5] that although the two cyber specific criteria were not essential in order to label an action cyberbullying, they connoted the context because they were related to severity evaluations, and how the nature of the attack, the bully–victim's relationship, and the victims' reaction were perceived and interpreted, by both age groups.

The second research question covered the topic of cyberbullying types and their relevance to the definition of cyberbullying. Both age groups (12–13 and 15–16 years old) labelled scenarios representing visual and impersonation types as cyberbullying. According to our previous study [10] visual cyberbullying was the most severe form for students, because it was the most convincing and humiliating for them; in addition, a picture or video can be spread very quickly in the cyber environment. Smith et al. [2] and Pierschl et al. [31] also found that students perceived videos/pictures as the severest type of cyberbullying. Our results are supported by Spears et al. [32] who claim that today's adolescents have very strong "photo-voice" best seen on Pinterest, Instagram, YouTube, Tumblr and Social Networking Sites. With photographs (e.g. selfies) and videos adolescents express their social context, their emotions, their perspective of themselves and their worlds and this is part of their identity [32]. In our previous study [10] older students explained that impersonation is the kind of cyberbullying that can cause a lot of trouble for the victim, for instance by spreading private information or writing nasty things about others in their name. Since identity is one of the most important developmental issues of the age group 11–15 [32] it can be assumed that students perceived the aspect of identity violation in impersonation scenarios *(M. has got access to C.'s password or private information*) and that may be the reason why impersonation scenarios emerged from both age groups.

Results also indicated that younger students evaluated impersonation more severe compared to visual cyberbullying. Older students' evaluations were contrary. Based on this we may assume that different age groups may need increased focus on specific cyberbullying types in bullying prevention and intervention programs. Furthermore, in the case of the younger students, two types of cyberbullying—visual and impersonation—were significantly distinguished from the two other types (written–verbal and exclusion), but with the older students there was no statistically significant difference between labelling scenarios represented by impersonation and written–verbal types of cyberbullying. Since during childhood and adolescence, the child becomes more aware of the nature and complexity of human relationships which leads to the use more sophisticated forms of aggression [16] we may assume as a result of this process, older students are able to better understand the nature of the different types of bullying. Moreover, online communication is characterized by the lack of tangible feedback which makes it difficult for people, especially for younger ones, to understand the harm that their behaviour has caused [8]. This outcome may also be explained by the development of children's emphatic feelings during the adolescents' years [33]. We may speculate that older students were able to distinguish between more cyberbullying types due to their more developed empathy. Based on our results we emphasize that the topic of empathy, particularly in the context of online communication, must be one of the central issue in bullying prevention and intervention programs.

The scenarios including exclusion were comparatively perceived as cyberbullying the least, and were also evaluated as the least severe, especially among the older students. Similar to our previous study [10], for Estonian students exclusion seemed to be more a defensive reaction against aggressive behaviour, i.e. to put an end to cyberbullying. This is a quite logical reaction for Estonian students, because in order to avoid or put an end to cyberbullying they are often recommended by parents or teachers to exclude or block the 'bully'. Consequently, it is important to teach students to distinguish the difference between exclusion as a coping strategy and exclusion as a cyberbullying act.

The topic of cyberbullying definition in the context of age differences was not well covered in previous studies. The starting point of the current study was the need to understand cyberbullying from the multiple perspectives of adolescents to measure, minimize, and prevent it. Results indicated that there were no diametrically different perceptions of cyberbullying between two age groups. Though we must be cautious about making generalizations from our results on a larger population, because of the sample characteristics and the randomized administration of the scenarios, the results of the current study are encouraging for researchers who want to develop valid instruments to measure cyberbullying behaviour across different age groups. Among both age groups scenarios involving the criteria of power imbalance were more likely to be labelled as cyberbullying, followed by scenarios involving the criteria intention and repetition. These are all criteria that define bullying behaviour [3]. Two criteria specific to the cyber context, publicity and anonymity, remained rather in the background. Based on these results we assume that cyberbullying can be defined under the broad concept of bullying. Although the age gap investigated in the current study was narrow and more differences might have been emerged if the age spectrum was broader we still want to emphasize the fundamental developmental issues (e.g. empathy and identity) that emerged in the context of the two investigated age groups. In line with Spears et al. [32] we recognize that in addition to offline relationships adolescents are dealing with the same issues more and more in a virtual environment and it may be challenging for them. This study outlined some aspects of how different parties could support students on this journey. In future studies it would be efficacious to examine adolescents' spontaneous definitions of cyberbullying, i.e. without being restricted to operationalised criteria or types of cyberbullying; in the same way as Vaillancourt et al. [26] approached the study of traditional bullying.

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Appendix: Presence (Y) and Absence (N) of the Cyberbullying Criteria in the 32 Scenarios

Scenario	Intention	Repetition	An imbalance of power	Public (PUB)/ private (RRI)	Anonymity
1	N	N	N	PRI	N
2	N	N	Y	PRI	N
3	Y	N	Y	PRI	N
4	N	Y	Y	PRI	N
5	Y	Y	Y	PRI	N
6	Y	N	N	PRI	N
7	N	Y	N	PRI	N
8	Y	Y	N	PRI	N
9	N	N	N	PUB	N
10	N	N	Y	PUB	N
11	Y	N	Y	PUB	N
12	N	Y	Y	PUB	N
13	Y	Y	Y	PUB	N
14	Y	N	N	PUB	N
15	N	Y	N	PUB	N
16	Y	Y	N	PUB	N

(*continued*)

(*continued*)

Scenario	Intention	Repetition	An imbalance of power	Public (PUB)/ private (RRI)	Anonymity
17	N	N	N	PUB	Y
18	N	N	Y	PUB	Y
19	Y	N	Y	PUB	Y
20	N	Y	Y	PUB	Y
21	Y	Y	Y	PUB	Y
22	Y	N	N	PUB	Y
23	N	Y	N	PUB	Y
24	Y	Y	N	PUB	Y
25	N	N	N	PRI	Y
26	N	N	Y	PRI	Y
27	Y	N	Y	PRI	Y
28	N	Y	Y	PRI	Y
29	Y	Y	Y	PRI	Y
30	Y	N	N	PRI	Y
31	N	Y	N	PRI	Y
32	Y	Y	N	PRI	Y

References

1. Slonje, R., Smith, P.K.: Cyberbullying: another main type of bullying? Scand. J. Psychol. **49**, 147–154 (2008)
2. Smith, P.K., Mahdavi, J., Carvalho, M., Fisher, S., Russell, S., Tippett, N.: Cyberbullying: its nature and impact in secondary school pupils. J. Child Psychol. Psychiatr. **49**, 376–385 (2008)
3. Olweus, D.: Sweden. In: Smith, K.P., Morit, Y., Junger-Tas, J., Olweus, D., Catalano, R., Slee, P. (eds.) The Nature of School Bullying: A Cross-national Perspective, pp. 7–27. Routledge, London (1999)
4. Brighi, A., Guarini, A., Melotti, G., Galli, S., Genta, M.L.: Predictors of victimisation across direct bullying, indirect bullying and cyberbullying. Emot. Behav. Diffic. **17**, 375–388 (2012)
5. Nocentini, A., Calmaestra, J., Schultze-Krumbholz, A., Scheithauer, H., Ortega, R., Menesini, E.: Cyberbullying: labels, behaviours and definition in three European countries. Aust. J. Guid. Couns. **20**, 129–142 (2010)
6. Olweus, D., Limber, S.P.: Some problems with cyberbullying research. Curr. Opin. Psychol. **19**, 139–143 (2018)
7. Volk, A.A., Veenstra, R., Espelage, D.L.: So you want to study bullying? Recommendations to enhance the validity, transparency, and compatibility of bullying research. Aggress. Viol. Behav. **36**, 34–43 (2017)
8. Willard, N.E.: Cyberbullying and Cyberthreats: Responding to the Challenge of Online Social Aggression, Threats, and Distress. Research Press, Champaign (2007)

9. Kowalski, R.M., Limber, S.P., Agatston, P.W.: Cyber Bullying: Bullying in the Digital Age. Wiley, Malden (2008)
10. Naruskov, K., Luik, P., Nocentini, A., Menesini, E.: Estonian students' perception and definition of cyberbullying. TRAMES: J. Humanit. Soc. Sci. **16**, 323–343 (2012)
11. Monks, C.P., Smith, P.K.: Definitions of bullying: age differences in understanding of the term, and the role of experience. Br. J. Dev. Psychol. **24**, 801–821 (2006)
12. Smith, P.K., Cowie, H., Olafsson, R.F., Liefooghe, A.P.D., Almeida, A., Araki, H., del Barrio, C., Costabile, A., Dekleva, B., Houndoumadi, A., Kim, K., Olaffson, R.P., Ortega, R., Pain, J., Pateraki, L., Schafer, M., Singer, M., Smorti, A., Toda, Y., Tomasson, H., Wenxin, Z.: Definitions of bullying: a comparison of terms used, and age and gender differences, in a fourteen-country international comparison. Child Dev. **73**, 1119–1133 (2002)
13. Frisén, A., Berne, S., Marin, L.: Swedish pupils' suggested coping strategies if cyberbullied: differences related to age and gender. Scand. J. Psychol. **55**, 578–584 (2014)
14. Sittichai, R., Smith, P.K.: Bullying and cyberbullying in Thailand: coping strategies and relation to age, gender, religion and victim status. J. New Approach. Educ. Res. **7**, 24–30 (2018)
15. Scheithauer, H., Hayer, T., Petermann, F., Jugert, G.: Physical, verbal, and relational forms of bullying among german students: age trends, gender differences, and correlates. Aggress. Behav. **32**, 261–275 (2006)
16. Barlett, C., Coyne, S.M.: A meta-analysis of sex differences in cyber-bullying behavior: the moderating role of age. Aggress. Behav. **40**, 474–488 (2014)
17. Del Rey, R., Lazuras, L., Casas, J.A., Barkoukis, V., Ortega-Ruiz, R., Tsorbatzoudis, H.: Does empathy predict (cyber) bullying perpetration, and how do age, gender and nationality affect this relationship? Learn. Individ. Differ. **45**, 275–281 (2016)
18. Smith, P.K., Slonje, R.: Cyberbullying: the nature and extent of a new kind of bullying, in and out of school. In: Jimerson, S.R., Swearer, S.M., Espelage, D.L. (eds.) Handbook of Bullying in Schools: An International Perspective, pp. 249–262. Routledge/Taylor & Francis Group, New York (2010)
19. Ybarra, M.L., Mitchell, K.J.: Online aggressor/targets, aggressors, and targets: a comparison of associated youth characteristics. J. Child Psychol. Psychiatr. **45**, 1308–1316 (2004)
20. Livingstone, S., Haddon, L., Görzig, A., Ólafsson, K.: EU kids online II: final report 2011. Accessed 04 Apr 2018
21. Lindfors, P.L., Kaltiala-Heino, R., Rimpelä, A.H.: Cyberbullying among Finnish adolescents - a population-based study. BMC Publ. Health **12**, 1–5 (2012)
22. Tokunaga, R.S.: Following you home from school: a critical review and synthesis of research on cyberbullying victimization. Comput. Hum. Behav. **26**, 277–287 (2010)
23. Patchin, J.W., Hinduja, S.: bullies move beyond the schoolyard: a preliminary look at cyberbullying. Youth Viol. Juv. Justice **4**, 148–169 (2006)
24. Perren, S., Gutzwiller-Helfenfinger, E.: Cyberbullying and traditional bullying in adolescence: differential roles of moral disengagement, moral emotions, and moral values. Eur. J. Dev. Psychol. **9**, 195–209 (2012)
25. Berne, S., Frisén, A., Schultze-Krumbholz, A., Scheithauer, H., Naruskov, K., Luik, P., Katzer, C., Erentaite, R., Zukauskiene, R.: Cyberbullying assessment instruments: a systematic review. Aggress. Viol. Behav. **18**, 320–334 (2013)
26. Vaillancourt, T., McDougall, P., Hymel, S., Krygsman, A., Miller, J., Stiver, K., Davis, C.: Bullying: are researchers and children/youth talking about the same thing? Int. J. Behav. Dev. **32**, 486–495 (2008)

27. Cuadrado-Gordillo, I., Fernández-Antelo, I.: Adolescents' perception of the characterizing dimensions of cyberbullying: differentiation between bullies' and victims' perceptions. Comput. Hum. Behav. **55**, 653–663 (2016)
28. Menesini, E., Nocentini, A., Palladino, B.E., Frisén, A., Berne, S., Ortega-Ruiz, R., Calmaestra, J., Scheithauer, H., Schultze-Krumbholz, A., Luik, P., Naruskov, K., Blaya, C., Berthaud, J., Smith, P.K.: Cyberbullying definition among adolescents: a comparison across six European countries. Cyberpsychol. Behav. Soc. Netw. **15**, 455–463 (2012)
29. Olweus, D.: Cyberbullying: an overrated phenomenon? Eur. J. Dev. Psychol. **9**, 520–538 (2012)
30. Sticca, F., Perren, S.: Is cyberbullying worse than traditional bullying? Examining the differential roles of medium, publicity, and anonymity for the perceived severity of bullying. J. Youth Adolesc. **42**, 739 (2013)
31. Pieschl, S., Porsch, T., Kahl, T., Klockenbusch, R.: Relevant dimensions of cyberbullying—results from two experimental studies. J. Appl. Dev. Psychol. **34**, 241–252 (2013)
32. Spears, B., Costabile, A., Brighi, A., Del Rey, R., Pörhölä, M., Sánchez, V., Spiel, C., Thompson, F.: Positive uses of new technologies in relationships in educational settings. In: Smith, P.K., Steffgen, G., Smith, P.K., Steffgen, G. (eds.) Cyberbullying Through the New Media: Findings from an International Network, pp. 178–200. Psychology Press, New York (2013)
33. Allemand, M., Steiger, A.E., Fend, H.A.: Empathy development in adolescence predicts social competencies in adulthood. J. Pers. **83**, 229–241 (2015)

Use of *Kahoot* and *EdPuzzle* by Smartphone in the Classroom: The Design of a Methodological Proposal

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Abstract. In these days, we live in a society where technology is everywhere. Some technological devices, such as smartphones, have become almost an extension of ourselves and a fundamental tool to carry out multiple tasks of our daily life. However, in the educational field, it has not been possible to develop the great potential that smartphones have as a teaching resource yet. Its use in the classroom can help us to improve the teaching and learning process, providing new tools to teachers and enhancing the acquisition of certain concepts by students, especially among "Digital Natives", who are accustomed to using technology. Technological development, new educational applications and studies on the advantages of using the smartphone in the classroom, endorse its use as an educational tool. Therefore, in this work is intended, on the one hand, to investigate the theoretical bases that position the use of *Kahoot* and *EdPuzzle* tools through the smartphone and the Master Class, and on the other hand, to design a methodological proposal that includes these tools in an active methodology, in order to achieve a more meaningful and constructivist learning, enhancing the students' knowledge acquisition.

Keywords: Smartphone · *Kahoot* · *EdPuzzle* · Master Class
Active methodology

1 Introduction

As indicated by Fernández in [16] the fact of providing information to students, favoring active participation in the classroom, through the Master Class, encourages meaningful learning. On the other hand, at present, the methodologies of educational innovation focus, mainly, on the use of ICT and they are based on the principles of constructivism [19]. To achieve this, some online tools will be used to enable the implementation of new teaching methodologies in the classroom. The use of ICT educational tools, such as *Kahoot*, implies that the student is an active element within the educational experience, fostering its attention, participation and motivation [18, 24, 28, 29, 37, 44]. Another tool is *EdPuzzle*, which enhances the student's autonomous work allowing him or her to be the builder of new knowledge, [31].

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On the other hand, with the use of these technologies, the teacher remains informed of the evolution of their students during all the process, being aware of the level of learning they have achieved. This would entail, therefore, a reinforcement on the way the teacher has to present the lesson [9, 15]. In the same line, this type of questionnaires, in addition to swelling the list of evidences that would be part of the continuous assessment of the students, they would also constitute a fundamental piece in their formative evaluation, since they help them to settle the knowledge of the new content, being considered as a good way to get a feedback necessary both for the students and the teacher.

The purpose of this work is based on the development of a methodological proposal based on the use of *Kahoot* and *EdPuzzle* with Smartphones in the classroom designed with the aim of improving students' meaningful learning. The first step has been based on carrying out a theoretical review on the use of personal response systems in classrooms through Smartphones that allows establishing the theoretical bases on which the work in this study is based on.

The objectives of this study are: 1. To carry out a theory review of the main sources in the field of personal response systems through Smartphones in the classroom, which serves as a basis for the design of the methodological proposal. 2. To design a methodological proposal that combines the use of the Master Class with the use of personal response systems as assessment and self-assessment instruments, to improve the teaching-learning experience in the classroom.

2 Master Class

According to Fernández in [16], the methodology based on Master exhibitions seeks the acquisition of updated and well-organized information by the student, coming, in most cases, from various sources of difficult access for the student, facilitating the understanding and application of the specific procedures of the subject and increasing the students' motivation towards it. However, for the students' knowledge, skills and values acquisition, using the Master Class as a methodology, as Fernández in [16] indicates, it has to be participatory, so that the teacher has to question the students so as to potentiate their active and collaborative learning.

In the development of the Master Class, the teacher should try to prepare and structure classes appropriately, transmit clarity, enthusiasm and expressiveness in the presentation, dedicate a time for student intervention, solve student doubts effectively, make a contribution in them toward the awareness of the need to continue learning, use of summaries during the lesson and at the end of it, highlight the fundamental ideas of the lesson, time the contents, relate the topics within the same master class and encourage meaningful and cooperative learning among students, since, as Ausubel et al. in [3] points out, human beings mainly learn receptively by assimilation.

In order to obtain the desired results in the application of such expository methodology, the teacher should avoid to: provide too much information, use excessive expository speed and assume too much knowledge in their students and use of excessive technical.

3 The Use of Smartphones in the Classrooms

Among the existing paradigms of education, the constructivist model is the one that has a more direct relationship with contemporary education since all the current methodologies of educational innovation, which have the use of ICT as protagonist, are based on the principles of constructivism [19]. Some studies have been carried out to know if those technologies affect positively in the academic results. In this sense, Alonso in [1] points out that “the adequate incorporation of ICT in training processes can be a great way of transforming traditional teaching processes into more creative and innovative formulas” (p. 17).

Castañeda in [13] makes a reflection about the advantages of using ICT in the learning process, they allow the development of individual and social skills, being each member responsible for both his learning and the learning of rest of the group, they allow to obtain and update knowledge through different sources, they allow the access to knowledge without requiring advanced skills, they adapt to the student and enhances his collaborative and cooperative learning and they are related to collaborative work since they allow the student to collaborate, reflect, discuss and share with others. In the opinion of Cabero in [10] when ICT are introduced in the field of education, they can have an impact on all elements of the curriculum, modifying the relationship that exist between the teacher and the student and affecting the form in which they communicate.

The purpose of continuous technological development is to adapt to our social and individual needs and the Internet is already part of our lives where smartphones “are an appendix of our body”, p. 145 in [27]. According to González-Fernández and Salcines-Talledo [17], smartphones are the mobile devices that symbolize the revolution of the mobile Internet and, therefore, those that have received the greatest reception. However, they are not only communication devices and instruments for social use, due to their potential, they are a powerful tool in the academic field [42].

Digital Technology is not the result of any fashion, but it is a change that has come to stay and that is transforming sectors of the Society completely. The Horizon Report in [23] highlights the main technological trends in education for the coming years which are: Mobile Learning, Social Networks, Online learning, Big Data, BYOD (Bring your own device), Hybrid and Collaborative Learning, Flipped Classroom, Cloud Computing, PLE (Personal Learning Environments), Gamification, Robotics, Maker Spaces and Virtual Reality.

As indicated by Barragán et al. in [5] the portability, mobility, ubiquity and interactivity of smartphones, as well as the access and exchange of information to the internet that they provide us, have contributed to the teaching-learning process. Different authors affirm that the introduction of mobile devices, such as the smartphone, in the teaching-learning-evaluation process opens up a wide range of educational potentialities, some of them still to be explored [8, 30, 39, 41]. Hernández and Pérez in [21] state in their study that three quarters of university students use mobile devices in tasks associated with their studies.

Young people learn best when something is relevant to them, when there is a social connection with what they learn and when they really have a personal interest [12, 20, 21]. Herrera and Fennema in [22], Camacho and Lara in [12] and Hernández in [19] agree that among the benefits of the pedagogical use of mobile in the classroom, are: portability and connectivity at anytime and anywhere, flexibility and ease of use, participation and commitment by the students, active and collaborative learning experiences, improvement in digital and communication skills and awareness in the digital identity of students.

Tourón et al. [41] highlights the three fundamental aspects in which the use of mobile technology in the classroom benefits students: students increase their interest in the task to be done, improving their performance in a positive learning environment (motivation); students as members of a group, strengthen their social skills, improving their cooperative spirit, interpersonal communication and empathy, growing in responsibility and personal commitment to the tasks and functions performed (Social skills); students develop their creativity by generating new ideas or content, improve information acquisition processes and promote their capacity for analysis, synthesis and evaluation of such information (Cognitive skills).

4 The Evaluation with the Use of Smartphones

Sevillano and Vázquez-Cano in [40] agree that this type of methodology, in which the smartphone is used in the classroom, should be accompanied by a system of training for its selection, contrast and evaluation. Therefore, teachers have to use a work methodology that adapts to the new instruments of access, treatment and management of information at any place and time [43].

The formative evaluation encourages the improvement of teaching-learning-evaluation process, giving feedback to the students so that they think and optimize their learning [38]. Given the importance of continuous, summative and formative assessment in education, imaginative solutions have been sought, such as strategies based on the implementation of objective tests or test-type exams, where after asking the student for certain concepts, the results of the tests are quickly obtained [14].

Pintor et al. in [34] point out that with the type of questionnaires where students answer to the teacher's questions through an electronic device, in addition to obtaining numerous evidences of the students' learning process, their active participation is stimulated and their motivation is increased, basing such improvements on the game and the competition of the students through Personal Response Systems.

Personal Response Systems

The Personal Response Systems provide a registration of the results which can be managed in such a way that it is obtained enough evidence of evaluation of the teaching-learning process at all times [26]. According to Pintor *et al.* in [34] the first Personal Response Systems appeared at the beginning of the 21st century, which initially became known as "clickers". These systems consist of a series of electronic controls used to answer and know in real time the results of the questions asked by a caller. Initially, they were focused on television competition programs, where their used was oriented to know the public opinion of the set before a certain question. It also began to be used in meetings and congresses, since they allowed to asked collective questions to an audience and to collect the individual responses, showing the statistical graphs of the answers [6].

Considering the potential of the clickers, it is understood that, as indicated by Panaqué et al. in [33] it did not take too long for them to be applied in education as a pedagogical and evaluation strategy. In fact, according to Bransford et al. in [7], the teaching methodology designed with clickers was conceived to increase the active learning of the students. According to Caldwell in [11], there are numerous studies in which significant results have been obtained and in which it has been positively assess the impact of clickers on the teaching-learning process. Pintor *et al.* in [34] indicate that the classic form of interaction in the classes, through this system, were the "clickers", also called "key-pads", "handsets" or "zappers".

As indicated by Prensky in [35] these educational strategies are particularly effective with the so-called Digital Natives, since the fact of having grown up in the era of ICT, make them perfect candidates for the use of this type of technologies in their teaching-learning process. However, there were important functional problems, which led to the disappearance of this first generation of online questionnaires.

Kahoot

In 2013, the Norwegian professor Alf Inge Wang developed an online program of free access called "*Kahoot*" that allows to perform the same activities as with the clickers, but without the technical problems that were attributed to them. Instead of the use of remote controls and infrared receivers, *Kahoot* requires only an internet connection through any fixed or mobile device [34]. Therefore, *Kahoot*'s advantages over clickers proved to be so conclusive that it was immediately accepted by the education system: it does not require previous software or infrared adapter, it does not need knowledge or previous management, it is a free resource for teachers and students, it does not have the limitation in number as it happened with the clickers, it does not require maintenance or transportation of the elements to be used, the design of the questions is quick and simple, images can be included in the questions, it allows individual or group answers and all entries are recorded in an Excel file.

The following advantages are added to those of the clickers [37]: the possibility of developing more attractive activities for students, with which their attention, participation and motivation are encouraged, it facilitates the evaluation of individual and group work, it allows to know the degree of knowledge acquisition of students and those parts that are worse understood, the subsequent analysis of the results in class (using statistical graphs) facilitates the feedback with the students in the classroom, the results obtained are automatically saved in an Excel table with the name of the students and the answers obtained and the data stored over a period of time allows the teachers to appreciate the evolution of each student, which enhances the individualized attention of each one and its continuous, summative and formative evaluation.

The research on *Kahoot* [36] concludes that it is an excellent tool to carry out activities in the classroom, contributing to improve student participation and the positive relationship among the group of students.

Therefore, *Kahoot* is emerging as a game tool that allows gamification and the inclusion of the smartphone in the classroom [25]. But it is not the only one. There are different applications of similar characteristics, among which, according to Pintor *et al.* in [34] include: Socrative, Pinnion, Google Forms, Questionpress or Polleveryway among others. However, if the School is not provided by tablets, the use of *Kahoot* in the classroom and the fact of obtaining the expected results require that students have to bring their own devices to the classrooms.

The use of smartphones in the classroom intends to encourage student motivation and participation in class. Likewise, the goal is to facilitate and accelerate the collection and presentation of evaluation results, since, after answering the questionnaire through the smartphone, the results would be available immediately [9].

EdPuzzle

Another example of a teaching tool is *EdPuzzle*. This application allows the teacher to edit any type of video, inserting audio tracks, voice notes or questionnaires [4]. Finally, it is obtained a personalized lesson that students can see and answer as an activity at home on the *EdPuzzle* platform [31]. Numerous articles related to the use of video/questionnaires support the positive impact they have on the learning [28].

According to Navarro in [31] the teacher's challenge is to provide students with the adequate materials and resources so that they can successfully tackle an autonomous study and develop formative assessment mechanisms to assess their learning and verify the appropriateness of their conclusions.

Among the advantages of *EdPuzzle*, according to Navarro in [31], the advantages of this tool are that it is free, the speed of uploading videos, the quality of the videos imported after processing on the platform, the absence of limits on the number of videos hosted on the platform, the simplicity in both editing and viewing videos, the possibility of using mathematical symbols in the questions, the immediacy of the results after the fulfilment of the questionnaire, the possible exportation of edited videos to any web page, it is an active project in constant development and with excellent technical support and it facilitates the formative evaluation of the students.

5 Methodological Approach

In the methodological proposal presented, it is intended the use of methodologies that adapt and come as close as possible to the reality and language of students, for which, we consider essential the use of the smartphone or mobile device to carry out the activities required, both in class and at home.

The methodology presented has been designed considering the student as an active element in the construction of its learning process. In order to build knowledge properly, a Master Class will be held initially to present the basic and sufficient contents so students can start developing it. Afterwards, so as to establish the new knowledge and verify that the beginning of the learning is being adequate, an online questionnaire will be carried out in the classroom using *Kahoot*, in which the theoretical concepts worked in the introductory class will be presented, being able to verify the level of learning acquired. Once these steps have been completed, it is necessary to overcome the possible gaps that have arisen at the beginning of the learning process being students involved in the process. To do this, a reflection in the classroom is required so that all the doubts can be clarified and the contents are settled. Once the basic theoretical contents have been established, students have to continue developing their own learning by acquiring new knowledge. To start with this development, a video/questionnaire will be used through *EdPuzzle*, which will be carried out in the student's own home to mark t students' own learning rhythm and to enhance their autonomy and self-learning as they can control the times and visualizations of the video and analyze the answers obtained. Finally, it will be possible to carry out at a review and clarification of doubts, so that in this way, we can consolidate the knowledge acquired by the students and they can continue themselves building new ones. This process will be performed by responding to the questions raised by the students and analyzing the information provided by *EdPuzzle* about the answers taking into account if they are correct or incorrect and the number of times the video has been viewed.

The didactic and methodological strategies used in the design of this methodological proposal, have been defined to be able to be implemented in a single session, being possible its use in successive sessions and they are the following:

(1st) Master Class: Master Class of the teacher, where the key points of the agenda to be discussed will be presented in the classroom, showing with the help of the Interactive Digital Whiteboard the characteristics and examples that are considered appropriate for the better acquisition of the contents by the students.

(2nd) Online Questionnaire in the Classroom (*Kahoot*): After the theoretical class and with the idea of establishing knowledge, detecting doubts and solving them as soon as possible, an online questionnaire (previously designed by the teacher) is carried out with *Kahoot* in class in which each student individually and with the help of the smartphone or mobile device, will answer the questions proposed by the teacher and whose statement will be projected in the interactive digital whiteboard.

(3rd) Thinking Process in the Classroom: Once the questionnaire has been completed, the application will return the individual results of each student in the class, as well as the statistics of the questions, which could enable to immediately detect possible gaps in knowledge of the subject. To clarify the contents that have not been properly understood by the students, a thinking process on the results achieved is made in the last section of the class that could lead students to clarify doubts that could have emerged in the questionnaire.

(4th) Video/Questionnaire at Home (*EdPuzzle*): Finally, and as a proposed activity to be carried out at home, students (using their mobile devices) have to answer a questionnaire inserted in a video within the educational platform *EdPuzzle*. That video, previously edited by the teacher, and the questions related to it and inserted in each specific section have to be related to the contents studies in the classroom. The appearance of each question paralyzes its reproduction which only reactivates after its answer.

After watching the video, *EdPuzzle* will send the teacher the statistics of the students who have completed the entire process, the correct answers, and the number of times the video has been watched and even which parts have been better or worse answered. All this information, returned by *EdPuzzle*, would reveal the work and the evolution of the students in relation to the subject of study.

On the other hand, it is recommended that at the beginning of the successive lessons, the first 5–10 min can be used to make a summary and clarify the possible doubts that arose in the previous session and those originated in the realization of the video-questionnaire. The idea is not only to review important concepts, but also to clarify the possible doubts that are generated in the students after reviewing the return of the results obtained in the video-questionnaire by themselves.

Necessary Resources

Material provided by the school: Interactive Digital Whiteboard - Computer, software and computer elements with internet connection.

Material provided by the students: Smartphone or mobile device- *Kahoot* application downloaded with a Gmail account - *EdPuzzle* application downloaded with Gmail account.

Student's Evaluation

The evaluation rubric can be found at: https://www.dropbox.com/s/tquq03gj83ej1y2/Rubrica.docx?dl=0

6 Conclusions

One objective of the present work was to carry out a theoretical review taking into account the main sources in the field of the use of personal response systems through Smartphones in the classroom, which will be a basis for the next objective which is the design of the methodological proposal in which the use of the Master Class is combined with the use of personal response systems as assessment and self-assessment instruments to improve the teaching-learning experience in the classroom.

Both objectives have been reached, so it can be said that it has been established the basis to be able to approach the next step of the research that consists on the implementation of the methodological proposal and the evaluation of its repercussion in the learning process of the students.

The analysis of the main teaching-learning didactic methodologies, where their fundamental and characteristic features have been highlighted, shows that none of them represents the definitive solution that guarantees the meaningful learning of the students in any situation, being the best methodology an amalgam of them, which will depend on innumerable factors related to the context of the group-class. However, it has been possible to verify the direct relationship between the constructivist model, which is based on the active acquisition of new knowledge by students, and ICT, which serve as support for students to achieve their learning in an actively, reflective, constructive and collaborative way.

Despite the possible risks involved in the implementation of ICT in the education system [32] they are a very positive contribution to teaching, since they favor the learning process, increasing their interest, motivation and creativity, improving the ability to solve problems, promoting group-work, reinforcing their self-esteem and allowing them greater autonomy in their learning overcoming the barriers of time and space [2].

The questionnaires in education have undergone a marked evolution, fundamentally due to the technological development. The excessive complexity and lack of functionality of the clickers, born at the beginning of the 21st century as Personal Response Systems, gave way to online questionnaires applications such as *Kahoot,* which allow the teachers the instantaneous verification of the understanding of the different concepts worked in the classroom, allowing to carry out a continuous evaluation of the students.

The educational platform *EdPuzzle* allows the teacher to design activities to be carried out by the students at home through the use of educational videos with different questions to answer over their duration through their mobile devices that favors the meaningful learning of the students. In the same way, the daily correction of the video-questionnaire by the teacher, can help him to know, in real time, the concepts the student has understood worse, favoring their reinforcement. Due to the fact that a part of the first minutes of the next master class will be based on the doubts raised in the realization of the video-questionnaire and in the details of the activity proposed for home, students who had not done it in the moment can do it in other moment so as to do not to be left out of the rest of the class.

Finally, as future prospective, it should be clarified that this work constitutes the previous step of the research to be carried out in which the necessary theoretical bases have been established and a classroom methodology has been proposed. The next step that will be addressed will be based on the implementation of this methodology in the classroom in order to assess its benefits based on the analysis of results of the questionnaires answered by the students of the sample of study.

References

1. Alonso, L., y Blázquez, F.: El docente de educación virtual. Narcea, Madrid (2012)
2. Amar, V.: Planteamientos críticos de las nuevas tecnologías aplicadas a la educación en la sociedad de la información y la comunicación. Pixel-Bit: Rev. de medios y educación **27**, 1–6 (2006)
3. Ausubel, D., Novak, J., Hanesian, H.: Psicología educativa: un punto de vista cognoscitivo. Trillas, México (1990)
4. Baker, A.: Active learning with interactive videos: creating student-guided learning materials. J. Libr. Inf. Serv. Distance Learn. **10**(3–4), 79–87 (2016)
5. Barragán, A.C., Martín, A.S., Peralta, A.L.: Análisis del smartphone como herramienta de apoyo en la formación académica de alumnos universitarios. Pistas Educativas **38**(112), 135–155 (2016)
6. Beekes, W.: The, “Millionaire” method for encouraging participation. Act. Learn. High Educ. **7**(1), 25–36 (2006)
7. Bransford, J.D., Brown, A., Cocking, R. (eds.): How People Learn: Brain, Mind, Experience, and School. National Academy Press, Washington, D.C. (1999)
8. Brazuelo, F., Cacheiro, M.L.: Diseño de páginas web educativas para teléfonos móviles. Edutec. Rev. Electrónica de Tecnología Educativa **32**, 1–14 (2010)
9. Bruff, D.: Teaching with Classroom Response Systems: Creating Active Learning Environments. Jossey-Bass, San Francisco (2009)
10. Cabero, J.: Bases pedagógicas para la integración de las TICs en primaria y secundaria. In: Ponencia impartida en el II Congreso Internacional UNIVER. La Universidad en la sociedad de la Información, Tijuana, México (2006)
11. Caldwell, J.E.: Clickers in the large classroom: current research and best-practice tips. CBE-Life Sci. Educ. **6**(1), 9–20 (2007)

12. Camacho, M., Lara, T.: M-Learning en España Portugal y América Latina. Universidad de Salamanca, Salamanca (2011). [Monográfico] SCOPEO, 3
13. Castañeda, M.L.: Tecnologías digitales y el proceso de enseñanza-aprendizaje en la educación secundaria. UNED (2011)
14. Córdoba, M.: Implantación de un modelo pluridisciplinar de evaluación formativa continua mediante la realización y análisis de pruebas objetivas desde nuevas plataformas ON-LINE. Universidad Complutense de Madrid, Madrid (2016)
15. Cortés, S.M.: Uso de las TIC en la práctica pedagógica. TIA **5**(1), 46–56 (2017)
16. Fernández, A.: Nuevas metodologías docentes. Instituto de Ciencias de la Educación, Universidad Politécnica de Valencia (2008)
17. González-Fernández, N., Salcines-Talledo, I.: El smartphone en los procesos de enseñanza-aprendizaje-evaluación en Educación Superior. Percepciones de docentes y estudiantes. Relieve: Rev. Electrónica de Investigación y Evaluación Educativa **21**(2), 1–20 (2015)
18. Green, K.R., Pinder-Grover, T., Millunchick, J.M.: Impact of screencast technology: connecting the perception of usefulness and the reality of performance. J. Eng. Educ. **101**(4), 717–737 (2012)
19. Hernández, G.S.: Evaluación de las habilidades cognoscitivas. Universidad de Guadalajara, México (2001)
20. Hernández, T.: Educación sin tiempo: ¿M-learning o U-learning en la Investigación y Docencia (2009)
21. Hernández, F.A.L., Pérez, M.M.S.: Factores que inciden en la aceptación de los dispositivos móviles para el aprendizaje en educación superior. Estudios sobre Educación **30**, 175–195 (2016)
22. Herrera, S.I., Fennema, M.C.: Tecnologías móviles aplicadas a la educación superior. In: XVII Congreso Argentino de Ciencias de la Computación. Buenos Aires, Argentina (2011)
23. Horizon, I.: Higher Education Edition. The New Media Consortium, Austin (2017)
24. Lloyd, S.A., Robertson, C.L.: Screencast tutorials enhance student learning of statistics. Teach. Psychol. **39**(1), 67–71 (2012)
25. Martínez Navarro, G.: Tecnologías y nuevas tendencias en educación: aprender jugando. El caso de Kahoot. Opción **33**(83), 252–277 (2017)
26. Mohanan, K.P.: Assessing quality of teaching in higher education. Centre for Development of Teaching and Learning (2005)
27. Moreno, I., García, J.A.: Las nuevas pantallas, un reto educativo. Rev. Complutense de Educación **17**(1), 135–149 (2006)
28. Morris, C., Chikwa, G.: Screencasts: how effective are they and how do students engage with them? Act. Learn. High Educ. **15**(1), 25–37 (2013)
29. Moya, M.M., Carrasco, M., Jiménez, M.A., Ramón, A., Soler, C., Vaello, M.T.: El aprendizaje basado en juegos: experiencias docentes en la aplicación de la plataforma virtual "*Kahoot*". In: Actas XIV Jornadas de Redes de Investigación en Docencia Universitaria, Alicante, España (2016)
30. Navaridas, F., Santiago, R., Tourón, J.: Valoraciones del profesorado del área de Fresno (California Central) sobre la influencia de la tecnología móvil en el aprendizaje de sus estudiantes. Relieve: Rev. Electrónica de Investigación y Evaluación Educativa **19**(2), 1–20 (2013)
31. Navarro, E.M.M.: Creación de lecciones a partir de vídeos con *EdPuzzle*. In: Tele (in) 2. Nuevos enfoques en la aplicación práctica de la innovación docente, León, pp. 47–52 (2015). Telein2.wordpress.com
32. Palomar, M.J.: Ventajas e inconvenientes de las TIC en la docencia. Rev. Digital: Innovación y Experiencias Educativas **25**, 1–8 (2009)

33. Panaqué, C.R., Chávez, A., Vásquez, A., Cohen, S.B.: Las TIC en la formación universitaria: Logros y desafíos para la formación en psicología y educación. Rev. De Psicología **34**(1), 185–199 (2016)
34. Pintor, E., Gargantilla, P., Herreros, B., López, M.: El aprendizaje basado en juegos: experiencias docentes en la aplicación de la plataforma virtual "*Kahoot*". In: XI Jornadas Internacionales de Innovación Universitaria. Educar para transformar. Madrid, España (2014)
35. Prensky, M.: Nativos e Inmigrantes Digitales (2010, 2014)
36. Ramírez Covarrubias, A., Arciniega Luna, A.L., Iriarte Solís, A., Arriaga Nabor, M.A.: Aplicaciones educativas para la enseñanza: Caso de estudio *Kahoot*! Educateconciencia **16** (17), 139–149 (2017)
37. Roig-Vila, R., Mira, J.E.B., Carreres, A.L., Buades, N.P., Alfosea, J.F.T., de Calidad, V.: Investigación e Innovación Educativa en Docencia Universitaria. Retos, Propuestas y Acciones. Alicante: Universidad de Alicante, Vicerrectorado de Calidad e Innovación Educativa, Instituto de Ciencias de la Educación (ICE) (2016)
38. Romero-Martín, R., Castejón-Oliva, F.J., López-Pastor, V.: Divergencias del alumnado y del profesorado universitario sobre las dificultades para aplicar la evaluación formativa. Relieve: Rev. Electrónica de Investigación y Evaluación Educativa **21**(1), 1–16 (2015)
39. Sandoval, E.A., García, R., Ramírez, M.S.: Competencias tecnológicas y de contenido necesarias para capacitar en la producción de recursos de aprendizaje móvil. Edutec. Rev. Electrónica de Tecnología Educativa **39**, 1–16 (2012)
40. Sevillano, M.L., Vázquez-Cano, E.: Modelos de investigación en contextos ubicuos y móviles en Educación Superior. McGraw-Hill, Madrid (2015)
41. Tourón, J., Santiago, R., Díez, A.: The flipped classroom. Cómo convertir la escuela en un espacio de aprendizaje. [The flipped classroom. How to make the school a learning environment]. Digital-Text, Barcelona (2014)
42. Vázquez-Cano, E.: Mobile distance learning with smartphones and apps in higher education. Educ. Sci. Theory Pract. **14**(4), 1505–1520 (2014)
43. Vázquez-Cano, E.: El reto de la formación docente para el uso de dispositivos digitales móviles en la educación superior. Perspectiva Educacional **54**(1), 149–162 (2015)
44. Zarzycka, E.: *Kahoot* it or not? Can games be motivating in learning grammar? Teach. Engl. Technol. **16**(3), 17–36 (2014)

Impact of an Introductory ERP Simulation Game on the Students' Perception of SAP Usability

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Abstract. Enterprise Resource Planning systems are immense environments that are quite hard for novice users to grasp. A new user will judge an unknown system heavily by its usability. This makes it crucial that the introduction of a system portrays the system as being as usable as possible. We used a gamified workshop based on the ERPsim simulation game to introduce students to the SAP Enterprise Resource Planning solution, and then measured the perceived System Usability Scale (SUS) of SAP and its modules. We then compared the usability results with other comparable studies and found them to be higher, which is correlated with the positive effect of gamification that the workshop left on its participants. The results need to be confirmed further, because the preliminary study employs several limitations on the sample size, demographics and different versions of the SAP ERP software used in comparable studies.

Keywords: Gamification · Gamification in higher education · ERPsim System usability · System Usability Scale

1 Introduction

Enterprise Resource Planning (ERP) are big complex suites of software aimed at helping organizations integrate data & information flow and business processes [1]. The systems cover all functional areas of the company [2] (Manufacturing, Sales & Distribution, Payables, Receivables, Inventory, Accounts, Human Resources, Purchases, etc.). Implementing such a complex system is very cumbersome and [3] notes that 50 to 75% of all US companies experience some degree of failure in implementation of ERP systems. Poor training and user involvement, together with user resistance to changes, are among the main factors [4] leading to failure. These implications mean that the first encounter with the ERP system is of the upmost importance, as an inadequate introduction may leave unrepairable consequences. We propose support of serious games for introducing ERP systems.

According to Marsh's definition [5] "*Serious games are digital games, simulations, virtual environments and mixed reality/media that provide opportunities to engage in*

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activities through responsive narrative/story, gameplay or encounters to inform, influence, for well-being, and/or experience to convey meaning.".

The only difference between serious and video games is their intended purpose; usefulness for serious and entertainment for video games [6]. Serious games have been found more motivating and engaging than traditional methods for conveying knowledge [6]. They are used in numerous fields, and studies found that additional cognitive abilities were gained that would not been attained in a classic non-gaming environment [7]. Serious games utilize the concept of gamification, that is [8] *the use of video game elements in non-gaming systems to improve user experience and user engagement.*

In this paper, we focus on measuring and comparing the system usability score of the SAP ERP system by using the business simulation game ERPsim for introduction to the system. The study was conducted on post-graduate students participating in an ERP course. The students were first introduced to ERPs in a workshop, and then interacted with them through the whole course as a part of computer exercises. We investigated the system usability scale, to decide how students would perceive such a complex system when introduced to it via use of serious games as compared to the normal introduction in other studies where the gamification approach was not used.

We aimed to find the answers to the following question:

Does using the business simulation game ERPsim increase user perception of the SAP ERP system usability?

This research paper is structured as follows. In the Related Works section, similar research is presented in measuring the usability of ERP systems. Subsequently, a quick description and presentation of the workshop execution is given, i.e. how the ERP simulation game was integrated and applied in our environment. The post workshop activities and the ERP course are presented in the fifth chapter. System Usability Scale (SUS), together with the results gathered, are presented in the sixth chapter. In conclusion, the findings are summarized and proposed directions for further research are given.

2 Related Works

We found no studies regarding the use of ERPsim for introduction to the field of ERP Systems, and no field that would measure the usability of learners that were just introduced to the ERP systems as a part of a moderated course.

A study "*Application of Modified Agile Methodology to Improve Usability of SAP ECC*" [9] investigated SAP FIORI user usability perception in a big company, which migrated to a newer version of the system. SAP FIORI is a new user experience (UX); it is role and task-based implementation of SAP S/4 HANA. This is the successor version of SAP ERP which we used. The notable difference between versions is that FIORI is role and task-based, whereas SAP 6.0.8 (our version) is transaction oriented. Based on responses from 103 users, they gave the software an SUS value of 34.47. The value was derived by averaging results from 5 different modules: MM (Materials Management), (Human Capital Management), SD (Sales and Distribution), FI & CO (Financing and Controlling), SCM (Supply Chain Management). A very low score of usability for the SAP system was measured, even though the main advantage of the FIORI version is a friendlier user interface than in the older, SAP ERP 6.08 version.

The University of Budapest proposed ways for measuring usability of ERP systems from the perspective of its users. They proposed the following existing methods that can be used to measure the usability of ERP systems: Software Usability Measurement Inventory (SUMI), System Usability Scale (SUS), ErgoNorm and IsoMetrics [10], and found all of them appropriate for use. We decided for the use of SUS, due to its simplicity and ability to measure the scores accurately nevertheless. They proposed these measuring scales for the following ERP systems: GUS OS Suite, OpenERP, Orlando, Sage, SAP, WorxSimply, MS Dynamics, infor:com, BMD, FAKTMANN, MKS Goliath and QUIX OFFICE.

3 ERP Workshop

In order to support the first steps in understanding ERP concepts and its' implementation SAP, we began our ERP course with an introductory ERPsim workshop, after which normal lectures and lab exercises were conducted. We finished the course with a final replication of the workshop at the very end of the course. The whole course lasted 15 weeks, 13 were normal lessons and 2 weeks consisted of this gamified workshop.

At the beginning of the course, the students were introduced to SAP ERP software by the use of the ERPsim distribution game [11], a business simulation game. ERPsim is developed by HEC Montréal, it is available for free, but may be used for educational purposes only by certified instructors. The certification itself is free. It is a game where players are split into teams, and each team represents a company which buys water from bottled water producers and sells it to stores. The simulation has 3 regions in which teams compete. The goal is to accumulate the highest profit. The teams have the ability to sell their products at different prices in each region, and they have 6 different products to sell. They can spend their company money on advertisements, and must also plan to order things in advance, since orders need some time for execution.

All the possible actions of a team during a business cycle are shown in Fig. 1. Transactions that are used for monitoring and generating business reports are independent of the business cycle (ZME2N, F.01, ZMB52, ZMARKET, ZVA05, ZVC2), and can reasonably be used at any time to execute the business transactions that have a reasonable order (MD61, MD01, ME59N, ZAD5, VK32) better, as illustrated by the arrows connecting them.

The workshop was conducted in 2017 at the Faculty of Electrical Engineering and Computer Science, University of Maribor, as a part of the Enterprise Resource Planning course. The workshop conducted is described fully in [12]. The same paper reported that using ERPsim for introduction to ERP concepts was beneficial, well accepted by both students, as well as instructors. 18 participants participated in the workshop and survey.

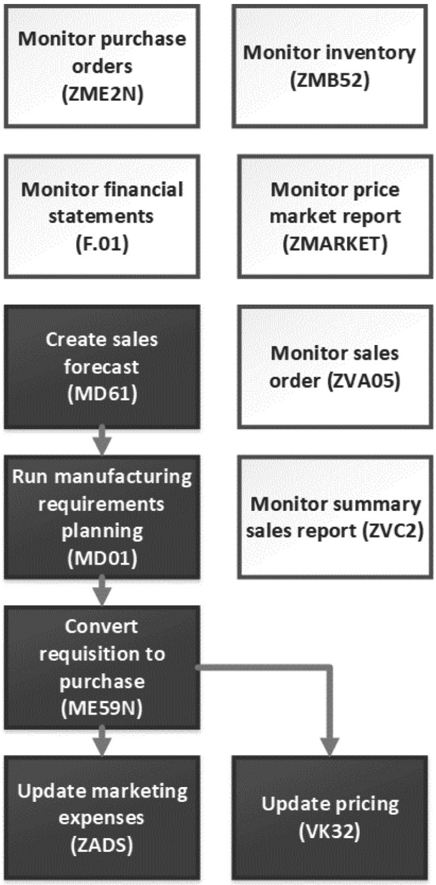

Fig. 1. ERPsim possible actions with their corresponding transactions (adapted from [11])

4 Post Workshop Activities

After the introductory workshop, learners studied MM (Materials Management), SD (Sales and Distribution), PP (Production Planning), CO (Controlling), PS (Project System) and EAM (Enterprise Asset Management) SAP modules as a part of their Enterprise Resource Planning course. These selected modules that the course curriculum requires for students to understand were taught to students by the use of Global Bike Inc 3.0 [13] and the course was executed on SAP ERP version 6.0.8. It is important to note that this remaining part of the course was non-gamified, but we wanted to investigate if the positive effects of the gamified workshop persisted throughout the course. The students, as a part of their course, used not only the transactions learned in the workshop, but also learned using several new transactions on each course session.

Global Bike Inc are sets of study materials and tasks in a fictional bike producing company that students work through to familiarize themselves with the use of the SAP system [14]. Students followed a set of instructions on each selected module, and then completed a short follow up quiz to test their knowledge on the module. The materials were provided by the SAP University Alliance.

5 System Usability Scale

5.1 System Usability

Usability is the quality of interaction between a human and a man-made object. In software, the quality of interaction is described as handling, user friendliness, ease of use and learnability [10]. The ISO/IEC 9126-1 [15] specifies usability as "*The capability of the software product to be understood, learned, used, and attractive to the user, when used under specified conditions*". Surveys for measuring usability from users' perspectives are [10]:

- Software Usability Measurement Inventory – measures performance and emotions of users towards the used system. Questions are divided into 5 categories (efficiency, affect, helpfulness, control, learnability) with 10 questions per category.
- System Usability Scale - (described in Sect. 5.2)
- ErgoNorm – two parts. In the first part, users evaluate software on 27 selected items subjectively, and in the second, the experts test the software.
- IsoMetrics – responses from 7 sub-scales with a total of 75 items are required from the user.

5.2 Research Instrument

A System Usability Scale is a 10-item, 5-point Likert scale. Responses used, with values for the Likert scale are: Strongly disagree (0), disagree (1), neither agree nor disagree (2), agree (3) and strongly agree (4). The ten items are divided in two halves. Half of the statements would receive strong agreement, the other half strong disagreement in a perfect solution.

The rated statements were:

1. I think that I would like to use this system (SAP) frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

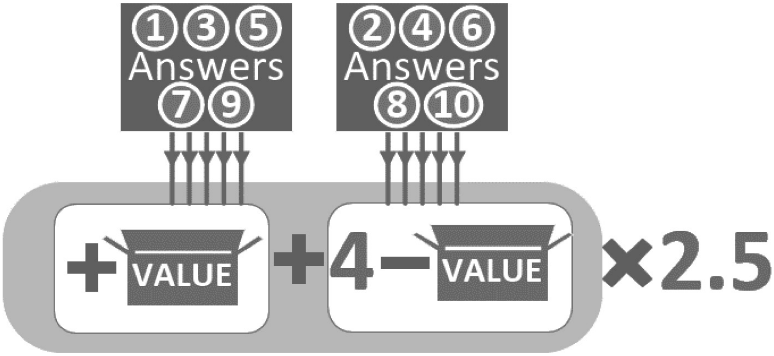

Fig. 2. Calculating SUS - simplified illustration

After collecting answers, the following procedure is used to calculate SUS.

For statements 1, 3, 5, 7, 9, the corresponding answer value is added to the total score, and for statements 2, 4, 6, 8, 10, corresponding answer values are deducted from number 4 for each statement. Finally, we multiply the whole score by a factor of 2.5. Figure 2 illustrates the entire process. The calculated value is the System Usability Score [16].

The value is much more understandable if it has an adjective meaning. [17] connected the values with the following adjective terms:

- Best imaginable (MV[1]: 90.9, SD[2]: 13.4)
- Excellent (MV: 85.5, SD: 11.3)
- Good (MV: 71.4, SD: 12.6)
- Ok (MV: 50.9, SD: 13.8)
- Poor (MV: 35.7, SD: 11.6)
- Awful (MV: 35.7, SD: 10.4)
- Worst imaginable (MV: 12.5, SD: 13.4)

They derived the values by comparing SUS values of different user interfaces from users' questionnaires, and asked those same users to rate the interface on a 7-point Likert scale with corresponding adjective ratings. Attaching meaningful words to the selected intervals makes numbers much more understandable and easier to relate to.

5.3 SUS Workshop Questionnaire Results

After the workshop, students completed the SUS questionnaire. An average SUS value of 59.17 (Fig. 3) was calculated from the workshop results, which would bear an adjective value of "Ok". This value is high compared to other studies investigating SAP usability, [9] reports a value of 34.47 based on responses from 103 users, adjective value of "Poor". This indicates that a complex system such as SAP was initially

[1] MV - Mean Value.

[2] SD - Standard Deviation.

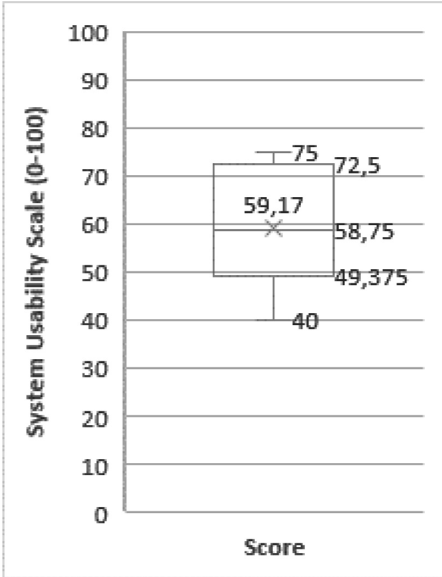

Fig. 3. Calculated SUS value after completing the workshop

perceived as relatively usable by students, when introduced using ERPsim. This is a much better SUS score than when the system is introduced normally (without the use of simulation).

A higher System Usability Score is correlated with greater consumer loyalty and user satisfaction [18] to the system, which leads to lower failure rate of implementing ERP systems, whereas a low SUS score could indicate the opposite; lower user satisfaction, lower loyalty, causing failure in implementing ERP systems. From the questionnaire results, we assume that ERPsim was a crucial positive factor in the more positive usability score compared to the baseline from other studies.

5.4 SUS Course Questionnaire Results

We continued our comparison by performing SUS questionnaires during the course after introducing each module (MM (Materials Management), SD (Sales and Distribution), PP (Production Planning), CO (Controlling), PS (Project System) and EAM (Enterprise Asset Management)) using the Global Bike Inc materials [13] to determine user perception of usability for each module. The SUS questionnaires were performed on the same set of 18 students that participated in the gamified workshop. The corresponding SUS values of each module are presented in Fig. 4 in chronological order. As seen, the average SUS values ranged from 44.56 to 52.13, all close to the adjective value of "Ok". These are a bit lower values than after the gamified workshop (59.17), but still higher than the average value collected by a similar aforementioned study (34.47) [9].

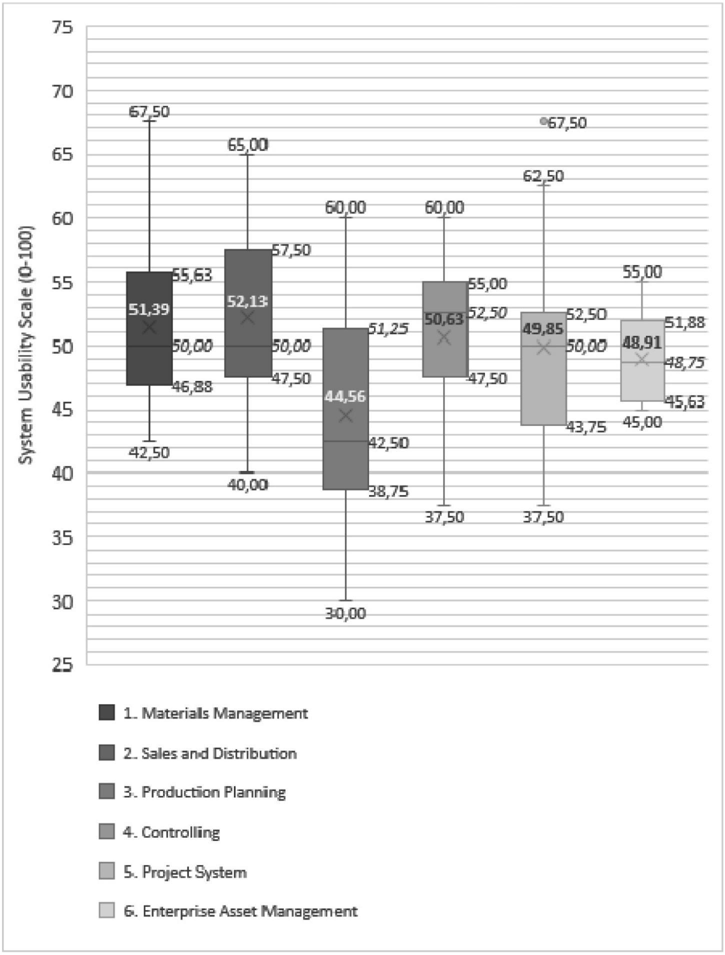

Fig. 4. Calculated SUS values after completing the course modules shown in a boxplot graph (average values are bold and median values are written in italics)

We believe the higher perception of system usability may have been a result of using the introductory gamified workshop, which improved the perception of usability throughout the whole course.

A module by module comparison can be derived partially for three modules that both studies investigated, as seen in Fig. 5. The following limitations for comparison should be considered before comparing the results: The population types; we used students, and they used their employees. Furthermore, they merged comparison for Controlling and Finance modules, whereas our students only met and evaluated the Controlling module, and different versions of SAP software - we used SAP ERP 6.0.8 and they used SAP FIORI. For all students, this was the first contact with ERPs, while the company employees all had prior experience. We found that our students rated

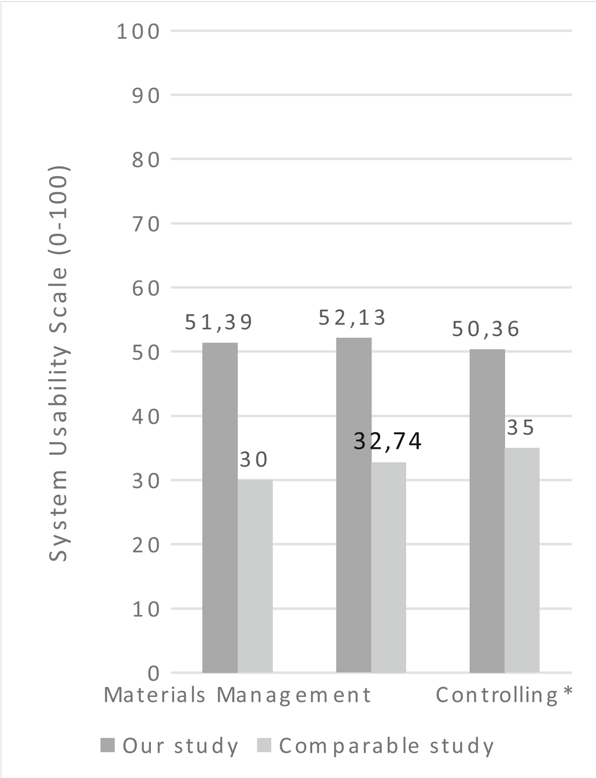

Fig. 5. Comparison of collected average SUS values between our and the comparable study [9]

modules an average of 20 points higher consistently, and were perceived as more usable than collected results in a comparable study found.

This supports our claim that the use of ERPsim increased the students' perception of usability of the SAP ERP system through the whole course, and higher ratings of SUS persisted even after the simulation. Even without comparing the results, this indicates a success, in that students had no reluctance to using a big complex system later on that does not even have a task oriented interface, and this was the purpose of the introductory ERP workshop.

6 Conclusion

In our case, the use of the business simulation game ERPsim was demonstrated to be an appropriate way of introducing students to SAP ERP. Using the business simulation game ERPsim increased the precepted usability of the system, thus affirming our question. Whereas a study reported [9] anSUS score of 34.47 for SAP ERP when the system was introduced normally, our measured SUS was 59.17 after the workshop. The higher rating persisted, even during the non-gamified part of the course, where they were found to be, on average, about 20 points higher than results from a comparable study where no gamified elements were used. The difference was likely caused by the benefits of using gamified environments to introduce users to a complex system. The results are preliminary, due to the small sample size (N = 18), different versions of SAP used in our and comparable studies, and different demographics; we had students, whereas other studies mentioned were measuring perceived usability on employees who worked with SAP.

Research queries for the future are: *Does using a gamification approach increase perceived usability if users are already familiar with the system? How can the gamification approach used be improved to increase perceived usability of SAP system further in both traditional courses and working environments?*

References

1. Abdinnour-Helm, S., Lengnick-Hall, M.L., Lengnick-Hall, C.A.: Pre-implementation attitudes and organizational readiness for implementing an enterprise resource planning system. Eur. J. Oper. Res. **146**, 258–273 (2003)
2. Jacobs, F.R., 'Ted' Weston Jr., F.C.: Enterprise resource planning (ERP)—a brief history. J. Oper. Manag. **25**, 357–363 (2007)
3. Umble, E.J., Haft, R.R., Umble, M.M.: Enterprise resource planning: implementation procedures and critical success factors. Eur. J. Oper. Res. **146**, 241–257 (2003)
4. Garg, P., Garg, A.: An empirical study on critical failure factors for enterprise resource planning implementation in Indian retail sector. Bus. Process Manag. J. **19**(3), 496–514 (2013)
5. Marsh, T.: Serious games continuum: between games for purpose and experiential environments for purpose. Entertain. Comput. **2**, 61–68 (2011)
6. Girard, C., Ecalle, J., Magnan, A.: Serious games as new educational tools: how effective are they? A meta-analysis of recent studies. J. Comput. Assist. Learn. **29**(3), 207–219 (2013)
7. Connolly, T.M., Boyle, E.A., 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)
8. Deterding, S., Sicart, M., Nacke, L., O'hara, K., Dixon, D.: Gamification: using game design elements in non-gaming contexts. In: CHI 2011 Extended Abstracts on Human Factors in Computing Systems, pp. 2425–2428 (2011)
9. Danda, S.: Application of modified agile methodology to improve usability of SAP ECC. In: Culminating Project in Mechanical Manufacturing Engineering, vol. 16 (2015)
10. Paa, L., Piazolo, F., Promberger, K., Keckeis, J.: Measuring ERP usability from the users' perspective. In: Piazolo, F., Felderer, M. (eds.) Multidimensional Views on Enterprise Information Systems. LNISO, vol. 12, pp. 149–160. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-27043-2_12
11. Leger, P.-M., Robert, J., Babin, G., Lyle, D., Cronan, P., Charland, P.: ERP simulation game: a distribution game to teach the value of integrated systems. Dev. Bus. Simul. Exp. Learn. **37**, 329–334 (2010)
12. Heričko, M., Rajšp, A., Horng-Jyh, P.W., Beranič, T.: Using a simulation game approach to introduce ERP concepts – a case study. In: Uden, L., Lu, W., Ting, I.-H. (eds.) KMO 2017. CCIS, vol. 731, pp. 119–132. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-62698-7_11

13. Magal, S., Weidner, S., Word, J.: Global Bike Inc. SAP University Alliances, pp. 1–11 (2014)
14. SAP University Alliance: Announcing introduction to SAP ERP with Global Bike Inc. 2.0—SAP Blogs (2010). https://blogs.sap.com/2010/12/28/announcing-introduction-to-sap-erp-with-global-bike-inc-20/. Accessed 14 Jan 2018
15. Bevan, N.: ISO and Industry Standards for User Centred Design (2000)
16. Brooke, J.: SUS-a quick and dirty usability scale. In: Usability Evaluation in Industry, vol. 189, no. 194, pp. 4–7 (1996)
17. Bangor, A., Kortum, P., Miller, J.: Determining what individual SUS scores mean: adding an adjective rating scale. J. Usability Stud. **4**(3), 114–123 (2009)
18. Flavián, C., Guinalíu, M., Gurrea, R.: The role played by perceived usability, satisfaction and consumer trust on website loyalty (2005)

Learning and Knowledge Transfer

Source Code Representations for Plagiarism Detection

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Abstract. At the present time the plagiarism is a growing problem due to a lot of easily accessible resources, and many papers deal with this topic. New algorithms are constantly being created, but there are not currently manny of systems, that we could use for plagiarism detection. Our aim is to explore plagiarism on a large scale.

This paper focuses on selecting the appropriate representation of the source code, that is very important when searching for plagiarism. There is an overview of the current representation possibilities. We focus on representation source code using AST. Comparison of the tree structures is time-consuming operation. We will try to find how effectively represent AST in order to facilitate comparison. There are two ways to represent AST. Representation by hashing or using characteristic vectors. We present the experiment and results on which we choose the appropriate form of the representation.

Keywords: Source code · Representations · Hash · Characteristic vector

1 Introduction

In our work, we are dealing with the problem of plagiarism in source codes, especially in the academic environment. Nowadays, students have access to various resources, mostly through the Internet. This simplicity of access, and often their inadequate ability, encourages them to copy these resources in the work of their own. This is just one way of creating plagiarism. More problematic way is when student does not even use internet resources but passes the complete work of his classmate. We often encounter this problem at our faculty. There are basically two ways to avoid plagiarism: prevention and inspection. In our work, we are not dealing with prevention, but we address the possibilities of discovery of plagiarism.

At present, there are two tools to help us find plagiarism in source codes. The first, *Measure of Software Similarity* (*MOSS*), allows us to test student's work using web service. It now supports several programming languages, which are used at our faculty in a teaching. The second – *JPlag* also allows us to search for plagiarism within the source code group. Unlike *MOSS*, it does not have such support for programming languages. However, both of these tools have one common drawback - they are unable to process a larger amount of source code, which is critical in reducing the level of plagiarism. There are studies that (in the case of textual documents, but as we show in

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our article *Using concepts of text based plagiarism detection in source code plagiarism analysis* [1], they are very similar to source code) show, that the plagiarism rate has decreased after the deployment of systems that inspect plagiarism on a large scale [2, 3]. In our work [1] we have also proposed a method for detecting plagiarism in source codes, which consists of 4 parts:

- input data processing
- indexation
- similarities detection
- resulting similarity calculation.

This method is complex and therefore it is necessary to deal with each part separately. In this paper, we focus on the first part – input data processing and representation. We will analyze possibilities of processing and representing source code, that we consider to be the important for the detection of plagiarism.

The main purpose of this paper is to find out which source code representation method is more suited to the for the plagiarism detection system we describe earlier. Currently, a lot of representation of the source code is used, but in this paper, we focus on those built on abstract syntax trees because the recent research [6] shows their strengths in this area.

This paper is organized as follows: in the first part we describe process of source code processing. In the next section we present the possibilities of source code representation and in detail we describe representations using abstract syntax trees. Third part of paper describes experimental comparisons between 2 basic principles of processing abstract syntax trees. After that we presents result of those experiments. The last part describes related work and presents our ideas for future work.

2 Source Code Processing

A source code is a text, usually written by human programmers, and except for them, also the computer as a compiler or interpreter needs to understand it. Therefore, the text contains information necessary for both, the programmer and the computer, to understand the given code. For the computer to understand a source code, the code has to meet the syntax and grammar of the given language.

Processing source codes consists of the following steps:

- tokenization
- purification
- representation of the source code.

The first two steps of this procedure usually do not pose a major problem. At present, almost every programming language has tools that allows it to be tokenized. This process we have further addressed in another paper [4].

3 Source Code Representation

When analyzing the source code, we usually do not work with the stream of tokens, but we represent this source code with some structure, and then we perform the analysis on this representation. There are several ways to represent the source code. When selecting a proper representation, it is necessary to consider its suitability for the given analysis, that we are going to perform. Some of them are appropriate, others are even unusable. Basic forms of representation of the source code we can consider:

- tooken stream
- n-grams
- document term matrix (DTM)
- vector model
- abstract syntax tree (AST),

The first four are commonly used to search for plagiarism in source codes. These methods use the same representation as we can use for text documents and thus can use the same algorithms. We have addressed this issue in another article [1]. For us in case of plagiarism detection, the most interesting method of representing the source code is representing using AST. There are studies [5, 6] that show, that this is the most appropriate method of representing the source code for detecting plagiarism.

AST gives us very good information about the structure of the source code. It automatically removes insignificant information from source code such as gaps, indentations… Also, when using AST, we can avoid some problems, for example obfuscation. Thanks to AST, we can compare code on different levels (classes, methods, cycles…).

However, as AST looks good for detecting plagiarism, they have one major drawback. Comparing tree structures is a very time-consuming operation, so they can not be used on a large-scale. In order to compare tree structures on a larger scale, we must transform them into a linear structure. There are two basic ways in the literature that we can use. The first is tree node hashing and subsequent hash comparison. The second way is the use of character vectors and vector matching. Both approaches generate a characteristic for each node in AST, and then try to find matching nodes.

Hashing uses the hash, which is recursively calculated for each node of the tree according to the formula $Hash(X) = x + \sum_{c \in Childrens(X)} Hash(c)$ [5]. This formula represents a hash calculation for node X, with x representing the actual hash coefficient of a given node that depends on its type, and $Childrens(X)$ represents the descendants of node X.

Characteristic vectors use a very similar approach. The vectors are recursively calculated using the formula $V(X) = v(x) \cup \bigcup_{c \in Childrens(X)} V(c)$ [7]. The formula is very similar to the one in the previous case but this time, instead of summing the numbers, we make there the unification operation. In formula $v(x)$ represents a custom node vector that is defined based on the type of node.

Hashing has on one hand the advantage that the resulting node characteristic is relatively modest (only one number) compared to the number set for vectors. On the other hand, we are concerned that this hash is capable of expressing the content of the particular part of the tree sufficiently.

4 Comparison of Hashing and Characteristic Vectors

This section aims to determine which is more appropriate method of representation AST to search plagiarism in source code. We have designed an experiment in which we compare the simple implementation of hashing and characteristic vectors to identify similarities between student submissions. We refer to the MOSS comparison result as the reference value.

4.1 Environment Description

In our experiment we chose a code written in *C#* language. *C#* and *.NET environment* provides tools for tokenize source code and syntax tree creation through the *.NET Compiler Platform* (*Roslyn* project). *Roslyn Syntax Analyzer* creates a syntax tree that consists of three types of nodes. The first is the so-called `SyntaxNode`. They express an abstract view of the structure of the source code. The second group is the so-called `SyntaxToken` nodes, that represent individual tokens. The third group of nodes is `SyntaxTrivia`. This group contains parts that are not important to the meaning of the source code. For example, there are gaps, empty rows, and comments.

For each node, we can determine the range that it includes in the source code. An important feature is that each `SyntaxNode` node has its own type (`ForStatement`, `VariableDeclaration`...). Another property of this tree is that each `SyntaxNode` must have at least one child. `SyntaxToken` and `SyntaxTrivia` are always leaf of this tree. Each `SyntaxNode` node always covers a certain portion of the source code block. Post-order view of this tree after `SyntaxToken` nodes can get a standard stream of tokens.

4.2 Experiment Definition

On the same set of data, we calculate the similarities of each assignment using both approaches (hashing and characteristic vectors) and compare these results with reference values. We refer to the values calculated using the MOSS system as reference values. When determining the similarities of individual submissions, we will not try to find similar sequences in the given assignments, but similarity will be determined only on the basis of similarities of whole **classes** and **methods**. In the classes or the methods, we will determine the similarity based on their representation (hash, vector). This approach will not allow us to detect plagiarism with a 100% probability, but it will allow us to compare the different representation methods. In this experiment, we will compare parts of the source code only on the basis of certain characteristics, and the resulting similarities will almost certainly contain a number of irrelevant matches. Nevertheless, we will not filter these similarities by comparing the similarities of their tree structures (as is usually done in the second step of such algorithms), because by filtering them, we would eliminate the differences that both methods achieve

With our algorithm we will use two parameters. Parameter α from the `0–1` range is used in the similarity of classes and parameter β from the range `0–1` specifying the threshold for determining similarities at the method level.

The basic metric is the **similarity of submissions**. The similarity of submissions a and b is defined as $simA(a,b) = \frac{|a \cap b|}{|a \cup b|}$ where the numerator represents the number of **similar classes** and the denominator represents the number of classes in the submissions. We classify C_a and C_b as similar if $simC(C_a, C_b) >= \alpha$ and C_a and C_b have at least one pair of **similar methods** or both do not contain any methods.

Methods m_1 and m_1 are defined as similar when $simM(m_1, m_2) >= \beta$. The similarity of classes (*simC*) and similarity of methods (*simM*) is defined separately for each representation.

The comparison algorithm is two-step. First, for similar submissions, the similarity of the classes is computed and then, suitable pair of classes are examined, and similar methods determined. Finally, a set of similar classes for submissions a and b are determined based on them.

Important is that in this experiment we do not look for exact match between the two submissions because it would involve comparing whole tree structures, but based on the representations described, we try to determine which is better suited to find plagiarism.

4.3 Similarities Based on Hashing

The formula for the similarity we used for hashing was as follows:

$$simC(C_a, C_b) = 1 - \frac{|Hash(C_a) - Hash(C_b)|}{\min\{Hash(C_a), Hash(C_b)\}}$$
$$simM(m_1, m_2) = 1 - \frac{|Hash(m_1) - Hash(m_2)|}{\min\{Hash(m_1), Hash(m_2)\}}$$

The main problem in calculation hash *Hash(X)* has been that none of the papers that used this approach have specified how the specific hash coefficients x have been determined. We have proposed several ways to determine these coefficients. The first was to generate these coefficients randomly so that each type of node gets its unique coefficient. Another method was to assign prime numbers as they have interesting properties when used in hashing functions.

4.4 Similarities Based on Vector Characteristics

When generating vector characteristics, we also considered simpler features than characteristics vectors. For classes, we determined the components of these vector: number of attributes, number of methods, number of properties. Thus, the vector has the advantage that for the calculation is not necessary to recursive pass entire subtree of the class. We have chosen a similar approach for the methods we used as a characteristic vector: number of parameters, number of expressions in the body of the method, maximum height of the subtree representing given method.

In addition to these basic characteristics, we can also include in the characteristic vector of the method number of individual types of nodes found in the given method. In our experiment, we identified 7, according to us, significant types of nodes that describe the structure of the method. These are nodes for conditional branching, cycles, variable declaration, and call method.

In experiments, we also considered the weighing of individual components of these vectors. Thanks weighting can be achieved, for example, that the number of methods in the class is more important than the number of attributes. Similarly, we can do this also for methods.

The formula for the similarity we used for vector characteristics was as follows:

$simC(C_a, C_b) = \frac{\sum_{i=0}^{n} 1 - \frac{\left|v_{C_a}(i) - v_{C_b}(i)\right|}{\max\left\{v_{C_a}(i), v_{C_b}(i)\right\}} h(i)}{\sum_{i=0}^{n} h(i)}$ where n is the length of the characteristic vector v_C and h is the weight vector for a class characteristic vector.

$simM(m_1, m_2) = \frac{\sum_{i=0}^{n} 1 - \frac{\left|v_{m_1}(i) - v_{m_2}(i)\right|}{\max\left\{v_{m_1}(i), v_{m_2}(i)\right\}} g(i)}{\sum_{i=0}^{n} g(i)}$ where n is the length of the characteristic vector v_m and g is the weight vector for a method characteristic vector.

4.5 Dataset Definition

Experiments were performed on different datasets. For this paper, we chose a dataset which consist of student submissions which goal was to create a text game (console application). The dataset contained originally 59 student submissions (in the examples labeled from pr_1 to pr_59) and 2 plagiaries were created. The first plagiarism (cp_01) is a 100% copy of the pr_8 solution. The second plagiarism (cp_02) originated from the pr_48 solution by manual editing (deleting, editing, and adding new code).

In total, the set contains 61 submissions that contain a total of 1050 classes and 2468 methods. These classes are divided into 958 files. The number of code rows in C # is 49653.

5 Results

With the data and algorithms described, we performed several experiments. Gradually we changed the parameters $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$. In the case of hashing, we changed the x coefficients and, in the case of vector characteristics, we changed the characters and their weights.

When comparing our result with the results of the MOSS algorithm, we did not compare absolute similarities. The submissions were ordered downwards according to the degree of similarity and we compared the positions on which the corresponding submissions ended. We evaluated the effectiveness of each configuration using the absolute difference in the place of the plagiaries found.

First, we examined the values of parameters $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$. It turned out that the best results were achieved at a value of **0.98** for both parameters. At lower values, several false positive matches were generated. At 1, only 100% of the plagiaries were found, but some of the code that was only slightly altered was not found by algorithm.

Then we looked to find the best configuration for the coefficients of x in hashing. The best we found was the use of prime numbers that we arranged so that the nodes representing the expressions had smaller primes than the nodes representing larger blocks (method, class…).

In the case of vectors, the best option was the vectors that have used the counts of all types of nodes that are found in AST. Such a vector had a much larger dimension than the ones proposed, but the results showed a clear advantage.

In the table below, we can see the positions that have reached submissions in the MOSS algorithm. In other two columns, we can see the positions assigned to them by the best of our algorithms. As we can see, in the first 10 entries by MOSS, algorithm using hashing reached deviation of 36 and vectors 27.

A	B	MOSS	Hash		Vectors	
pr_8	cp_01	**1**	1	0	1	0
pr_48	cp_02	**2**	7	-5	3	-1
pr_12	pr_29	**3**	2	1	4	-1
pr_26	pr_50	**4**	16	-12	14	-10
pr_14	pr_12	**5**	5	0	6	-1
pr_14	pr_39	**6**	12	-6	12	-6
pr_50	pr_12	**7**	3	4	7	0
pr_14	pr_50	**8**	8	0	7	1
pr_39	pr_50	**9**	10	-1	11	-2
pr_39	pr_26	**10**	17	-7	15	-5
				36		27

In this example, we can see several anomalies. For example, the similarity between pr_26 and pr_50 that using the algorithm MOSS ranked in 4th position but in the case of our algorithm ended by an average of 11 positions below. This anomaly was due to the fact that these two solutions include the amount of automatically generated code that was identical but located only in one class.

In addition to comparing the accuracy of the methods, we compared the execution times for each of the proposed solutions. Our measurements show, that method using hash is approximate 30% faster than method using vectors. This difference is not so great, mainly because the way how the algorithms are implemented. As for hashing as well as vectors, it is necessary to calculate the characteristics of the entire sub-tree (method, class) which is computationally demanding than the actual comparison hash vectors.

6 Conclusion

In this work we dealt with processing capabilities of source code representation. In theory, we examined different way to processing and representation of the source code. We investigated and experimentally verified some of the appropriate source code representation possibilities.

With this simple experiment, we verify the real possibilities of each approach. Using a vector as a characteristic of either methods or classes has resulted in overall better results. Very similar results were also obtained for the other tested datasets.

Based on the results obtained, we have confirmed that the vectors generated by AST are the appropriate way of representing the source code. This fact is confirmed by other studies [7] dedicated to code clone that use these vectors for code clone analysis.

7 Related Work

There are lot of related work in this field. This work is based mainly on two other works using AST for code similarities detection. The first of them (*An AST-based code plagiarism detection algorithm.* [8]*)* search for plagiarism using AST using hashing. The authors point out that AST can be optimized so that attempts to hide plagiarism can be detected and explored. There are more studies proves this fact [5, 6]. The second work (*Deckard: Scalable and accurate tree-based detection of code clones.* [9]) describes the use of source code vectorization using AST to detect source code clone. Based on this approach, there are several other works that use vectoring for different purposes [7, 10]. Unfortunately, at present there are no works that compare or use both of these approaches.

8 Future Work

In our work, we were dealing with the basic comparison of the representation of the source code for the purpose of the anti-plagiarism system. For further research in this area, it would be worthwhile to make this comparison in a more systematic way.

Based on the experiments, we will continue to design the anti-plagiarism system using vector code source. Based on our outlined the proposal is a logical next step indexation of these vectors. Currently used methods [7, 10] are unable to process source codes for the anti-plagiarism system. They are excellently in search of plagiarism in a given group of work but can not be applied to large anti-plagiarism systems. To handle large amounts of data, we plan to use clustering techniques.

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References

1. Ďuračík, M., Kršák, E., Patrik, H.: Using concepts of text based plagiarism detection in source code plagiarism analysis (2017)
2. Curtis, G.J., Vardanega, L.: Is plagiarism changing over time? A 10-year time-lag study with three points of measurement. High. Educ. Res. Dev. **35**(6), 1167–1179 (2016)
3. Kravjar, J.: Sk Antiplag is Bearing Fruit (2015)

4. Ďuračík, M., Kršák, E., Hrkút, P.: Current trends in source code analysis, plagiarism detection and issues of analysis big datasets. Procedia Eng. **192**, 136–141 (2017)
5. Zhao, J., et al.: An AST-based code plagiarism detection algorithm. In: 2015 10th International Conference on Broadband and Wireless Computing, Communication and Applications (BWCCA). IEEE (2015)
6. Tao, G., et al.: Improved plagiarism detection algorithm based on abstract syntax tree. In: 2013 Fourth International Conference on Emerging Intelligent Data and Web Technologies (EIDWT). IEEE (2013)
7. Lazar, F.M., Banias, O.: Clone detection algorithm based on the abstract syntax tree approach. In: 2014 IEEE 9th International Symposium on Applied Computational Intelligence and Informatics (SACI). IEEE (2014)
8. Feng, J., Cui, B., Xia, K.: A code comparison algorithm based on AST for plagiarism detection. In: 2013 Fourth International Conference on Emerging Intelligent Data and Web Technologies (EIDWT). IEEE (2013)
9. Jiang, L., et al.: Deckard: scalable and accurate tree-based detection of code clones. In: Proceedings of the 29th International Conference on Software Engineering. IEEE Computer Society (2007)
10. Lee, M.-W., et al.: Instant code clone search. In: Proceedings of the Eighteenth ACM SIGSOFT International Symposium on Foundations of Software Engineering. ACM (2010)

Digital Technologies Applied to Textual Reading and Understanding in English: A Practical Approach Using Kahoot

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Abstract. This paper presents the analysis of a multimodal practice proposed that combines reading and textual comprehension in English, through a text available in the Voice of America (VOA) website joined with a digital game using the Kahoot application. The practice was carried out in two classes of the Jovem Aprendiz Project at Feevale University, with a total of 43 participants. Besides, categories of analysis were defined and a semi-structured interview was performed with the teacher responsible for the English subject and the application in the classroom. The content of the interview was analyzed using the content analysis of Bardin. From the content analysis of the semi-structured interview, within the pre-established categories, it is considered that multimodal resources and digital games can be allied to the teaching practices in order to motivate and engage the students into the learning process. It is also concluded that the use of technologies in the classroom can make learning more effective.

Keywords: Multimodality · Second language acquisition · Digital games

1 Introduction

The present article has as its theme pedagogical practices with the use of digital technologies in the classroom, as a support to the process of reading and textual comprehension in English, as a second language (L2). Social practices of reading and writing in addition with the use of digital technologies are subject of study and discussion of teachers and researchers around the world. It is necessary to develop these skills in students, essentially related to immersion and experimentation in the learning process. In this context, the incorporation of Information and Communication Technologies (ICTs[1]), are essential to classroom teacher activities [1].

Digital games used for educational purposes encourage students and accelerate the dynamics of learning. However, in order to be used in this context, it is necessary to clarify the learning objects used, as well as the contents of the knowledge areas developed [2].

The aim is to provide teaching methods focused on the learning through the experience of the learner, taking into account the preferences of the students and the content that will be given. In this scenario, there is a huge potential for learner-centered

[1] In this article, ICTs are referred as digital technologies.

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learning through the use of technology. However, although schools have computers and internet access, there are still few practices proposed. This is mainly due to the training of teachers, because they find it difficult to use the computer resource in the classroom [3].

As per Prensky [3], even if the need for a different approach in the classroom is perceived, the presentation of the contents or effective methods for teaching is still an area not well known to teachers and educators. According to Santaella [2], the use of multimodal resources can motivate students in the learning process.

Thus, the present study deals with a multimodal practice of reading and comprehension in English, as a L2, with digital games support, in an approach focused on the learner motivation and engagement. The objective is to analyze a proposal of a multimodal practice that combines textual reading and comprehension in English, through a text available in the Voice of America (VOA)[2] website, to the application of a digital game using the Kahoot[3] application. Furthermore, categories were defined and built up a semi-structured interview script based on them. The interview was performed with the teacher of the discipline after the application of the practice in the classroom. The content of the interview was analyzed through the content analysis of Bardin [4]. From the teacher's observation, a significant gain to the students' motivation to content developed in the classroom was perceived. The relevance of this research is in the need of use a pedagogical approach to promote the use of digital resources in the process of reading and textual comprehension in English as L2, as well as the multimodality, transcending the common verbal language reading.

Therefore, the present article is organized in five sections: in addition to this introduction, Sect. 2 addresses the main concepts and authors used as a basis for the practice development and results analysis. Section 3 will describe the materials and methods used in the study. Section 4 presents the results and the discussion of them in relation to theory and previous studies. Finally, Sect. 5 contains the final considerations and suggestions for future studies.

2 Background

According to Ellis [5], globalized communication enables people to get in touch with others, far beyond their speaking communities. In this way, the need to acquire a second language emerges, not only as a pastime or leisure, but also for education and job security. The same author mentions that this increase in number of people seeking for a second language became necessary more researches about how to learn a second language.

In case of Second Language Acquisition (SLA), it is possible to list some factors that affect this process. According to Lightbown and Spada [6], the main factors are: motivation, attitude, personality, intelligence and student preferences. The authors further complement, saying that motivation is the factor that can be most easily worked

[2] VOA Homepage, https://www.insidevoa.com/, last accessed 2018/01/19.

[3] Kahoot Homepage, https://kahoot.com/, last accessed 2018/01/19.

by the teacher, since the reason for studying a second language and the attitudes towards the classroom proposals are personal, but the motivation can be influenced by the proposed practice.

According to Ellis [5], motivation involves attitude and affective state, which influence in the degree of effort that the learner makes to learn a foreign language. For the author, there are types of motivation that can be identified in the learner of second language, among which stand out:

- **Instrumental motivation:** due to some functional reason, such as access to educational and economic opportunities.
- **Integrative motivation:** learning is intended as a way of integrating the learners with the people or the culture of the language speakers.
- **Resultative motivation:** motivation may be the cause of L2 learning or the outcome of the learning process. Learners who have some success experience may be more motivated to learn.
- **Intrinsic motivation:** involves the intrinsic motivation of the learner to dominate the language, without a crucial reason that determines their motivation. The goal is to learn the L2 and curiosity continue moving the learner on this course.

During the learning process, the types of motivation can be both complementary and opponent. Learners can combine factors such as instrumental and integrative motivation. Besides that, motivation is not something that the learner may or may not have, but something that will vary according to the educational context in which the student is inserted [5].

Thus, the potential of ICTs applied to the teaching of second language is perceived since they contribute to increase the learners' motivation, which is one of the aspects that affect the SLA process. According to Lieberman [7], in the context of the interactivity of the game, one of the main motivational elements is the goal and, in order to achieve it, promotes the student as the protagonist in this scenario. As per the author, the game objective motivates the learning process, even for those who, at first, have no interest in the subject.

Any environment can be a game place, and this place can be the classroom. The ludic environment is natural inserted in the context and allows students, as players, to learn without realizing and to develop skills, such as teamwork [2].

Emerging themes in the development of digital resources for education include multimodality, which is responsible for the increase in the level of digital games, through innovative dynamics and mechanics or associated with other digital or traditional elements. A multimodal interface allows the interaction with contents through different modalities, it means, from different forms of subject presentation involving different human senses for their perception [8]. According to Rowsell and Walsh [9], multimodality is the field that studies how individuals make sense through different modes, be they visual, sound, words, animations and spatial dimensions. In this context, multimodality is understood as the presence, in the same text or statement, of different modalities of language in an integrated and relational way. Moreover, Santaella [2] affirms that the games have an interdisciplinary purpose, which has been instigating researchers from the most varied areas of knowledge.

According to Prensky [3], six structural factors make the games engaging as followed: (a) rules impose limits, forcing players to follow the same paths, showing what is allowed and what is not; (b) goals or objectives, direct the player, contributing to the motivation; (c) results and feedback, how to measure progress against goals, and where to give learning, as it aims to enhance the player's experience that understands what has missed and continues; (d) conflict/competition/challenge/opposition, are the problems that the player tries to solve and that make the game happen; (e) interaction with the computer, through feedback, and social interaction through contact with other players; (f) plot and narrative on which the game is built. As per the same author, "the gaming world is an example of a totally user-centered environment" [3, p. 142].

According to Sung et al. [10], learning through mobility with the use of technology is significantly more effective than a traditional classroom. In this study, tablets were used during the application of the game, which allowed mobility in class. In addition, it is possible to find a huge number of educational resources on the Internet, most of them, when properly used, contribute to the development of the contents. This is the case of VOA website, which presents a series of leveled texts for English language teaching, and where the text of the proposed practice was found.

In this context, the present study proposed to an application of a multimodal practice, composed by a digital game that used Kahoot as authoring tool to create a quiz allied to a text and audio content selected in the VOA website.

3 Material and Method

3.1 Participants

The application occurred in two classes of the Jovem Aprendiz Project at Feevale University[4], with a total of 43 participants. Considering that the content developed was planned for the time of one class, the activity was carried out in one class in the morning (21 students) and in another class in the afternoon (22 students). The students that participated in this study had a basic level of English as reported by the teacher responsible for the classes of English subject.

All students that participates in the study are in high school, that is, they are adolescents.

The teacher responsible for the classes of English subject reported that the students appreciate of taking classes in computer labs, but he has difficulties to propose practices that will keep them connected to the class. In this case, the teacher reports that the students were dedicated in the activity.

[4] Jovem Aprendiz Project at Feevale University Homepage, http://www.feevale.br/pesquisa-e-extensao/programas-e-projetos-sociais/tecnologia/projeto-jovem-aprendiz-feevale, last accessed 2018/01/19.

3.2 Materials

The multimodal construct used the content available in the VOA website as the base text of the practice. Thus, the text *Bicycles Mean Less Demand for Fuel in East Asia*[5] was selected, with an English level appropriate to the class. In addition, a quiz was created using the Kahoot application, also available for online use.

The application of the practice was developed in a computer lab, where an individual computer with internet access was available to the students. For the game with Kahoot was used tablets of the institution that were distributed one for each group. In addition, the room also had projection equipment, used in practice with the Kahoot and audio equipment, used in the audio of the text available in the VOA website and in the application of the game with Kahoot.

3.3 The Multimodal Construct and Application

In its conception, the multimodal practice sought to ally the content of a text with audio in English, to a digital content, planned as a game. These materials – text, audio, and game – set up the multimodal construct. First of all, a text was selected in the VOA website, considering the English level of the students where the proposal would be applied. The text selected for classroom practice presented multimodal content, with images and complete audio of the written content, as well as addressing the theme of sustainability, as an interest of the researcher in working with interdisciplinary contents that have as background the environmental preservation.

In the first stage of the application, the teacher of the class was asked to deliver the printed texts, as well as the VOA website link where the material was, in case of the students wished to follow on the computer screen. In the sequel, the audio of the text was placed, for the follow-up of the class. After this stage, the teacher reviewed with the students all the contents of the text, as a way to guarantee the comprehension of the vocabulary and the discussion of the text theme with the class.

The content presented in the text was used to create of a quiz, through the online application Kahoot, where the activity of the game was allied to the revision of the main topics of the text. Tablets were necessary because the Kahoot platform works with quiz games, where questions are presented and students answer on tablets. The game automatically computes the students' answers, and calculates the points according to the accuracy of the response and the time that the response was sent. Responses more faster and assertive earn more points. At the end of all questions, the game indicates the winning group. As the response was given in group, only one tablet was available per group, since each group could only have one answer. However, the questions and answers choices are presented by the teacher using a projector, which allows all students have a clear view of the question and their response options. The tablet was used only to register the group answer.

Before starting the digital game activity, the teacher divided the class into groups. The groups would be composed of up to 5 students. The decision to perform the

[5] Bicycles Mean Less Demand for Fuel in East Asia, https://learningenglish.voanews.com/a/bicycles-mean-less-demand-for-fuel-in-east-asia/4048547.html, last accessed 2018/01/19.

activity in groups was due to the contribution that the components can do to each other, since this interaction would not occur in an individual activity where the students would be in a competition with each other. Instead of leaving the students free to choose their groups, the teacher decided on how to organize the students into groups willing to keep them more homogeneous. Although there is a general English level of the class, each student has their own language knowledge and the division arranged by the teacher would guarantee greater contribution among the students, as well as equality in the competition.

The proposed quiz was developed with ten questions and four answering options per each question. For each question, thirty seconds were given for the group to discuss and choose an answer option. In the end, a symbolic award was offered to the winner team.

Finally, students were asked to create a slogan, using the theme of environmental sustainability and one of the words mentioned in the text section “Words in This Story”.

Following, some pictures of the practical activity in the classroom can be observed (Fig. 1).

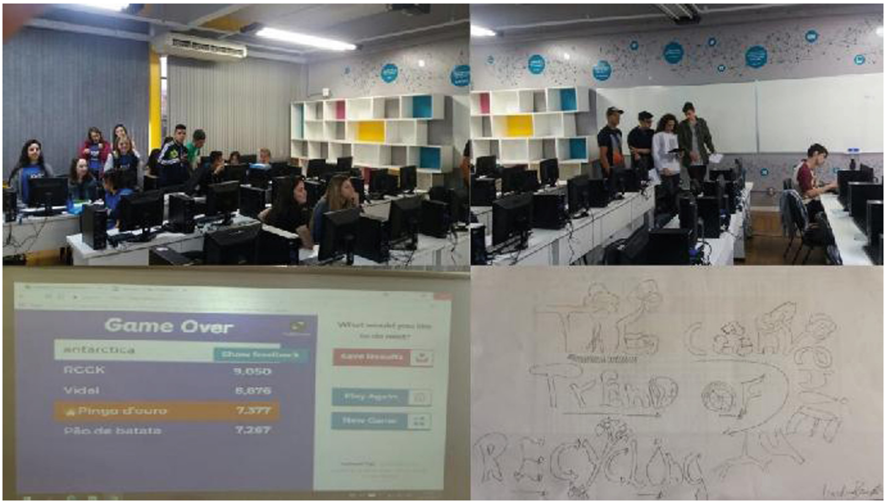

Fig. 1. Pictures of practice in the classroom

3.4 Data Analysis

As data collection instruments, the semi-structured interview with the teacher responsible for the application of this practice in the classroom was applied, using as a method of analysis the content analysis of Bardin [4]. The categories of analysis were the activity procedure, the motivation and the engagement of the students, and the reading and textual comprehension in the English using the multimodal resources. This interview was performed after the practice application and lasted 20 min. Also, it was composed of open questions, in order to collect the largest amount of information that will be used for later analysis.

For each one of the pre-established categories of analysis, questions were asked which outlined the content to be analyzed. Regarding the category of the activity procedure, were asked the questions: "How was the procedure of the practical activity with the students?"; "What are the main positive points you highlight with using Kahoot?"; "What are the main negative points you highlight with using Kahoot?". Regarding the category of motivation and the engagement of the students, it was asked: "Are the students motivated and engaged to participate in the activity?". Also, regarding the category of reading and textual comprehension in English with the use of multimodal resources, the teacher was asked: "Do you evaluate that the multimodal resources can help the learning process of second language, with regard the reading and textual comprehension in English?". The analysis of the answers given to these questions will be presented in the Sect. 4.

4 Results and Discussion

This section presents a content analysis through the method proposed by Bardin [4]. Thus, the content of the post-application interview will be analyzed concerning the theory proposed by Ellis [5] and Lightbown and Spada [6], regarding the acquisition of second language; Santaella [8] and Rowsell and Walsh [9], regarding multimodality; in addition to Prensky [3], Santaella [2] and Sung et al. [10], regarding technologies and their application in education.

4.1 Activity Procedure

Regarding the activity procedure, the teacher reported that it occurred fluidly and with great interaction and participation of the students. The students followed the listening and reading of the text as well as the practice with the Kahoot. The digital game was also more easily carried out due to the good laboratory and internet structure available in the space. The students understood well the proposal and also the operation of the game platform. In this perspective, Santaella [2], indicates that any environment can be a game place and also that the ludic environment is naturally inserted in the context of the students.

On the use of the Kahoot application, the teacher did not report any difficulties. The use of the game was positive, because it was possible to review and be sure that the content was effectively understood by the students. The success of the game and its fluidity in practical classroom activity can be explained through the theory proposed by Prensky [3], when determining the six structural factors that make the games involved: the Kahoot game developed had clear rules, targets, and well-defined goals, results and feedback immediately after each questions time complete, exposed conflict with the problems that the group had to solve, interaction with the computer via feedback and interaction with the other players in the group, narrative built on the text previously treated.

The same author further states that the game environment is user centered, and it was observed in practice, since the game was also important to conclude what was learned by the students in respect to textual content.

4.2 Motivation and the Engagement of the Students

The pedagogical strategy proposed used the multimodality as a way of motivating and engaging the students. According to the teacher, the students' motivation was greater when the group activity was carried out using the digital game. The students participated more actively, because everyone wanted to be the winner. They were engaged in building a positive and successful result. Instead, during the reading activity, some students were distracted. Students' preference for the practice involving the digital game can be explained by Sung et al. [10], when they state that learning mediated by technology becomes more effective than a traditional classroom.

It was observed an active participation of students in the digital game, which as mentioned by Santaella [2], encourage students and accelerate learning dynamics. The motivation of students, according to Lightbown and Spada [6] is one of the factors that affect the learning of second language. The motivation was observed in the students who contributed and try to solve correctly each of the challenges presented in the Kahoot. As explained by Prensky [3], the resources are available, but the teachers must be prepared to work the intended content through the learner-focused digital technologies. In addition, it can be observed the naturalness relation of the insertion of the digital games environment in the context of the students, that according to Santaella [2], provides learning without the student perceiving and developing other skills, such as team work.

According to Ellis [5], there are types of motivation that can be identified in the learner of second language. These factors are individual, so, in a class with a large number of students, different types of motivation are found. Among the students of the two classes where the study was applied, there are a huge number of students interested in educational and economic opportunities, this being the instrumental motivation. The practice proposed worked the resultative motivation, in the context that the result motivates the student to continue and win the game. Also, the student may be motivated to continue in other activities involving English learning by the result of this practice. The intrinsic motivation was also pointed out by the teacher, mainly observed in students who have an interest in learning English, without an apparent reason for doing it. The curiosity of these students develops their learning beyond the contents presented in class. According to the teacher's experience and report, the integrative motivation is not present in the students of the classes, since they are all speakers of the same mother tongue (L1). It is important to emphasize that these factors can be complementary or opponents. The same student may have more than one motivational factor and may also oppose another one.

Furthermore, Ellis [5] states that the motivation may vary according to the educational context, that is, it can be potentialized or not according to the teaching practice. The practice proposed in this study aroused the students' interest in understanding the textual content, in order to obtained a positive result later, in the digital game. In the context of SLA, Lightbown and Spada [6] affirm that motivation is one of the factors that influence the acquisition of second language and the one that can be more easily worked by teachers, that is, it is important to propose practices that motivate the students, as this will influence learning.

Moreover, according to the teacher, the multimodality present in practice also contributed to the interest and participation of students, making them motivated to learn. According to Santaella [8], the multimodality has increased the level of the games, that can be combined digital and analog contents. In the analyzed practice, digital and analog contents were articulated, and a greater interest was observed, mainly, in the part of the class composed by the digital game.

4.3 Reading and Textual Comprehension in the English Using the Multimodal Resources

Regarding the understanding of the content presented in the text of the VOA website, the teacher reported that it was possible to perceive that the students understood the text. During the review, after the text listening, some doubts were pointed by the students and clarified before the beginning of the game using Kahoot. This ensured a good number of overall hits of the teams. The scores of the two classes were good, and the highest concentration of errors was perceived in questions involving percentages and numbers, where the alternatives could make the students confused.

Santaella [8] affirms that a multimodal interface allows interaction with content through different modalities. Thus, Rowsell and Walsh [9] understand multimodality as the presence of different modes of language, be they visual, sound, words, animations and spatial dimensions. The practice proposed had contents with different modalities: visual language, sound, words and animations. The learning process can be noticed in the course of the practice: first, when the teacher presents the audio of the VOA website, the students had many doubts. Next, when the teacher read the text, most of the doubts were clarified. The use of Kahoot was positive to fix the content and the development of the slogan contributed to the review of the keywords through an activity involving the creativity of the students.

5 Conclusion

The use of digital technologies as a support for reading and writing practices is a subject of teachers and researchers studies. From the content analysis of the semi-structured interview, within the pre-established categories, it is considered that digital games and multimodal resources can be allied to teachers in classroom practices, when used as a way of motivation and engagement of the students to the practice. As motivation is an individual component and an important factor for second language learning, the use of multimodal resources can leverage students' motivation and engagement in the learning process.

The findings of this research were positive regarding the acquisition of English language (L2) through a multimodal practice. In addition, multimodal practice do the class fluid and allowed interaction and participation of all students.

Regarding the use of technology in classroom practice, this study verifies that learning is more effective with the insertion of it. In addition, the classroom can be an environment for a game application, which is inserted naturally in the context of the student. In its structure, the digital game is composed of factors that make it engaging, so that the students learns without realizing it, even in the case of content that at first does not interest them.

The objectives of this practice were achieved, but it is suggested as a guide for future studies the extended of the application in the classroom, so that it is possible to follow the effectiveness of the use of the multimodal resources applied to reading and textual comprehension in English (L2).

References

1. Kersch, D.F., Rabello, K.R.: São atitudes como estas que podem fazer a diferença para uma escola melhor: outros tempos, novos letramentos. In: Kersch, D.F., Coscarelli, C.V., Cani, J. B. (eds.) Multiletramentos e multimodalidade: ações pedagógicas aplicadas à linguagem. Pontes Editores, Campinas (2016)
2. Santaella, L.: Comunicação ubíqua: repercussões na cultura e na educação. Paulus, São Paulo (2013)
3. Prensky, M.: Aprendizagem baseada em jogos digitais. Editora Senac, São Paulo (2012)
4. Bardin, L.: Análise de conteúdo. Edições 70, São Paulo (2011)
5. Ellis, R.: Second Language Acquisition. Oxford University Press, Oxford (1997)
6. Lightbown, P.M., Spada, N.: How Languages are Learned, 2 edn. Oxford University Press, Oxford (2000)
7. Lieberman, D.A.: What can we learn from playing interactive games? In: Vorderer, P., Bryant, J. (eds.) Playing Video Games: Motives, Responses, and Consequences, pp. 379–397. Lawrence Erlbaum Associates, Mahwah (2006)
8. Santaella, L.: A ecologia pluralista da comunicação: conectividade, mobilidade, ubiquidade. Paulus, São Paulo (2010)
9. Rowsell, J., Walsh, M.: Rethinking literacy education in new times: multimodality, multiliteracies, & new literacies. Brock Educ. **21**(1), 53–62 (2011)
10. Sung, Y.-T., Chang, K.-E., Liu, T.-C.: The effects of integrating mobile devices with teaching and learning on students' learning performance: a meta-analysis and research synthesis. Comput. Educ. **94**, 252–275 (2015)

A Competence Framework for Open Educational Resources: The Case of the Public Sector

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Abstract. Although Open Educational Resources (OER) initially aimed to facilitate access to educational topics in school, these tools and contents may be used in the public sector, for example, embedded in an e-learning concept. According to Stoffregen [1], this may still seem quite challenging but getting there is possible as also Nurhas et al. [2] have pointed out. In this paper, we therefore present an initial OER competence framework to successfully use OER also in the public admiration. Our framework aims to provide a first set of competences that may be specific for the public sector, but also abilities one may find in various industries, such as acquiring technical, legal or collaborative skills that are needed to implement a sustainable strategy for the use of OER in the respective organization. Therefore, we will present two examples for its practical application: a questionnaire for self-assessment and an example for an OER training concept.

Keywords: Open Educational Resources · OER · Competences
Competence framework · Public sector · Public administration

1 Introduction

The public administration's approach towards the re-use and production of OER has been rather timid in the past years. Once a grass root movement, they may now find their way into the public offices thanks to the open government movement in Germany. In this paper, we develop a competence framework regarding the production, the (re) use, and the implementation of the OER concept in organizational structures, namely in public administrations. The framework describes the competences for various levels of OER activities and roles: users, developers and disseminators. The framework was developed in the German project ÖWR (Offene Wissensressourcen im öffentlichen Sektor), which aims at competence development and sensitisation of the public administration in Germany with regard to OER by addressing in particular employees,

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trainers and multipliers. Here, the framework has been used to elaborate individual workshop concepts, training materials and to evaluate the participants' competence development and attempts to bridge the research gap to required competences and to answer the question: Which competences are required to overcome OER-related barriers in the public administration? To answer this question, we start with a literature review and present our research methodology. We then go on, to the process of designing our competence framework as well as its validation. Finally, we provide an example for its application including a first evaluation.

2 Background Literature and Concepts

As an initial step, we aimed at identifying competences and skills for different levels of OER, followed by developing networks to collaborate around OER, since a competence framework can be seen as the basis, on which a concept for further training is grounded: It helps in identifying the gaps, and thus, in tailoring training concepts. Especially in the context of the public administration, the need for a competence framework seems omnipresent. An analysis of Stoffregen et al. [3] indicates that, among other things, not only the lack of resources but also the perceived technology fit of OER may still present a challenge. Here, a defined framework may help to understand the requirements of the public administration and to fill in the gaps.

2.1 Competences in General

The term competences has been investigated and discussed in numerous domains from multiple perspectives. There is no widely accepted definition in the literature [4–6], rather various conceptual understandings and concepts are summarized by Winterton [7] under the term competences. Based on Chomsky [8] and White [9], McClelland [10] pointed out that competences could be derived from the actual action, the performance, and the application of existing possibilities in practice. With this, McClelland [10] laid the foundation for many of today's competence definitions. For example, van der Blij [11] defines competences as the "*the ability to act within a given context in a responsible and adequate way, while integrating complex knowledge, skills and attitudes*".

Similar definitions can be found from other researchers [12, 13]. According to the statement of [14], there is no general definition of competences, but rather widely accepted working definition: "*As competences, we understand dispositions to self-organization, which is self-organization dispositions*" [14:63, own translation]. Applied to the field of information systems, the following definition will be used: "*We define thus competences as a collection of skills, abilities, and attitudes to solve a problem in a given context*" [15:2].

2.2 The Need for a Competence Framework in OER

With a view to the ÖWR project, a literature study was carried out indicating that there is no qualification and competence construct per se which is explicitly devoted to the use of OER by public service employees. Without going deeply into discussions on the categorisation of competences, one can expect basic information and media competences and digital competences (e.g. the person is qualified to collaborate with others using different technologies), which are essential for the use of online media. In addition, with a view to the introduction of a new concept of knowledge and learning, it can be assumed that conceptual training skills must be imparted. For the creation of an OER focused competence framework regarding the public sector, we focused on the following sources which proved to be particularly helpful. **Digital Competences.** As a first approach to the subject of digital education, the *Digital and Information Literacy Framework* [16] aims for an overview on the competence development in this area, especially with respect to modules, programs and qualification teams by integrating the respective competence level into the learning objectives for Open University students. Complementing this framework, *the Open Distance Learning Competencies* [17] focus on the professional and technical aspects from a pedagogical perspective. A *self-assessment grid is provided by the European Union* [18], dividing the proficiency levels into Basic, Independent and Proficient Users of digital tools. **OER Competences**. Moving on to the subject of Open Educational Resources, the *German UNESCO* attempts to answer the frequently asked questions in cooperation with the *Commonwealth of Learning (CoL)* [19], giving a general overview. Also, a guideline on the use of *OER in higher education* [20] was released aiming to inspire decision-makers in politics and institutions to invest in the systematic creation and use of OERs and to include OERs in higher education. A *comprehensive framework* on the subject of OER has been conceptualized by the Commonwealth of Learning (CoL) [21], discussing the basic principles and ideas. The list below summarizes skills mentioned in the framework:

- Competence *in advocating and promoting OER* as a means of improving the quality of learning and teaching in education (with a good understanding of conceptual and practical issues, policy implications, etc.)
- Legal knowledge of *copyright law and appropriate licensing*
- Competence in *developing and explaining business models* that justify institutions, individual teachers and other educational content creators (including publishers) to use open licenses and illustrate the benefits
- *Program, course and material design and development skills*, with a focus on assisting educators to exploit the full potential of resource-based learning in their curricula
- *Technical competence in multimedia-based material creation*, facilitated by the immediate availability of digitized, open-licensed learning content
- Competence in the *management of networks, individuals and institutions* working together on various projects to improve teaching and learning processes
- Competence in the *mediation and effective exchange* of OER
- *Communication and research competence* to be able to pass on information about OER in various formats like web updates, brochures, case studies, and research reports.

Based on these findings, the German *MuMiW project* [22] conceptualized a German OER competence profile and a training concept specifically for OER experts. Here the different skills necessary for the successful use of OER are divided in 3 categories: Professional Competence, Methodological Skills and Social Competence. These are assigned to the respective competence level of the user, which is divided into 4 categories: OER acquaintances, users, creators and multipliers [23]. **Further sources on public administration**. Apart from confidential information we received from some offices, we extended our research towards the *Online Administrative Encyclopedia* [24]. This digital reference guide for public administrations (www.olev.de) with wiki character provides not only definitions on administration-specific topics. It also contains explanations and brief instructions on economic topics with relevance for the public administration. In addition, the *ZUM Wiki* [25] provides an open platform for teaching content and learning processes. In addition to creating new educational content, the association's goal is to network existing platforms and build up its own infrastructure for working on the net.

To conclude, as we did not find a competence framework matching the needs of employees in the public administration, we mainly focused on criteria that could be included in an OER-specific competence framework for this target group, either from a technical, strategic, legal, communicative or didactic perspective. We did not include rather general skills and abilities such as the ones mentioned in the "European Computer Driving License" [26, 27] which we see as a prerequisite for further training.

3 Methodology

The use of the Action Design Research (ADR) method enables the creation of innovative (IT-)artifacts to solve a problem in the organizational context. According to Sein et al. [28], the evaluation and the resulting interventions enable the continuous reshaping of IT artifacts. The ÖWR project aims to impart competences and skills and to develop networks in order to introduce and sustain the finding, use, creation and sharing of OER. It was worked out that there is neither a qualification nor a competence construct per se which is explicitly dedicated to the use of OER by public service employees. In this context, a competence framework has been developed that explicitly addresses the use of OERs in the public sector. A permanent adaptation of the framework to the requirements of the public sector is necessary in order to overcome OER-related barriers in the best possible way. Thus, the ADR method is very well suited for the building, intervention and evaluation of the initial competence framework.

The first step of the ADR method is problem formulation. A comprehensive literature review (see Sect. 2.2) has identified a number of literature sources relating to the use of OER in the public sector. The study of further, common competence frameworks serves to delimit the problem definition.

The second step of the ADR method focusses on the building, intervention and evaluation of an IT artifact. Sources identified in the first part were used to work out and consolidate competences of interest for the work with OER. For this purpose, the competences were tested through a focus group for their proximity to the topic and for redundancies. The focus group consisted of thirteen employees in various positions in the administration (processing, case handling, management, recruitment, human resource development). The remaining competences were finally clustered, and transferred into an initial framework of competences. The initial framework contains the competences necessary for the creation and use of OERs. It was then divided into five categories, each with three characteristics (level of the respective target group).

In order to evaluate the competence framework, the focus group was then expanded by long-term OER creators and users (6 participants) were asked to assess the competence framework in terms of its completeness, its intelligence and conciseness of the categories, both from an academic and practical perspective. From the initial competence framework, a questionnaire was developed for this purpose (see Sect. 4.1), which allows the assessment of the framework, especially with regard to the relevance of the competences and the formulation. The resulting questionnaire was used in workshops (about thirty-five participants) within the ÖWR project to obtain expert feedback for validation of the competence framework. In addition to this quantitative evaluation, conclusions could also be drawn from written feedback and consultation. The feedback received was used to create an improved version of the competence framework (see Sect. 4.2).

The fourth and last step of the ADR method extends the evaluation by developing application scenarios for the practical use of the improved framework (see Sect. 4.3). In this context, a self-assessment tool has been developed which enables an assessment of one's own abilities with regard to the individual competences. In addition, a training scenario was developed, which exemplifies the transfer of competences by using various tools.

4 The OER Competence Framework

The following section shall give an overview of our findings so far after discussing the construction of initial framework. Based on the feedback we received in the workshops and interviews, we constructed a first draft of the competence framework. For reasons of clarity and comprehensibility, we will refer to the final version of the framework. In a first step, we defined three proficiency levels, as not all items possess the same degree of expertise:

OER Users. The first stage aims to enable individuals to know the possibilities of OER and to apply them to their own context. Individuals are able to identify and search for OER. They can develop scenarios on how existing OERs can be used at the workplace and how they can be integrated into their daily work.

OER Developers. This level includes the use of OER with appropriate customizations. Individuals are able to identify and to contextualize OERs. This includes the use of appropriate tools for customization. Trainers and knowledge managers are the target groups for this level.

OER Disseminators. OER disseminators are able to carry out both the adjustments of the previous levels and OER training courses. This includes the "multipliers" who are particularly important, as they will help protecting OER in the end - after the project has been completed - and implement long-term strategies.

4.1 Results and Revised Framework

The competences necessary for a successful use and creation of OER consist of five categories and characteristics (level of the respective target group) after their identification and definition:

1. **Digital competences**. This category deals with the general knowledge regarding technical basics, which are a prerequisite for the (technical) setup and implementation of a learning platform. This also includes digital research methods and digital collaboration for example. Here, not only the basic knowledge for the production of materials is located, but also the ability to build up the necessary infrastructure (platform), which is necessary to make the collected knowledge or the finished materials accessible and to share them with others. This second aspect is considered in the next dimension (communication/networking) (Table 1).

Table 1. Excerpt digital competences

Competence	Description	Proficiency level
Material production	Is able to produce material in different open digital formats (odt, doc, ppt, mp3)	Basic user
Publishing of material	Is able to publish material in different ways (e.g. Wikis or leaning platforms)	Basic user
Digital collaboration	Is able to collaborate online	Basic user

2. **Networking Competences.** Since a platform thrives on exchanging, it comes down to the collaboration and communication skills of each individual, as well as motivating others to do so [21]. Since a (learning) platform builds on this interpersonal dynamic with others, i.e. is dependent on collaboration. The basic structure of our OER competence framework also includes key competences from the communication and networking area (Table 2).

Table 2. Excerpt networking competences

Competence	Description	Proficiency level
Critical faculty	Is familiar with the feedback rules	Developer
Provide feedback	Applies the feedback rules on a regular basis	Developer
Motivate	Is able to motivate others to use and utilize open content and open technologies	Disseminator

3. **Legal Competences.** Since not all educational resources are freely accessible or cannot be shared, basic knowledge of copyright and licensing law is essential - not only for the use of existing materials, but also for the creation of new ones. In addition, it is crucial for an open exchange to be familiar with the legal framework and the context in which OER may be used. This means that a basic knowledge of license law and the requirements for open licenses also play an important role when dealing with "open" resources, as the unclear situation in Germany can be seen as one of the OER drivers as also Orr et al. [29] point out (Table 3).

Table 3. Excerpt legal competences

Competence	Description	Proficiency level
Familiar with license terms	Is aware of pros and cons of open licenses	Developer
Copyright	Understands the basic concept of copyright/intellectual property	Basic user
Requirements for open licenses	Is able to define steps to share materials (metadata, licensing, networking) under an open license (e.g. CC)	Developer

4. **Strategic Competences.** A long-term strategy for OER in the administration ensures a successful implementation of the new proceedings. Strategic thinking and knowledge of recent developments in this field are therefore paramount. As an example, it helps to be a proponent of the idea to share knowledge "for free" in order to build a good argument pro OER and to convince others. In order to implement a sustainable solution that is also used, competences such as *strategic thinking*, own inner conviction and interest in current developments are just as important as the *ability to manage OER productions* (Table 4).

Table 4. Excerpt strategic competences

Competence	Description	Proficiency level
Interest in open trends	Is interested in current developments on open approaches (Open Government, Open Source, Open Data, OER)	Developer
Familiarity with open trends	Keeps regularly informed about developments in open approaches (Open Government, Open Source, Open Data, OER)	Disseminator
Options for OER Use	Is aware of different OER options for my own administration (e.g. retain, reuse, revise, remix, redistribute)	Basic user

5. **Pedagogical Competences.** Didactic knowledge is not only advantageous for the final quality assurance. It also forms the (methodological) framework for the creation of (new) open learning content. Ultimately, it is the content, its level and a good referencing that make it possible to consolidate and invite multiple uses. Even though the second dimension of our competence framework plays a major role here (communication and networking), we focus on the teaching-related creation of target group-oriented content (Table 5).

Table 5. Excerpt pedagogical competences

Competence	Description	Proficiency level
Content creation	Is able to create OER	Developer
OER selection	Is able to identify relevant OERs	Developer
Referencing	Is able to adequately refer to sources	Developer

4.2 Validation and Feedback

Based on the feedback we received in the workshops and expert interviews with the focus groups, we carried out the following changes: **Harmonizing redundancies.** Some definitions have been streamlined as their meaning appeared quite redundant or too close to make an exact distinction. Especially in the teaching cluster, the items dealing with implementing OER in already existing teaching modules and setting OER in a new context were condensed into the competence 'Contextualization'. In addition, in the strategic cluster, competences regarding the strategical planning and its use have been aligned in the competence 'Strategy Development". **Clarifying unspecific Items.** However, some items needed more clarification. For example, the competence '*Understanding of copyrights and intellectual property'* originally was phrased too vague and needed a more specific wording. As well, the competence *'Taxonomy use and creation'* needed to be clarified as this term may not be understandable for every employee in the public administration. Some items, such as the *'informal collaborative approach among colleagues'* needed to be rephrased into '*Networking'* to avoid ambiguous understanding. The reason for this is that, unlike the authors, some people may find a negative connotation in its wording, which may imply undermining authorities. **Splitting Items.** Finally, some items seemed too congested and needed to be split in two parts in order to reflect either the different perspectives (e.g. the ability to give and accept feedback) or proficiency levels (e.g. the technical ability to produce material on a basic level and the ability to publish the material on different (learning) platforms).

4.3 Practical Examples for Use

In this section, we will discuss two cases how the competence framework is used. In the first example, we will introduce the questionnaire as a self-assessment tool for one's own competences in the field of OER. This may also serve as a tool to evaluate the degree of familiarity with OER in the respective public administration. The second example then gives an overview on how the findings of the first example can be used to develop an individual OER training concept, also by providing examples on where to find the respective OER.

Questionnaire for Self-assessment. The figure below shows the final questionnaire for the self-assessment of OER competences in the public sector. On the one hand, we hope to find out to what extent OER have already reached the public sector. On the other hand, this self-assessment tool may serve as a first location determination for the employees in the public administration, as to where they currently stand regarding their personal OER competences. The participants indicate to which extend respective competence statement applies to them or their situation. Therefore, the participants can mark the degree of agreement from "*5-strongly agree*" to "*1-strongly disagree*". If the statement does not apply to their situation at all, "0-not applicable" can be marked. In a next step, the results may serve as an orientation for an individual training concept on OER for the respective public administration unit (see Sect. 4.4) (Fig. 1).

Technical Competences	5	4	3	2	1	0
I can develop material in different open digital formats (odt,doc, ppt, mp3).						
I can pblish material in different ways (e.g. Wikis or leaning platforms).						
I can collaborate online.						
I can share knowledge online (via social networks or through communities).						
I can use search engines to find open materials.						
I am familiar with the key OER search engines or search functions and OER-repositories.						
I understand the meaning of metadata in the context of OER (retrievability).						
I know how to create metadata.						
I can use taxonomies or classifications for the description of resources (metadata).						
I can embed OER in websites with learning content.						
I can create a virtual learning environment.						
Communication Competences	5	4	3	2	1	0
I am familiar with the feedback rules.						
I apply the feedback rules on a regular basis.						
I can motivate others to use and utilize open content and open technologies.						
I can enable others to use and utilize open content and open technologies.						
I can enable others to use open content and open technologies.						
Legal Competences	5	4	3	2	1	0
I am aware of pros and cons of open licences.						
I understand the basic concept of copyright/intellectual property.						
I can define steps to share materials (metadata, licensing, networking) under an open license (e. g. CC).						
I can inform others about the advantages and disadvantages of different licenses.						
Strategic Competences	5	4	3	2	1	0
I am interested in current developments on open approaches (e.g. Open Government, Open Source, Open Data, OER).						
I keep myself regularly informed about developments in open approaches.						
I know different OER options for my own administration (e.g. retain, reuse, revise, remix, redistribute).						
I can recognize diversity-relevant OER criteria (e. g. gender-neutral formulation or barrier-free colour design).						
I can practically convey the advantages and risks of OER.						
I know about shortcomings (in knowledge management/organization).						
I know evaluation mechanisms for selecting OER or can locate evaluation mechanisms in the organization.						
I can argue convincingly in favour of OER against adversaries.						
I can develop a sustainable OER strategy for the administration.						
I can provide advice on the integration of OER in organisational structures.						
I can manage OER productions (e. g. areas of responsibility, resources, sustainable financing).						
I can evaluate the costs and benefits of OER (re-)use and production.						
Teaching Competences	5	4	3	2	1	0
I can create OER.						
I can identify relevant OERs.						
I can adequately refer to sources.						
I can embed and customize OER in a new context of use.						
I can organise and carry out the quality assurance of OER.						

Fig. 1. Questionnaire self-assessment OER Competences (without proficiency level)

4.4 Developing an Individual OER Training Concept

A second practical implementation option is the development of learning and training scenarios for specific competences. With the help of the training scenario, individual OER competences can be acquired by using different materials/tools. In addition, it is determined which level of the corresponding competence can be achieved with the respective learning activity and tool. The learning scenario focuses on locating and modifying existing OER content. For this purpose, examples of the existing OER Workshop internationalization will be used, which is freely available on the Jointly Platform [30]. The competences can be subdivided according to the competence framework into digital(dig), communication(c), legal(l), strategic(s) and teaching/didactic(did) competences.

#	Learning activity	Tool	Competence	Level
1	Search for available resources	Trainer presents OER search-engines as starting point, cf. Pawlowski [31]	Digital research (dig)	Developer
			Use of OER repositories(dig)	Developer
			OER Selection (did)	Developer
2	Specification of requirements	Creation of requirements list e.g. requirements for internationalization of OER content (cf. Analysis of Hofstede's Dimension of culture in [31:19])	Contextualization (did)	Developer
3	Validation whether the resources found meet the requirements or whether adjustments need to be made.	Requirement Checklist e.g. technical requirements, didactical requirements. For examples, cf. examples for in Pawlowski [31:16]	Contextualization (did)	Basic User
			Quality assurance(did)	Disseminator
			OER Selection (did)	Developer
4	Specification of possible adaption needs	Content Plan with the requirements created previously for implementation in the next step	Contextualization (did)	Disseminator
5	Adaption of content to requirements	The original OERs will be adapted to meet the new requirements e.g. language adaptions [31: 26]	Content creation (did)	Developer
			Referencing(did)	Developer
			Contextualization (did)	Disseminator
			Material Production (dig)	Basic User

(*continued*)

(*continued*)

#	Learning activity	Tool	Competence	Level
6	Licensing & Publication	Assigning the right license for the new content and making it available. The moderator introduces CC Licenses and sharing possibilities [31:12, 33]	Familiar with license terms(l)	Developer
			Publishing of material(dig)	Developer

5 Discussion, Conclusion and Outlook

The aim of this article was to develop an OER competence framework for public administration. The need for this has been identified in the Eagle project. The competence framework was then developed within the ÖWR project, which focuses on sensitization and competence development for OERs in the public sector by using the ADR method. In a first step, the relevant literature was identified. After explaining the methodology, first findings and examples for its practical application were discussed. As the framework, in the end, now also consider aspects that are not exclusively valid for the public administration, it can easily be adapted for other domains. Another step could be the generalization of the framework to make it applicable for various industries, possibly by including an individual cluster including the particular requirements, e.g. for the private sector or higher education.

Although the *framework* has been validated, its effective *use* and the *impact of the training measures on the use of OER*, have yet to be evaluated. Therefore, a quantitative analysis of the results may help to define the priorities and the extensions of the framework and measures in a next step. Hence, more examination is needed focusing on the framework's comprehensiveness, essential success factors and possible training measures (interventions) that can be taken to ensure a sustainable application of OER.

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References

1. Stoffregen, J.D.: Barriers to Open E-Learning in Public Administrations. Academic dissertation to be publicly discussed, University of Jyväskylä (2017). http://urn.fi/URN:ISBN:978-951-39-7298-1
2. Nurhas, I., Pawlowski, J.M., Jansen, M., Stoffregen, J.: OERauthors: requirements for collaborative OER authoring tools in global settings. In: Verbert, K., Sharples, M., Klobučar, T. (eds.) EC-TEL 2016. LNCS, vol. 9891, pp. 460–465. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-45153-4_43

3. Stoffregen, J., Pawlowski, J.M., Pirkkalainen, H.: A barrier framework for open e-learning in public administrations. Comput. Hum. Behav. (2014). https://doi.org/10.1016/j.chb.2014.12.024
4. Hoffmann, T.: The meanings of competency. J. Eur. Industr. Training (1999). https://doi.org/10.1108/03090599910284650
5. Jubb, R., Robotham, D.: Competences in management development. Challenging the myths. J. Eur. Industr. Training (1997). https://doi.org/10.1108/03090599710171422
6. Strebler, M.T., Robinson, D., Heron, P.: HR Response to Organisational Change. Getting the Best out of Your Competencies. The Institute for Employment Studies, Brighton (1997)
7. Le Deist, F.D., Winterton, J.: What is competence? Hum. Resource Dev. Int. (2005). https://doi.org/10.1080/1367886042000338227
8. Chomsky, N.: Syntactic Structures. Mouton, The Hague (1957). (Aspects of the Theory of Syntax. MIT Press, Cambridge (1965); Lectures on Government and Binding. Foris, Dordrecht (1981); Some concepts and consequences of the theory of government and binding. LI Monographs **6**, 1–52 (1982))
9. White, R.W.: Motivation reconsidered. The concept of competence. Psychol. Rev. (1959). https://doi.org/10.1037/h0040934
10. McClelland, D.C.: Identifying competencies with behavioral-event interviews. Psychol. Sci. **9**(5), 331–339 (1973)
11. van der Blij, M.: Competentieprofielen over schillen en knoppen. Stichting Digitale Universiteit, Utrecht (2002)
12. Euler, D., Hahn, A.: Wirtschaftsdidaktik. UTB, Stuttgart (2004)
13. Weinert, F.E.: Leistungsmessungen in Schulen. Weinheim, Beltz (2001)
14. Erpenbeck, J., Sauter, W.: Kompetenzentwicklung im Netz New Blended Learning mit Web 2.0. Luchterhand, München (2014)
15. Pawlowski, J.M., Holtkamp, P.: Towards an internationalization of the information systems curriculum. In: Proceedings of the Multikonferenz Wirtschaftsinformatik, MKWI 2012, pp. 437–449 (2012)
16. Reedy, K., Goodfellow, R.: Digital and information literacy framework **2012** (2012). http://www.open.ac.uk/libraryservices/pages/dilframework/dilframework_view_all.pdf. Accessed 17 July 2017
17. Arinto, P.B.: A framework for developing competencies in open and distance e-learning. ODeL (2013). http://www.irrodl.org/index.php/irrodl/article/view/1393/2433. Accessed 7 Sept 2017
18. European Union: Digital Competences. Self-assessment grid (2015)
19. Butcher, N., Malina, B., Neumann, J. (eds.): Was sind Open Educational Resources? Und andere häufig gestellte Fragen zu OER. UNESCO, Bonn (2013)
20. Deutsche UNESCO-Kommission: Leitfaden zu Open Educational Resources. Empfehlungen für Politik, Hochschulen, Lehrende und Studierende (2015)
21. Butcher, N.: A Basic Guide to Open Educational Resources (OER). Commonwealth of Learning (COL), Vancouver (2015)
22. MuMiW Projekt: Open Educational Resources. Macher und Multiplikatoren in der Weiterbildung (2017). https://www.oer-fachexperten.de/projekt/. Accessed 17 July 2017
23. Günther, C.: OER-Kompetenzprofil (2017). https://oer-contentbuffet.info/edu-sharing/ng2/components/render/624fcd4d-9d40-4592-bab8-63dc624d3f5a. Accessed 19 July 2017
24. Krems, B.: Köln/Cologne, Germany: Online-Verwaltungslexikon - Wissen für gutes öffentliches Management (2016). http://www.olev.de/. Accessed 19 July 2017
25. ZUM: Medienvielfalt-Wiki (2017). http://medienvielfalt.zum.de/wiki/Hauptseite. Accessed 23 Oct 2017

26. Hattenhauer, R.: Informatik für Schule und Ausbildung. Pearson Deutschland GmbH, Hallbergmoos (2010)
27. Poulter, A., McMenemy, D.: Beyond the European computer driving licence. basic and advanced ICT skills for the new library professional. IFLA J. **30**(1), 37–46 (2004)
28. Sein, M.K., Henfridsson, O., Purao, S., Rossi, M., Lindgren, R.: Action design research. MIS Q. **35**(1), 37–56 (2011)
29. Orr, D., Neumann, J., Muuss-Merholz, J.: German OER Practices and Policy — from Bottom-up to Top-down Initiatives (2017)
30. OER-Contentbuffet. https://oer-contentbuffet.info/edu-sharing/components/oer. Accessed 18 Jan 2018
31. Pawlowski, J.M.: Internationalisierung von Open Educational Ressources. Eine Einführung (2017). https://rendering.oer-contentbuffet.info/eduConnector/src/tools/onlyoffice/doceditor.php?id=fa330ef58d62bb1a8d87ea981f34e34cb2bd1bd5a90884dc00a7b5f198320b44&ref=aHR0cHM6Ly9vZXItY29udGVudGJ1ZmZldC5pbmZvL2VkdS1zaGFyaW5nL2NvbXBvbmVudHMvcmVuZGVyL2Y4YmYzYmUwLTEyOTktNDhjOC1hMDQyLTgwZTMxMmQ5OGI4MC8xLjE=. Accessed 18 Jan 2018

Business Students' Experience with Peer Grading

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Abstract. Implementing peer grading in a business study programme presents a challenge for teachers and students, especially at universities where peer grading still presents un unusual and unknown pedagogical approach. The whole process must be well-planned in advance, and the assessment criteria must be clear, defined, and understandable. In addition, students need to develop assessment literacy. Increased interest for an elective course forced us to think about maintaining all students' interactions that had been developed in the previous years without compromising learning outcomes achievements and the course quality. Peer grading/assessment was gradually implemented. Despite the larger and heterogeneous group, the students qualified for peer evaluation and met the course learning outcomes without any problems. The use of peer assessment had several advantages, including that the students worked more and harder than in other "traditional" courses. It was evident that students were learning through this peer assessment process, which gave their studies additional depth. Students left the course with a positive learning experience that might be used in other learning circumstances.

Keywords: Peer grading · Higher education · Assessment

1 Introduction

Massive open online education (Massive Open Online Courses, or MOOCs) has impacted brick and mortar universities to change [7] and consider opening their curricula, as well as to change how they are implementing "education". The knowledge is not only that which is transmitted by a teacher. New ideas and new knowledge are constantly around us in different formats delivered through different media. The new revolution and changes had happened first in the USA and lately also in Europe [7, 18]. But change does not occur within itself, not because of missing institutional motivation to open up their curriculum, but mostly because governments are not aware of the changes that are arise out of such changes. New ways of doing things must be done on a system level and not only at the level of enthusiasm [7].

Intensive usage of information and communication technology (ICT) in pedagogical processes offers the opportunity to make learning more flexible and adaptable to learners and, consequently, influences effectiveness, thereby decreasing drop-out rates [7]. ICT is changing the role of teachers and learners to facilitate higher levels of learning outcomes

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achievement. In our country, the learner-centred pedagogical approach is more often presented at primary and secondary levels of education than at higher education. The reasons for not following trends that have been continuing since 1995 [2] might be found in the existing legislation, both national and institutional. Teachers are much more motivated to have traditional lectures in larger groups than use a more active teaching method in smaller groups of students. This way of teaching is supported by institutional facilities through their amphitheatres and halls with inflexible furniture that easily support transmission modes of teaching and obstacle active methods of teaching. In these environments, ICT is limited to use in demonstration techniques. Cvetek [5] investigated teaching in Slovenian higher education institutions, and the results showed that public universities in our country deliver study programmes mostly by using traditional modes of teaching outlined by national legislation guidelines. If there are several constraints for innovative methods of teaching implementation in traditional delivery courses, then the obstacles in online learning environment are easily overpassed. The online learning environment, where different ICTs are used, offers many possibilities limited only by the teacher's creativity and his/her skills. In this article, we want to present a student-oriented teaching and learning method that is carried out with the support of ICT. Due to length limitations, we will first present the results of the peer grading implementation for the first time. Peer grading implementation resulted from an increased number of students who had chosen the E-learning course. The course about e-learning is delivered online and is designed with many activities. To support this design, a new assessment method had to be implemented even though these methods are not usually presented in Slovenian higher education areas. Not only this, but managing a large group of students actively was a challenge that had to be met.

2 Assessment in Higher Education

Assessment is an activity that helps a teacher or instructor to see whether learning has taken place [9]. There were developed various techniques how to do it. Assessments are not used only to check the results of learning, however. Different assessment techniques are used for other purposes too, such as to motivate learners, to allocate them into different groups, to (not) admit students to schools, jobs etc. [9]. In education, assessment is mostly used to evaluate learning outcomes achievements. Assessment might be formal, informal, formative, and summative [5]. While summative assessments are done at the end of a course, to measure the learning results, a formative assessment is used to follow a learner throughout the learning process and help him/her achieve learning outcomes.

In the middle of the nineties, the shift from an instruction to a learning paradigm happened in the USA [2]. Transferring knowledge was substituted with environments that permitted students to discover and construct knowledge themselves. This shift impacted traditional methods of assessing knowledge and skills, too. Unfortunately, evaluation in higher education is too often focused only on the final results (summative assessment), but less on the processes of acquiring knowledge and on processes where skills are developed. In the long-term, the learning process is even more important than knowledge expressed in a time and place. It is indisputable that evaluation in higher education affects learning more than just teaching itself, as it attracts the attention of students who know what needs to be done and how [3]. The chosen assessment system helps to recognize the education system itself [12].

The differences between following the learning process and learning outcomes are also highlighted by QAA [11], with particular emphasis on evaluations that have to be focused more on the learning process. Students learn from assessment activities and from their interactions with their evaluators (teachers and other staff participating in the evaluation process) [11]. Sadler [14] pointed out that students often do not understand, or do not know, the teacher's expectations and assessment criteria. The problem of unclear standards of knowledge is also recognized by QAA [11], and therefore it has recommended that students be included in the assessment process. Students can be involved through self-assessment or peer assessment. These approaches help students to recognize the teacher's expectations and the level of knowledge that they have to achieve [11]. All these requirements are called assessment literacy.

The important part of the assessment is feedback on student performance that helps students to learn [1, 11, 13]. Rich, meaningful, and timely given feedback presents assessments for learning instead of assessments of learning [8]. With the implementation of assessments for learning, students can learn more efficiently and effectively. Orsmond [8] presented a model of "new feedback" that encourages dialogue and students to be more active. Feedback in this model is process not assignment oriented. Assessment for learning requires the involvement of peers. Peer review/evaluation/assessment is understood as a process of reviewing or evaluating student tasks [4]. Such an assessment method has many positive effects. Research has shown [17] that peer evaluation has a positive impact on the learning experience. Peer assessment helps students to become more familiar with the content and learning in this way. Peer assessment has a positive impact on the development of critical thinking, reading, and writing skills and it also promotes partnership between the student and teacher [17]. Through peer assessment, students can better understand basic concepts and theory (ibidem). In addition, exposing students to different assessment methods helps them to become more autonomous learners [16]. Improved student achievements by using peer evaluation methods were also reported by [10].

Although peer assignment is widely used at different higher education institutions, these assessment methods are not used often in Slovenia. Therefore, there is very little research in this area at the national level. The lack of research and the confrontation with a large number of students has led us to experimentally introduce peer assessment as one of the methods of student evaluation. With this, we have come closer to the trends that have been taking place in the international higher education area for a long time, and at the same time opened the door for deepening the behaviour and practice in the national higher education area.

3 Peer Assessment Through Moodle Workshop Activity

Seeing an increase of more than double the number of students selecting to attend the course of E-learning in 2016/2017 forced us to consider changing our existing assessment methods, as we did not know how to deal with a larger group of students and maintain the same learner-centred course design. We were aware that Massive Open Online Courses (MOOCs) deal with larger groups of students more or less successfully from the very beginning. In these courses, either machine (automated) or peer grading is used [6, 15]. Automated grading is simple and is easily integrated in the content. Students go through their study materials (text, audio, video, or animations) and solve different quizzes or do assignments that are assessed automatically. Our course design, however, is based on teamwork, intensive communication among students, and collaboration. We are aware that automated assessment is very objective, but machine assessment is impersonal and therefore does not fit our course design. Peer grading fits much more even though it is not frequently used in higher education areas in our country [5]. We were also aware that paper-based peer grading might be very time consuming, even though it has several positive impacts on learning, students' behaviour, and their achievements [1].

Moodle, an open source learning management system, is used at our faculty to support all of our courses, so we are familiar with it. Workshop is a Moodle activity that specifically supports peer grading. We had tried the Workshop activity several times before, but it seemed to be too complicated to manage it. Other Moodle activities are much simpler, and their implementation does not need as much effort. Still, a large group of students encouraged us to think about using Workshop anyway. On the web, there are numerous guidelines (textual and video) to deal with the technical issues with using Workshop. But, beyond the technical parts of peer grading processes, the whole assessment strategy has to be well-defined in advance, with who, when, what, and how.

The most important part of the whole procedure is the content and the assignment criteria. During the course, it was obvious that the criteria had to be known in advance and incorporated into weekly activities. Students reported that it was easier to prepare a good assignment if they knew on what and how the assignment would be evaluated. Students reported that they became aware of what they had to do only when they evaluated other assignments. This confirmed the claims [3, 5] that peer grading helps students to learn. Also, peer grading has to be used more than once, as it is better as a formative than only as a summative practice [1].

The Workshop activity is performed through five phases. As mentioned, a good planning in advance is crucial for the whole peer grading process. The advance planning was emphasized by Watkins [19], where the preparation phase (Phase 0) is followed by five connected phases. Moving from phase to phase can be done manually or automatically, based on a date and time defined in advance.

The Workshop starts with the »Setup phase« (Phase 1) where the teacher sets up the basic parameters of the Workshop activity. The most important parameter is the grading strategy, which is the method used to score student submissions and students' reviews. The final grade of the Workshop activity is compounded from both grades – the grade for submission and the grade for evaluation. We set Workshop up in the way that the submission grade impacted the final grade with 80%, and the review grade (peer grade) with 20%.

The Workshop activity starts with the Submission phase (Phase 2), where students submit their assignments. After the submission deadline, the Assessment phase (Phase 3) starts. In this phase, the system allocates in advance the planned and defined number of assignments to students. In our case, students who submitted their assignment received from 4 to 6 classmate assignments for evaluation. Allocation can be done manually or automatically. We set up the Workshop activity randomly using Moodle, and excluded the possibility that students who were working in the same group have no possibility to receive the groupmate assignment in the evaluation process. The whole evaluation process was anonymized. Using these two parameters helped us to eliminate the possibility for biased evaluation.

Based on detailed criteria, students had two days to check and evaluate their allocated assignments. After that, the system moved the Workshop activity to the next phase (Grading evaluation phase), where the final Workshop grade was calculated. Grades were published in the gradebook and seen by the students when the Workshop activity closed (the fifth phase).

4 Peer Grading in Practice

4.1 A Course Design Presentation

E-learning is an elective course in the undergraduate academic and professional study programme of Management. While the academic study programme is delivered only at the faculty headquarters, the professional study programme is delivered in two other study centres. The E-learning course can be selected by students of both programmes in their second or third year of study. Even if the study programme is performed in a traditional manner, the e-learning course is delivered entirely online. The online delivery method enables students from different study centres to be enrolled in the same course at the same time.

To accomplish the course obligations, students have to accomplish different weekly activities and assignments, some of which are done individually, but most of them demand coordinated group work. The assignments are regularly evaluated and assessed by points, and students receive weekly feedback from the teacher. The assignment points are used to calculate the final grade, which is compound by two groups of assignments – weekly assignments (50%) and the final project (50%). For the final project, students prepare e-content that can be used for study or training purposes. The presentation of the e-content is a part of the final project as well. All courses for the faculty are delivered quarterly. A quarter lasts eight weeks; the whole pedagogical process is organized in seven weeks; and the eighth week is dedicated to the examinations. For the E-learning course, students worked intensively for seven weeks, and in the eighth week the grades were calculated based on the points gained at the weekly activities and the final project. In the previous academic years, there were from 20 to 60 students enrolled in this course. In the academic year 2016/2017, the number of students increased dramatically. There were 124 students who wanted to participate in the course. Students came from different study centres, from two different study programmes and from two different study years. The heterogeneity of the group is presented in Table 1.

Four students did not start the course, so the course was delivered to 120 students. Of those 120 students, 110 successfully accomplished the study obligations (91.7%). Among the 10 students who did not succeed, four of them dropped out in the first

Table 1. E-learning course students

Centre year/programme	Centre 1		Centre 2		Centre 3		Total	%
	2	3	2	3	2	3		
Professional	6	27	18	14	12	29	**106**	85.5%
	33		32		41			
Academic			12	6			**18**	14.5%
			18					
Total	**33**	**26.6%**	**50**	**40.3%**	**41**	**33.1%**	**124**	**100.0%**

week, and six of them in dropped out in the second or third week. The course was delivered between February 20 and April 14, 2017. The students were invited to enrol in the course before the course actually started. The most motivated students accomplished the first assignments even before the first video conference meeting occurred. Each week started with a short video conference session that supported weekly written guidelines and helped to substitute the missing meetings in the real classroom. The largest part of students' obligations were defined in detail weekly. Students received weekly guidelines and study materials on Sundays, but the work week started and finished on Mondays. Students' activities were done online using Moodle as the faculty learning management system or by collaborating in Google documents. Google apps are particularly useful because they support group work, and the activity of each student can be easily followed, thereby preventing social loafing. During the course, Moodle was used not only for delivering study materials and communication, but students also had the possibility to learn how to use Moodle as trainers/teachers to prepare and deliver e-content. The activity statistics presented in Fig. 1 are based only on data collected in the primary Moodle course (E-learning course). Students' activity in other virtual environments is not included. Activity data presents students' clicks in the Moodle course – posts, content views, forum activities, upload assignments, etc. The student activity line (Fig. 1) is a collection of activities for all 120 students, while

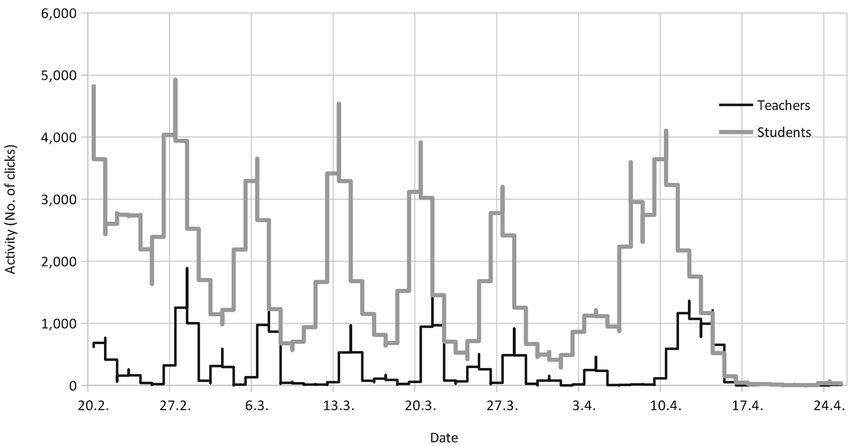

Fig. 1. Participants' activity dynamics

the teacher activity line presents only the activity of a single teacher who had led the whole course. The data for the student and teacher activities are statistically and significantly connected.

As mentioned, students had to accomplish different weekly defined activities. The students' activities are more intensive at the beginning of the week when students were reading the weekly guidelines and when they were submitting their assignments from the previous week (starting from the second week and on). All these assignments would be, in normal circumstances, evaluated by a teacher, which would be impossible to deal with in such a numerous group of students. A teacher could check the assignments of all 120 students, but it would take time to give students feedback. Time-delayed feedback is worthless and will not help students to learn. Therefore, a peer assessment strategy was implemented. Students submitted their assignments in the Moodle Workshop activity at the end of the week, which is well seen from the increased activity in the second part of the week (Fig. 1). After the submission deadline, the system delivered ahead of time the defined number of assignments to each student who submitted the assignment. Students had to evaluate their colleagues' assignments, mostly anonymously, within two days. Even if the criterion for the assignments were defined in detail, some students complained about the grades they received from their classmates. Based on these complaints, the teacher had to check if the peer evaluation of those assignments had been done correctly. These teacher interventions are evident from more intensive teacher activity – the blue line peaks a day after the red line peaks (students finished with their evaluation process) in Fig. 1. It was planned that students would work on the final project from the fifth week up to the end of the course, which explains the lower student activity at the end of the sixth week and an increase in activity at the end of the course (Fig. 1).

The teacher's role in online learning changed. In a traditional course, a teacher has to do lecturers, seminars, and labs. His/her activity is usually evenly distributed through the whole course time. In an online course, the major part of a teacher's activities is done before the course even starts. The course materials, all the guidelines, activities, etc. are prepared in advance. When the course starts, the teacher has to follow the students' progress, motivate them, explain if something is unclear, etc. The teacher's role in online learning is more collaborative, connective, and the guidelines oriented. Transmission of knowledge has no place in online learning. At the end of the course, the students' work has to be evaluated independently of how the course was performed (traditionally or online).

4.2 The Acceptance of Adaptive Teaching and Learning Strategies

The new course design was evaluated with a survey at the end of the course. There were 94 students (78.3% response) who completed the e-survey. We would like to know why students decided to select the E-learning course. Most of them (84%) selected this course because of the delivery method. The online study would be definitely or very likely a choice for 62.8% of students. Only 8.5% of respondents would definitely or very likely would not choose an online study programme. Students reported that the course was delivered as they expected (51.0%), for 20.2% the course exceeded their expectations, and 19.1% of respondents were really impressed with the course.

We mentioned that peer grading is not widely presented in our country, which was confirmed by our survey as well. For 70.2% of the respondents, this was their first experience with the peer grading method. For one fifth of them (19.1%) it was the second time, and for 5.3% the third time they had the opportunity to evaluate their classmates' work. Teachers frequently express doubts that students are not able to evaluate mates' assignments appropriately and objectively. Thus, at the end of the course, we made a test to check this notion. Based on the course design for the last assignment, a group project, had to be evaluated by a teacher. We updated the planned grading strategy with peer grading. Each student received three others' group projects to evaluate.

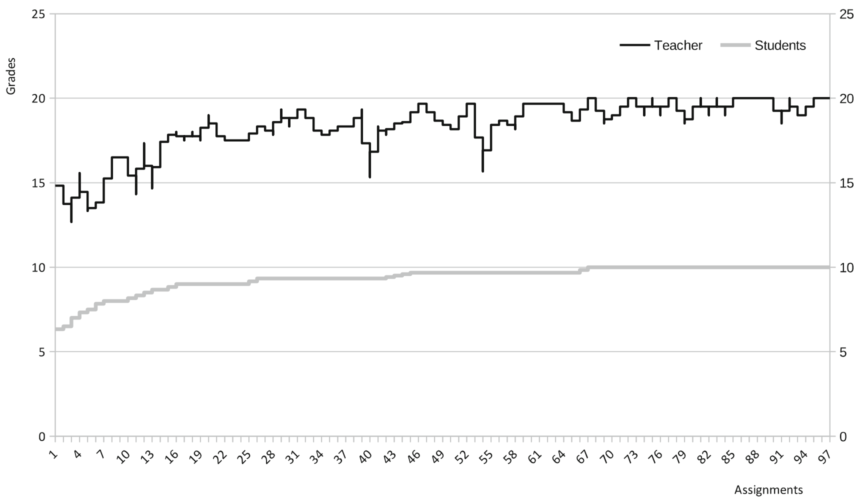

Fig. 2. Students' and the teacher's grade comparison

Students evaluated other projects on 10-degree scale, while a teacher used a 20-degree measurement scale (higher grade for projects that met expectations) (Fig. 2). From comparing both grades (Fig. 2), we could see some partial deviations, but the data are statistically significantly correlated (correlation coefficient = 0.58, $p < 0.001$). Well-prepared projects were recognized as being good and were graded at the highest grades, while the poorly prepared projects were recognised as such and thus graded lower.

We asked students to estimate their skills for peer grading.[1] Opinions about their abilities for peer grading (Self-estimation) and abilities of their classmates (Others) were gathered (Fig. 3). Students who estimated themselves as friendly evaluators who tried to award their classmates assignments are presented at the bottom, and those who were critical and rigorous are on the top of the y-axis. Their classmates (Others in Fig. 3) were estimated from inconsistent at the bottom to equitable and consistent reviewers on the top of the y-axis.

[1] We use 5-degree scale: 1-totally unprepared and unskilled, 5-totally prepared and well skilled.

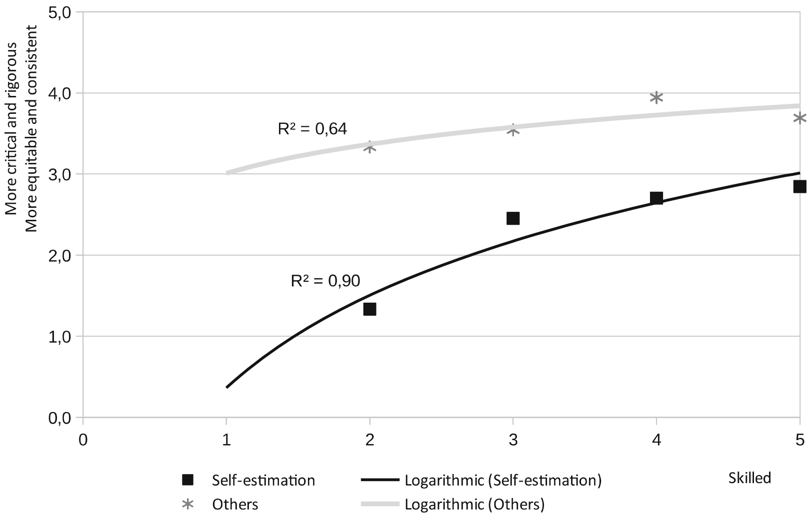

Fig. 3. Students' opinions about peer grading preparation

As can be seen from Fig. 3, students who were more critical and strict had a more positive opinion about their reviewers (are more equitable and consistent) than friendly oriented and generous student-reviewers. Less skilled peer grading students were more critical towards their classmates. This was also noticed after the conclusion of each week, when the less-skilled students complained about their received peer grades. Based on these complaints, the teacher checked the disputed assignments again and recognized that assignments were evaluated correctly and consistently.

At the end of survey, students were asked to write their positive and negative experiences with peer grading. Surprisingly, there were only a few with negative feedback. Only 13.8% of respondents reported troubleshooting with guidelines understanding as a consequence of superficial reading. Superficiality of reading in the study is becoming a real issue in higher education, but it was not a subject of our research. Students with a negative experience also reported that peer grading was time consuming. Two students exposed some technical problems. A large number of students (77.7%) reported a positive experience. Peer grading was interesting, flexible, and helped them to recognise their faults, study expectations, and helped them learn more. As we expected, peer grading leads to deeply and more qualitative learning. Based on survey data, the students in this course, on average, studied for 17.1% more hours than in an average classical course. There were differences between answers (SD = 34.9%). One third of students (34.0%) studied the same amount or less (9.6%) of time, 35.1% of them studied up to 30% more, and 18.1% reported studying even 40% or 50% more.

As shown in the results above, peer grading contributes to active learning and increased studying time, and therefore it needs to be used in higher education more frequently.

5 Conclusion

In Slovenian higher education, traditional methods of teaching and learning are still prevalent. Although the national legislation and institutional rules are not favourable to implementing modern modes of teaching and learning yet, teachers are autonomous enough to use active methods of teaching, especially if a part of the course or the whole course is delivered online.

As predicted, prevalent traditional methods usage can be seen from the data analysis. Even though more than half (61.3%) of course students were third graders, 70.2% of all course students did not have any experience with peer grading. This means that most of them were totally assessment illiterate. Implementing a peer grading method demanded assessment-literate students, which is why we started with peer grading gradually. In the first week, we had a test peer grading activity, and after that we implemented more demanding tasks. Based on weekly video conference meetings, we improved assessment guidelines and the criteria became clearer and written more in detail. During this experiment with peer grading, not only did the students develop their assessment literacy, but the teacher also developed her skills and her guidelines became clearer and much more understandable. Peer grading really impacted not only the students, but also the teachers who have to clarify the whole assessment process [16].

The research presented in this paper was made among students participating in the learner-centred course, which is not the practice at our faculty. Students had to be active through the entire course. There was a lot of interaction and communication among members of each group and between groups. It is not surprising that the students reported that they had to do more work in this course versus in other, traditional courses. Even though the course design predicts a very active student role, the peer grading (or self-grading) was used only for the oral presentation and no other activities/assignments and not during the whole course. We were aware that there are many positive aspects of peer grading, but we were also concerned with the time we needed to spend on it and about the students' assessment ability, where students tend to overrate themselves or their classmates. We also did not have enough experience in how to manage a large group of students without any additional help. Taking all these into account encouraged us to become more familiar with the Moodle Workshop activity and to experiment with it. Managing a larger group of students was supported by different Moodle reports and statistics, which helped us to intervene when it was needed. It is very important that inactive students and those who had met obstacles were identified in time and motivated to accomplish their obligations. The course activity dynamics were well-visualised in Fig. 1, where the patterns of both graph lines are very similar. Even though the teacher's role in online learning is changed, that does not mean that the teacher is not needed any more. Online learning does not mean that we only upload different (multimedia) learning content and prepare quizzes that help us to check the learning results. Quality online learning courses have to be well-prepared, with good course design, well-planned, and also well-supported by a teacher or tutor who is present in a real time and place. Tutor support is crucial, which was confirmed by the low dropout rate in our course. Practically almost all students (91.7%) finished the course successfully. Half of them (52%) finished the course with the highest grade (9 or 10) and only 8% of them passed with a lower grade (6) ($M = 8.6$).

Thus, we were concerned about potential grade overrating in the peer grading process. We tested students' assessment literacy with a comparison assessment of the final project. As presented in Fig. 2, the good projects were recognized as such and vice versa. Thus, the data for the teacher's and the students' grades are statistically and significantly correlated ($r = 0.58$, $p < 0.001$). Students' assessment literacy was recognized as appropriate as was their peer grading. Data analysis showed that students who esteemed themselves as critical and rigorous reviewers estimated their reviewers as critical and consistent (Fig. 3), and as such are skilled at peer grading. The data for the »skilled at peer grading« and »self-estimation« are statistically and significantly correlated ($r = 0.28$, $p < 0.001$).

Students finished the course with mostly a positive peer grading experience. They reported that peer grading was interesting, flexible, and they learned more because of it. Through peer grading, they became aware more about their teacher's expectations.

Peer grading really supports learning and teaching. Through peer grading, students in our study became more aware of what they were doing and how they were doing in the course. The whole process of assessment needs to be prepared in advance, clearly defined, and clearly delivered. It is obvious that "peer assessments can lead teachers to scrutinize and clarify assessment objectives and purpose" [16], which is why the peer grading positively impacts not only students, but also teachers.

References

1. Anson, R., Goodman, J.A.: A peer assessment system to improve student team experiences. J. Educ. Bus. **89**(1), 27–34 (2014). https://doi.org/10.1080/08832323.2012.754735
2. Barr, R., Tagg, J.: From teaching to learning - a new paradigm for undergraduate education. Change Mag. **27**(6), 12–25 (1995)
3. Bound, D., Falchikov, N. (eds.): Rethinking Assessment in Higher Education: Learning for the Longer Term. Routledge, London (2007)
4. Ching-Wen, C., Pearman, C.J., Farha, N.W.: Assessing a peer evaluation strategy. J. Educ. Technol. Dev. Exch. **3**(31), 69–84 (2010). https://doi.org/10.18785/jetde.0301.06
5. Cvetek, S.: Učenje in poučevanje v visokem šolstvu – teorija in praksa. Buča, Ljubljana (2015)
6. Duhring, J.: Massive MOOC grading problem – stanford HCI group tackles peer assessment. MOOC News Rev. (2013). https://goo.gl/W359dr
7. EC – European Commission: Report to the European commission on new modes of learning and teaching in higher education (2014). https://doi.org/10.2766/81897
8. Jackel, B., Pearce, J., Radloff, A., Edwards, D.: Assessment and feedback in higher education, a review of literature for the higher education academy. ACER (2017). https://www.heacademy.ac.uk/system/files/hub/download/acer_assessment.pdf
9. Jarvis, P., Holford, J., Griffin, C.: The Theory and Practice of Learning, 2nd edn. Kogan-Page, London (2003)
10. Mulder, R., Baik, C., Naylor, R., Pearce, J.: How does student peer review influence perceptions, engagement and academic outcomes? A case study. Assess. Eval. High. Educ. **39**(6), 657–677 (2014). https://doi.org/10.1080/02602938.2013.860421

11. QAA – Quality Assurance Agency for Higher Education: Assessment of students and the recognition of prior learning. In: UK Quality Code for Higher Education, chap. B6 (2013). https://goo.gl/QCNwvW
12. Rowntree, D.: Assessing Students: How Shall We Know Them? Kogan Page, London (1987)
13. Sadler, D.R.: Formative assessment: revisiting the territory. Assess. Educ. Princ. Policy Pract. **5**(1), 77–84 (1998). https://doi.org/10.1080/0969595980050104
14. Sadler, D.R.: Interpretations of criteria-based assessment and grading in higher education. Assess. Eval. High. Educ. **30**(2), 175–194 (2010)
15. Sandeen, C.: Assessment's place in the new MOOC world. Res. Pract. Assess. (2013). https://goo.gl/lTztCs
16. Tiew, F.: Business students' views of peer assessment on class participation. Int. Educ. Stud. **3**(3), 126–131 (2010)
17. Todd, V., Hudson, J.C.: Using graded peer evaluation to improve students' writing skills, critical thinking ability, and comprehension of material in a principles of public relation course. J. Coll. Teach. Learn. **4**(10), 39–46 (2007)
18. Tremblay, K., Lalancette, D., Roseveare, D., (n.d.): Assessment of Higher Education Learning Outcomes, Feasibility Study Report, Volume 1 - Design and Implementation (Rep.) (2012). http://www.oecd.org/education/skills-beyond-school/AHELOFSReportVolume1.pdf
19. Watkins, S.: Enabling peer review in moodle: a look at the workshop activity. DeltaNews (2015). https://goo.gl/I5inxF

Citation Function Classification Based on Ontologies and Convolutional Neural Networks

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Abstract. In recent years, there has been significant growth in the use of citation to improve the methods of evaluating the quality of publications. To determine the quality of the publications, traditional methods such as impact factor depend only on the citation count. Recently, citation functions or purposes have gained attention to evaluate the quality of these methods. Citation function classification is defined as a way to find out the reasons behind quoting previous literature. Several approaches for citation function classification have been proposed to classify citation functions in scholarly publication. However, these approaches do not consider the author's characteristics such as author's information, neither the publication level. Those characteristics can be useful in the process of citation function classification. In addition, previous studies mainly used classical machine learning techniques such as support vector machine and neural networks with a number of manually created features. The manual feature representation is time-consuming and error prone. To address these problems, we propose a citation function classification model by combining ontologies with convolutional neural networks (CNN). In our model, ontologies were used to represent the author's characteristics and the citations semantically. Then, we have incorporated this representation into a CNN model to classify citations into six functions. We have conducted experiments using public dataset and showed that the proposed approach achieves good performance compared with the existing techniques in terms of accuracy.

Keywords: Citation annotation · Citation function classification
Ontology · Conventional neural network

1 Introduction

The citation is used to calculate the impact factor of scientific publications in the literatures [1]. Recently, a survey have been conducted by Yousif et al. [2] and reported that citation classification is useful method for research evaluation. The citation

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function classification is categorized as the motivation or reason to why the researchers cite specific paper in their work [3]. Researchers' motivations for citing other authors' work are varied. For example, an author can cite previous work to gain assistance of some sort in the form of background information, tools, and ideas. It can be also for reviewing methods, critiques or refuting previous work to help improve many citations-based applications such as: automatic survey generation [4] and citation summarization [5]. This accurate representation of citation functions could provide precise representation of the influence or the impact of publication. The prior art has shown that different citation function schemes have been created with the aim to answer an important question to why the authors cite the literature review with number of functions and granularity's levels [2, 3]. Different names are used to represent the motivation in citation scheme such as "class", "category", "type", and "reason". For clarity, the term "function" is used here to refer to such names.

Manual citation function classification has been conducted in the literature with different granularity level which varies from 35 to 3 functions [6, 7]. Subsequently, automated classification became inevitable due to the large number of publications produced on daily basis [3]. Hernandez et *al*. [8] proposed a citation scheme for classifying citation function into six functions mainly based on: supply, useful, weakness, contrast, acknowledge and hedges; where a set of citations were labeled by human annotators to build the training data and the authors applied machine learning approaches to detect citation functions. Jurgens [9] proposed a new scheme to annotate the citations which had seven functions: background, motivation, uses, extension, continuation, comparison, and future.

Ontology is defined as an explicit specification of a conceptualization [10, 11]. It contains a set of concepts which are attributes, entities and properties. While such concepts are related to a domain along with their relations and definitions [12, 13], researchers can create the domain ontologies automatically or manually and integrated them using different web mining tools [14]. Different ontologies were created using ontology representation language such as Web Ontology Language (OWL) and Resource Description Framework (RDF). Note that the ontologies enable the reuse of the domain knowledge. Due to it flexibility, ontology as a tool for knowledge representation has been widely used by researchers to handle the problem of citation function classification. Ciacarini et *al.* [15] used the semantic similarity to identify citation function purpose and proposed CiTo[1] (Citation Typing Ontology) and CiTaLo function to retrieve the nature of citation function. They have used many functions such as: cite as (compare, authority, data source, evidence, method, metadata document, potential solution, recommended reading, related, confirms, corrects, critiques and derides). Di Iorio et *al*. [16] developed CiTaLo software using 18 articles and combining ontology mapping with NLP techniques to analyze the citations. Ciancarini et *al.* [17] have proposed CiTo model to investigate an existing reference for classifying citations. They used semantics technology to annotate scholarly articles in two conditions; a full set of CiTo properties and specific subset. Moreover, the above mentioned techniques do not take into account additional information about the

[1] http://purl.org/spar/cito/.

publications such as authors in the process; whereas authors can have different characteristics such as: author's information, publication level; which can outperform the citation function methods that do not incorporate ontology about authors. In addition, these techniques used supervised machine learning methods and rule-based methods; such methods require the domain experts to manually perform the citation function classification. The supervised learning approaches suffer from two issues: first, the use of the incomparable citation schemes used to label the training sets which are involved in the supervised algorithms to train on; second, manual annotation of training by humans is often with high cost.

Some researchers have leveraged neural networks for document classification models and reported promising results [18, 19]. Mikolov et *al*. [20] employed a model for designing features from words representation in neural network called word embedding. The citation function classification became a new emerging research topic and an important field. It is a way to identify author's reasons for citing the literature.

To overcome the manual feature selection and improve the classification performance issues, we propose in this paper a novel approach for citation function classification by combining author and citation ontologies as inputs to the convolutional neural network (CNN) classifier. The author ontology will be represented by authors' characteristics including: author's information such as personal demographic data (author-id, name), institution and publication level. The CNN output vector is classified into six functions to annotate the corpus.

The rest of the paper is structured as follows: Sect. 2 presents the state of the art on citation function classification. In Sect. 3, the proposed model is presented. In Sect. 4, the experimental settings and the results are presented and discussed. Finally, we present the conclusion and future work in Sect. 5.

2 The State-of-Art on Citation Function Classification

Citation function classification defines the process of detection and the relationship between citing paper and the cited paper [21]. Teufel et *al.* [21] employed seven functions argumentative for citation classification scheme. However, the above schemes have some limitations, due to the large number of functions used which is time-consuming for citation annotation and cannot process large number of documents. By using a rule-based approach, Abdullatif [22] developed an alternative approach to automatically generate citation function classification scheme by tagging citation sentences then extracting the verb that represents the citation sentence; although their annotation was developed manually and relied on limited number of examples.

Clustering techniques were also proposed to address the difficulty of the annotations in previous schemes such as the one found in Abdullatif et *al*. [23]. Ciacarini et *al.* [15] used the semantic representation to identify citation function purpose. They proposed CiTaLo and CiTo functions to retrieve the type of citation function and created many functions to annotate the corpus. Di Iorio et *al*. [16] focused on semantic technology to annotate scholarly publications. They used cue verbs as functions to annotate the scheme following the previous annotation created in [15]. They used ontological domain based on CiTo, and tested their scheme using SVM on data from ACL.

Although several studies on citation function classification have been carried out using various techniques, a more efficient citation function classification approach is yet to be realized. Our novel approach is different from the existing techniques since we aggregate ontology for citations as well as for authors representation and use CNN to capture features and classify citations functions automatically. The effectiveness of the proposed scheme is demonstrated via our corpus data from ANN database.

3 The Proposed Citation Function Model

In this section, we introduce the proposed approach which is citation function based on ontologies as input to the CNN model. First, we describe our ontologies models for representing author's characteristics and citations. Then, we present the CNN model which combines the created ontologies in detail. Figure 1 shows our citation function classification model. Our proposed model has three major components namely: author's characteristics and citations extraction, creating author and citation learning ontologies, and citation function engine which uses word2vec with CNN network for classifying citations into six functions. The following subsections explain the details of the proposed model.

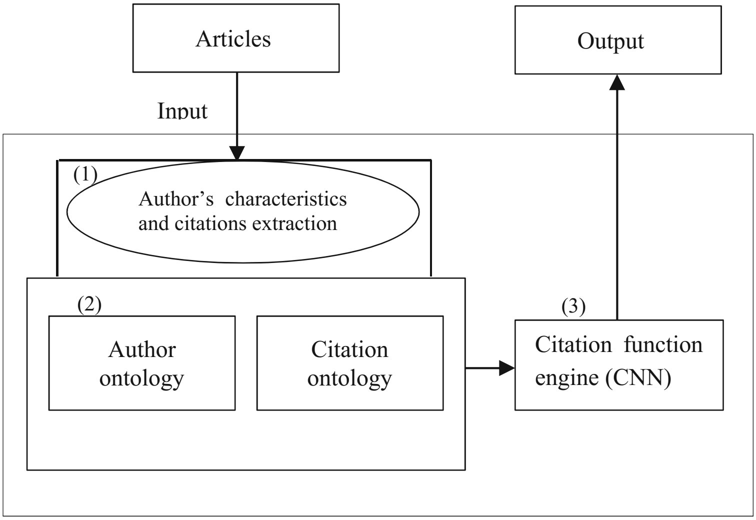

Fig. 1. Representation scheme of citation function classification.

3.1 Author's Characteristics and Citations Extraction

To test our approach, we used a real dataset extracted from ACL anthology network[2] (ANN). ANN is an academic repository that contains full-text articles with associated

[2] http://clair.eecs.umich.edu/aan/index.php.

meta-data. We have chosen 300 papers as our corpus; the selection of these papers follows same criteria as a number of previous works [8]. To extract citations and authors characteristics, we use simple rules followed by regular expressions. We perform data cleaning and non-citation sentences were excluded, and finally 8700 citations were obtained. For citation annotation, as mentioned in the background; several annotation scheme have been proposed to code the citations into their functions. To annotate our data, we used recent functions from Hernández-Álvarez [8]. We chose these functions because they cover the most general and mutually exclusive citation functions for different domains. Moreover, they facilitate the annotation since it will be easy for annotators to have these functions separated and easily to use afterward. Three PhD students work separately as annotators to annotate the citations using the functions in Table 1. To test annotation reliability, we measured the inter-annotator agreement between the three annotators, we used K coefficient following [24]. A small section of the corpus about 800 citations was used to analyze them according to their function. Inter-annotator agreement was K = 0:81 with n = 6 and N = 800. The result is quite high given the fact that K value of 0:81 is considered as stable [25]. By using these functions, we obtained 8700 annotated citations along with the author's characteristics of the associated articles.

Table 1. Function classification description.

Citation Function	Description
Based on, supply	Citing paper applies some material from cited paper (*Based on*). Citing paper study is built on some material from cited paper (*Supply*)
Useful	Cited paper material is recognized as useful and it is applied in some other work, not their own
Acknowledge	Cited paper is mentioned to recognize some previous work. Citing paper may just mention the citation (*Acknowledge*)
Contrast	Cited paper is compared with other studies, resulting a criterion that can be positive, negative or neutral
Weakness, correct	Citing paper notes or correct an error or weakness from cited paper (*Weakness*)
Hedges	Citing paper uses careful language to disguise criticism towards cited paper (*Hedges*)

3.2 Creating Author and Citation Learning Ontologies

The author ontology model (Fig. 2) contains the information and preferences related to the author such as personal demographic data (author-id, name). The author personalizes his profile according to his characteristics. Figure 2 shows the proposed author model ontology.

Similarly, the citation ontology represents knowledge about the citations extracted from the article. The knowledge represented in this ontology includes citation format which may be sentence or context (several sentences). Figure 3 shows the proposed citation model ontology.

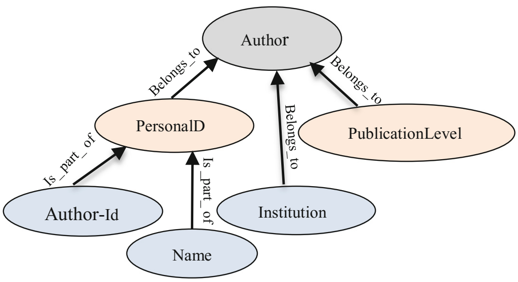

Fig. 2. The proposed author model ontology.

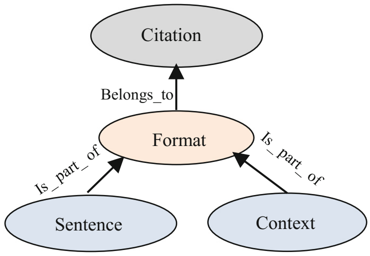

Fig. 3. The proposed citation model ontology.

In our proposed model, ontologies have been created to personalize the author profile as well as the citation model. The OWL representation language was employed to create the ontologies. Moreover, we used Protégé ontology editor environment [26] to develop the author model ontology and citation model ontology. The graph knowledge learning as shown in [28] is reliable and can be used to embed entities, although, it is possible to learn different relations leading to complex knowledge graphs. Therefore, we followed similar graph walks method as in [28] to convert our graph into sequences of entities, which can be considered as sentences. Then, we have adopted word2vec as in [20] to build the CF matrix.

Similarly, we propose to exploit author's characteristics such as personal demographic data (author-id, name), institution and publication-level to build author A matrix. Where A represents the author as continuous matrix and CF represents the citation-function as continuous matrix. Finally, the two matrices were passed to the CNN to classify citation into six functions which will be shown in details in the next subsection.

3.3 CNN Architecture

We feed the result of ontologies into the configured CNN to classify citations into their categories/functions. In our model, w_i means the i^{th} word in the citation sentence consisting of n words as $\{w_1, w_2, w_3, w_4, w_i \ldots w_n\} \in R^{\mathrm{d}}$ be the d dimensional word vector corresponding to the sentence of length n. The following subsections describe in detail each component of the model.

3.3.1 The Convolutional Layer

The convolutional layer consists of applying filters $\mathrm{W} \in \mathrm{R}^{\mathrm{h} \times \mathrm{d}}$ in a window of h words in the sentence of length n $\{w1\mathrm{:h}, w2\mathrm{:h} + 1, \ldots w\mathrm{n} - \mathrm{h} + 1\mathrm{:n}\}$ to extract higher level features from the input matrix. We have chosen multiple convolutional filters with varying filters window size from 3 to 5, and applying these filters using Rectified Linear Unit (Relu) [27] as non-linear activation function for each window of words within the citation to produce a new feature p_{i} of size $\mathrm{n} - \mathrm{h} + 1$. A feature p_i is generated from a window of words wi:i + h − 1. The non-linear activation function operation is given as:

$$p_i = f(\mathrm{W} \cdot w_{i:i+h-1} + b). \quad (1)$$

where $b \in R$ is the bias, and f is the non-linear activation function.

3.3.2 Pooling Layer

After the convolutional layer, the information is represented by the extracted features and then passed through the pooling layer. The pooling layer is used to reduce the dimension of features and select most important information. In our study we use the max-pooling operation inspired by Collobert et *al.* [28], which is the most widely used pooling methods and is useful for our task as well because we want to capture all the features needed with maximum value. The idea is to take the maximum value p_{max} from the feature map as the most important feature among one map P as shown in the Eq. (2).

$$p_{max} = max\{P\} = max\{p_1 \ldots p_{n-h+1}\}. \quad (2)$$

We combine the output vectors by concatenating and feed them into the fully connected layer as a joint layer. Finally, we apply *softmax* as output layer for classification.

3.4 The Function Classification

To perform citation function classification, our classifier uses citations with function labels. The performance of the classifier can be affected by over-fitting problem, which could come from the weakness of the neural net. We employed the dropout regularization to prevent over-fitting problem of the hidden units in the classifier. In the classification stage, we feed the final feature map to the *softmax* layer. We used *softmax* because it is widely used in classification problem, which gives a probability of the sample belongs to each label. The outputs of *softmax* layer can be interpreted as conditional probabilities. Equation (3) shows the *softmax* function formula.

$$softmax\ x_i = \frac{\mathrm{e}^{x_i}}{\sum_{\mathrm{j}=1}^{\mathrm{L}} \mathrm{e}^{x_j}}. \quad (3)$$

where the L is number of labels (for our case from 1–6 labels) and $\mathrm{x_j}$ is the weight vector of the L^{th} label.

4 The Experiments and Evaluation

This section reports the experimental settings and results obtained with our proposed approach.

4.1 Experiment Settings

We considered author model as a graph as well citation model as another graph to concatenate them later. To convert our RDF graph, we address some hyper parameters used: we followed the approach described in [29] to generate limited number of random walks for each entity, and we experiment with 4 iterations and depth of 8. Then, after each iteration we extracted all walks for each entity with the same depth. We have tested and simulated our dataset using CNN method. The CNN is used to automatically extract the features. In this work, we used multiple convolutional filters with varying filters. Before we classify the citation function, we computed the concatenation of the citations and the authors using the pooling layer. We calculated the results using stratified 10-fold cross validation. In the output layer, a vector length of six functions is classified using *softmax* function. To evaluate the efficacy of our proposed approach, the following state-of-the-art machine learning approaches were used.

- N-gram + SVM: use Three-gram and train classifier with SVM (SMO) [8].
- N-gram + NN: use Three-gram and train classifier with Neural Networks (NN) [30].
- N-gram + Naive Bayes: use Three-gram and train classifier with (NB) [31].
- CNN without knowledge representation: in this method, we replace ontologies based representation (A) and (CF) by matrices based on traditional representation (A) and (CF) and train the model with CNN.

4.2 Experimental Results

We used the same dataset in three experiments to evaluate our proposed approach using CNN algorithm. The results from the three experiments were then compared.

4.2.1 Accuracy Measure

The final vector is fine grained classification into six functions. We used the accuracy formula described in [32] for the classification. The accuracy is used to evaluate the model by classifying the citations using the six functions.

Table 2 shows the results of the experiments in terms of accuracy of the proposed model (Ontology + CNN) tested and comparing against the four baseline methods (SVM, NN, Naive Bayes and traditional CNN). The results indicate the evaluation performance calculated in accuracy (Acc) by incorporating different feature sets. The 64:7% of accuracy obtained is the best performance achieved using CNN method. Similarly, comparing with other different methods the accuracy of SVM, NN, Naive Bayes and traditional CNN methods is 55:8%, 56:5%, 58:6%, 61:2% respectively. It can be observed that the proposed model has outperformed the baseline methods, this clearly illustrates the importance of integrating both semantic representation and CNN contribute to improve the accuracy. Thus, indicate that the author's characteristics improve the performance of citation classification.

Table 2. Illustration of accuracy measure.

The method	Acc (%)
N-gram + SMO	55.8
N-gram + NN	56.5
N-gram + Naïve bayes	58.6
Our CNN model	64.7

4.3 Discussion

In this paper, the experiments were carried out has shown that the proposed model (CNN + ontology) achieves better performance in terms of accuracy comparing against the traditional machine learning methods. The advantage of the proposed approach is that since the knowledge representation represents the author's characteristics as well as citations semantically. Using CNN model, our approach can overcome the manual features extraction and address the problem experienced by traditional machine learning techniques such as SVM and NN. The citation function engine makes use of semantic representation arising from integration of ontology into the citation function classification process. This will not only improve the accuracy of the classification but also help alleviate the features selection and the data representation problems. The proposed ontologies represent knowledge about the author's characteristics and the citations semantically as additional information in the process can improve the performance. Hence making our approach more efficient in concatenating them.

5 Conclusion and Future Work

In this paper, we presented an approach that uses the convolutional neural networks based model combined with authors and citations ontologies to classify citations into six functions. The proposed approach achieved good results of about 65% accuracy. This implies that our approach can accurately identify author's reasons semantically and retrieve the nature of functions automatically. In addition, combining author information such as publication level with citations achieves best performance in the corpus used. The proposed ontologies can solve the problems such as functions nature retrieval in the aim of citation function classification task.

Our future work is to explore other deep learning approaches such as Long Short-Term Memory Networks (LSTM) which is a type of Recurrent Neural Network (RNN) into the citation function process to further enhance the classification performance and accuracy.

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References

1. Garfield, E.: Citation analysis as a tool in journal evaluation. Am. Assoc. Adv. Sci. **178** (4060), 471–479 (1972)
2. Yousif, A., et al.: A survey on sentiment analysis of scientific citations. Artif. Intell. Rev. **50**, 1–34 (2017)
3. Teufel, S., Siddharthan, A., Tidhar, D.: An annotation scheme for citation function. In: Proceedings of the 7th SIGdial Workshop on Discourse and Dialogue (2009)
4. Moravcsik, M.J., Murugesan, P.: Some results on the function and quality of citations. Soc. Stud. Sci. **5**(1), 86–92 (1975)
5. Yousefi-Azar, M., Hamey, L.: Text summarization using unsupervised deep learning. Expert Syst. Appl. **68**, 93–105 (2017)
6. Xu, H., Martin, E., Mahidadia, A.: Using heterogeneous features for scientific citation classification. In: Proceedings of the 13th Conference of the Pacific Association for Computational Linguistics (2013)
7. Li, X., et al.: Towards fine-grained citation function classification. In: RANLP (2013)
8. Hernández-Álvarez, M., Gómez Soriano, J., Martínez-Barco, P.: Annotated corpus for citation context analysis. Lat. Am. J. Comput. Fac. Syst. Eng. Natl. Polytech. Sch. Quito-Ecuad. **3**(1), 35–42 (2016)
9. Jurgens, D., et al.: Citation classification for behavioral analysis of a scientific field. arXiv preprint arXiv:1609.00435 (2016)
10. Lee, K., Lee, J., Kwan, M.-P.: Location-based service using ontology-based semantic queries: a study with a focus on indoor activities in a university context. Comput. Environ. Urban Syst. **62**, 41–52 (2017)
11. Tarus, J.K., Niu, Z., Mustafa, G.: Knowledge-based recommendation: a review of ontology-based recommender systems for e-learning. Artif. Intell. Rev. **50**, 1–28 (2017)
12. Storey, V.C.: Conceptual modeling meets domain ontology development a reconciliation. J. Database Manag. (JDM) **28**, 18–30 (2017)
13. Tarus, J.K., Niu, Z., Yousif, A.: A hybrid knowledge-based recommender system for e-learning based on ontology and sequential pattern mining. Futur. Gener. Comput. Syst. **72**, 37–48 (2017)
14. Mahalingam, K., Huhns, M.N.: An ontology tool for query formulation in an agent-based context. In: Proceedings of the Second IFCIS International Conference on Cooperative Information Systems COOPIS (1997)
15. Ciancarini, P., Di Iorio, A., Nuzzolese, A.G., Peroni, S., Vitali, F.: Semantic annotation of scholarly documents and citations. In: Baldoni, M., Baroglio, C., Boella, G., Micalizio, R. (eds.) AI*IA 2013. LNCS (LNAI), vol. 8249, pp. 336–347. Springer, Cham (2013). https://doi.org/10.1007/978-3-319-03524-6_29
16. Di Iorio, A., Nuzzolese, A.G., Peroni, S.: Towards the automatic identification of the nature of citations. In: SePublica (2013)
17. Ciancarini, P., et al.: Evaluating citation functions in CiTO: cognitive issues. In: European Semantic Web Conference (2014)
18. Lam, S.L., Lee, D.L.: Feature reduction for neural network based text categorization. In: The 6th IEEE International Conference on DASFAA (1999)
19. Tang, D., Qin, B., Liu, T.: Document modeling with gated recurrent neural network for sentiment classification. In: EMNLP (2015)
20. Mikolov, T., et al.: Distributed representations of words and phrases and their compositionality. In: Advances in Neural Information Processing Systems (2013)

21. Teufel, S., Carletta, J., Moens, M.: An annotation scheme for discourse-level argumentation in research articles. In: Proceedings of the Nsinth Conference on European Chapter of the Association for Computational Linguistics (1999)
22. Abdullatif, M.: Making the H-index more relevant: a step towards standard classes for citation classification. In: IEEE 29th International Conference on Data Engineering Workshops (ICDEW) (2013)
23. Abdullatif, M., Koh, Y.S., Dobbie, G.: Unsupervised semantic and syntactic based classification of scientific citations. In: Big Data Analytics and Knowledge Discovery (2015)
24. Carletta, J.: Assessing agreement on classification tasks: the kappa statistic. Comput. linguist. **22**(2), 249–254 (1996)
25. Teufel, S., Siddharthan, A., Tidhar, D.: Automatic classification of citation function. In: Proceedings of the Conference on Empirical Methods in Natural Language Processing (2006)
26. Tudorache, T., Noy, N.F., Musen, M.A.: Collaborative protege: enabling community-based authoring of ontologies. In: Proceedings of the International Conference on Posters and Demonstrations, vol. 401 (2008)
27. Xu, B., et al.: Empirical evaluation of rectified activations in convolutional network. arXiv preprint arXiv:1505.00853 (2015)
28. Collobert, R., et al.: Natural language processing (almost) from scratch. J. Mach. Learn. Res. **12**(1), 2493–2537 (2011)
29. Perozzi, B., Al-Rfou, R., Skiena, S.: Deepwalk: online learning of social representations. In: Proceedings of the 20th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (2014)
30. Goyal, R.D.: Knowledge based neural network for text classification. In: IEEE International Conference on Granular Computing (2007)
31. Peng, F., Schuurmans, D., Wang, S.: Augmenting naive Bayes classifiers with statistical language models. Inf. Retr. **7**, 317–345 (2004)
32. Sriram, B., et al.: Short text classification in Twitter to improve information filtering. In: Proceedings of the 33rd international ACM SIGIR Conference on Research and Development in Information Retrieval (2010)

Training Teacher in the Generation of Knowledge in Higher Education: b-Learning Teacher to Prosumer Teacher

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Abstract. This study seeks to investigate the change in the role of the teacher faced with the inclusion of collaborative elements of social networking under the concept of the teacher-prosumer and to present prospective analyses of training in the context of higher education. The methodology used is qualitative, based on grounded theory in the axial and selective methodological framework, and oriented towards reflection on the communicative and collaborative implications for the teacher. The result obtained is the classification of functions and the characterization of new teacher competency functions, the latter being obtained from a prospective outlook regarding changing scenarios in our information society. To that end, a parallel is drawn between current teacher competencies in b-learning contexts and new competencies based in prosumer action. In the conclusion, some training process needs and some of the difficulties facing prosumer action in education are illustrated.

Keywords: Cooperative/collaborative learning
Interactive learning environments · Pedagogical issues
Teaching/learning strategies

1 Introduction

According to studies on the influence of Information and Communications Technologies (ICTs) in higher education conducted by the Pedagogy and Teaching group in Higher Education (Pedagogía y Didáctica en la Educación Superior – PYDES), the role of the teacher, whether in the use of virtual learning environments or aspects of Web 2.0, involves an entire pedagogical and didactic action around facilitating educand learning (Padilla et al. 2012). To that end and in light of that shown by Giurgiu and Bàrsan (2008), the teacher's functions are viewed in metacognitive, creative, and autonomous aspects that allow the development of significant learning for the educand. Therefore, there is a need to characterize the teacher-prosumer (a portmanteau of the words producer and consumer) as an emerging figure in the context of higher

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education, contributing to more dialogic and interactive processes, based on a shift in paradigm from that of teaching to that of learning.

Despite the existence of a scarce bibliography and infographics on the topic of the teacher-prosumer, some of the antecedents analyzed in this study, such as those of Alonso (2011); Sánchez and Contreras (2012); Giuseppe and Gil (2012); Ara and Pessoa (2012); Giurgiu and Bàrsan (2008); Aparici and Silva (2012); Araya (2008) and Soep (2012), attempt to conceptualize the prosumer in relation to the theory presented by Toffler concerning the third technological wave (1980) and the precepts of McLuhan with respect to media communication (2009). In this sense, the study is focused on interpreting the texts from the assumptions of Sautu et al. (2005) and Valles (2003) using a qualitative focus, inductively analyzing the emergence of data for classification via the grounded theory presented by Strauss and Corbin (2002).

1.1 An Examination of the Referent of Prosumer: Producer and Consumer

The term is used to refer to a user who transforms from consumer to producer, which throughout the text is called prosumer (producer and consumer). According to the definition presented, the prosumer exercises both roles together, without separating these roles, constructing a bridge, which, according to Soep (2012), should be a part of the consciousness of the work of the user in anticipating complexity and offering help to other users. This is especially true because the prosumer will evoke the principle of user action – placing oneself in one's role – when incentivizing the consumer to become in some way a producer of communicative experience. Thus, they will have a voice and a vote in how the prosumer is configured, and simultaneously, this will impact the activities that the user will perform.

Alvin Toffler inserted the concept of the prosumer explicitly to leave behind the standardization of products or services that were being managed through the cycles of mass production in the industrial era (Giurgiu and Bàrsan 2008). The context of Toffler's vision was the impact of technologies on society (1980), enabling the relationship of the coexistence of modernity and postmodernity that makes a distinction between producers and consumers. This idea also places the figure of the prosumer as one of power in postmodernity, which emerges in design, creativity, and innovation as they are lived today, amounting to a value added to the specialization of the content, information, services, and products that go hand in hand with an invisible economy of the masses.

The prosumer is a figure subsequent to the emergence of the social web, (Giurgiu and Bàrsan 2008); thus, it could not have developed this role in the industrial era or in another moment other than our current information society. Expressions, forms of packaging information, and collaborative chains are some of the peculiarities generated in the context of prosumers, which has penetrated even the services of the social web themselves, gradually reaffirming their conviction to provide for the needs of other users. Similarly, prosumer activity is characterized by exponential growth, specifically in the impact of web-based designs and collaborations that have culminated in the quality of contents or services presented by a range of entities that offer services in the network of networks.

In the 21st century, the prosumer becomes a polysemic concept that alludes to hybrid elements in different social, economic, and cultural fields. Similarly, the term begins to take off with web users who create content in a self-sufficient manner, without intermediaries but with a range of tools that are capable of resolving their own needs. Thus, the term first had greater impact in the area of economics to define the producer of elements and values; however, with the technological revolution, it has spread to various fields, going from being an obsolete concept to taking its prospective nature in the dynamics of the cybernaut. In this context, the prosumer permeates the transformed educational field to reach the teacher and teacher training.

2 Method

Taking into account the study object (teacher-prosumer), the study adopted a qualitative focus (Sautu et al. 2005; Valles 2003) to establish relationships or tendencies regarding the concept of the social web and the emergence of the figure of the prosumer through the exegesis and categorization of texts based in grounded theory. In this type of methodology, 342 studies were considered and subsequently analyzed in an interpretive exercise. The data were classified, codified, and represented in semantic networks – categories and sub-categories of analysis – and are contrasted using the constant comparative method (Valles 2002) with technical support from Atlas.ti software.

2.1 Codification Process

Prior to coding or classifying the information, three categories (Web 2.0 in higher education, the teacher-prosumer in the educational field, and ITCs and tools used in Web 2.0) and nine subcategories were created to serve as a reference point. These

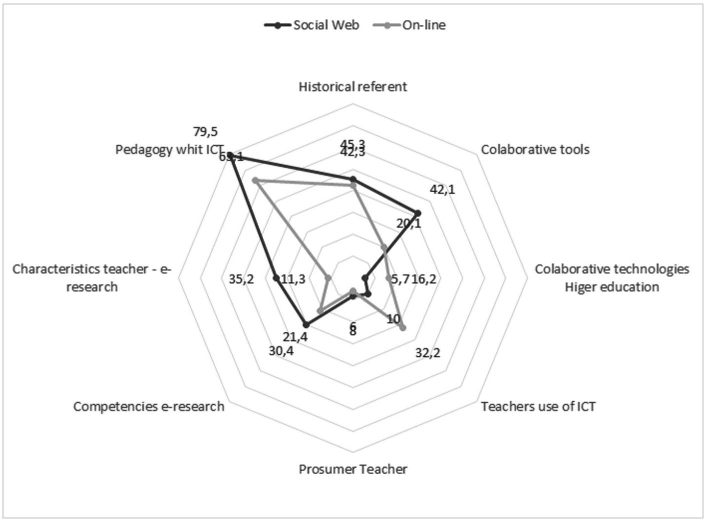

Fig. 1. Basing codes on the sub-categories.

categories were constructed from the discussion and conceptualization of theories of academic authorities on Web 2.0 and prosumers (Alvin Toffler and Marshall McLuhan), in addition to studies on the topic by the team of researchers. The figure below presents the initial categories with their respective sub-categories (Fig. 1).

3 Results and Discussion

The results should be divided into three large focus areas: (i) the evaluation of roles, (ii) the classification of teaching functions in contexts mediated by the social web from the compendium of studies analyzed, and (iii) the characterization of new teaching competencies, obtained from a prospective outlook at scenarios of change in the information society. Regarding this last area, a parallel is drawn between current teaching competencies in b-learning contexts and new contexts based on prosumer action.

The results show that the new roles performed in media environments for the social web are as follows: (1) design, (2) communication, (3) research, and (4) evaluation. These offer a complex task to the teacher interested in reforming the forms of interacting and knowing together in which the educand is a subject with experiences, knowledge, and contributions, eager to be understood in the framework of a collaboration in which both the teacher and the student learn in synergy. For this reason, the discussion of these results revolves around the obstacles that the teacher may face in taking on this dynamic role because it addresses a transition not only in scenarios, strategies, or resources but also in terms of attitudes, methods of researching, and ways of comprehending the ability to form one's own autonomy and that of the student as a basis for educational transformation.

Given the expectations presented by the entry of the prosumer, a synergy is proposed between the roles found and validated by teachers and coordinators in the field work and those regarding the perspectives of the prosumer. In summary, the mixture and coupling of the roles played in current practice with the roles that will be faced as challenges in the near "future" unveil an innovative and proactive vision of what it means to be a teacher in the digital era (González et al. 2013).

Consistent with the idea of role transformation, the functions of the teacher-prosumer emerge and are classified as follows: communication, interaction, empowerment, and educational action.

1. The prosumer communicates, necessarily in dialogic form, based on his or her profile as producer-communicator and user-analyst, and therefore, the communication is not unidirectional. Furthermore, it calls upon not only the linguistic channel but also the capacity for visual and symbolic communication. In this manner, prosumer communication goes beyond dialogues and conversations with others, transcending to an intersubjective relationship found in communication theories anchored and/or objectified in social groups. Hence, Area and Pessoa (2012) stress the need for literacy in various codes and communicative elements transformed by the impact of technology in light of media competency to search, select, and interpret the information to be discussed and refuted in a framework of prior knowledge and experiences (Fig. 2).

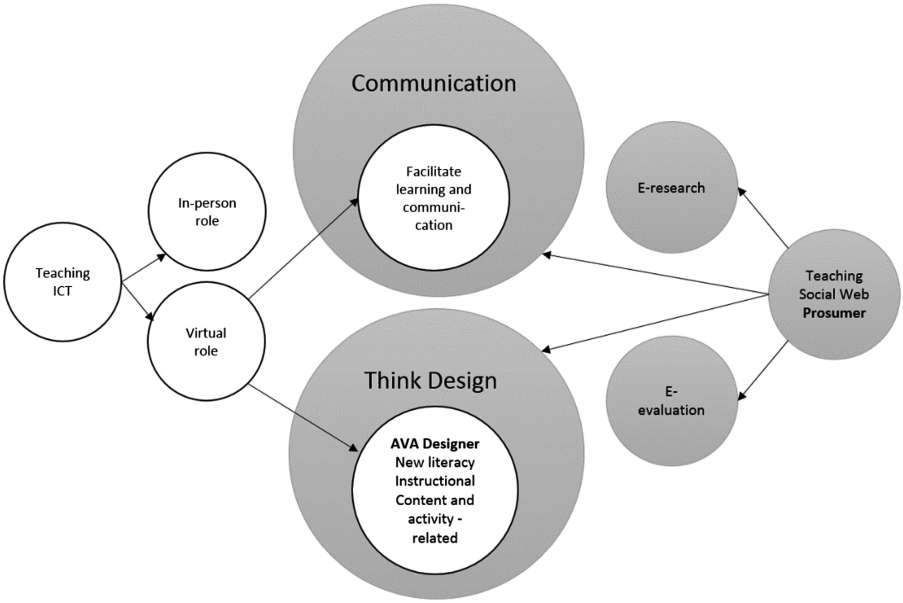

Fig. 2. Re-definition of the roles for b-learning contexts from the prospective outlook of the teacher (prosumer) and mediated by the social web

The system of communication can no longer be based on that of sender, message, and recipient (Aparici 2011) because, in addition to these, the component of feedback as a regulatory factor changes; thus, the informational tends towards the formative as a result of patterns of participatory dynamics. This is when a dialogic and conversational model is conceived and gains strength in the educational field through Cloutier's term for the sender and recipient, denoting the condition of a teacher and educand with the ability to self-regulate, manage, and alternate messages and information through the duality of sending and receiving messages, without failing to contextualize this information.

2. In light of this increase in prosumer practices, the prosumer interacts, revealing the importance of interactivity, whose importance has grown over the course of the 1980s due to the joint efforts of users and producers. Meanwhile, technologies and their resources have made it possible to mediate, communicate, and collaborate among chains and structures of social groups towards a shared end goal. In the words of Araya (2008, p. 55), interactivity among prosumers can be catalogued as follows: intervention by the user upon content, the transformation of the spectator into actor, individualized dialogue with connected services, and reciprocal actions.

These elements can be grouped into a series of principles that describe interactivity as inherent to the form of social communication, especially among prosumers and users. The first principle according to Aparici and Silva (2012) can occur through participation and intervention as something beyond mere opinion, when practices and contents are modified through the inclusion of prosumer experiences, bringing with them multidirectionality or the principle of hybridization (Aparici and Silva 2012), which converges on the actions of emission and reception in a co-construction of messages with shared sense and meaning. Finally, the principle of exchange and promotion (Aparici and Silva 2012) can be characterized as the ability to consolidate communication networks to transform meaning through new contents as a product of exchange, association, and free expression.

3. The prosumer is empowered, another characteristic dimension of the prosumer, calling forth an action of empowerment whose intrinsic value lies in the defense of rights (Sánchez and Contreras 2012), of values, and of respect for citizen action to transform their environment and improve quality of life. The common citizen, the expert, the professional, and even people with limitations are capable of transforming and bringing forth sociocultural development. Consequently, the change in role from simple recipient should be gradual, such that one's creative participation is central in defining freedom of expression and intervention in detrimental features of ethical, political, and aesthetic dynamics.

Prosumers are empowered whenever they create, construct, and innovate, leaving aside the original role of waiting to receive that which is produced by others. Now, this polymorphism gives everyone the possibility of motivating or creating something but not something isolated or the result of individual effort, given that the prosumer is only one in a set of prosumers. Thus, one cannot refute that which one does not know; this is the old adage that opens the path to the empowerment of the prosumer, who, beyond producing, provides initiatives for others to do something for change (Sánchez and Contreras 2012, p. 80).

4. For the prosumer and his or her educational action referred to in this study, the master key for change towards an autonomous pedagogical model facilitated by associated pedagogical perspectives is held by the teacher because teachers guide the reflective transition and the priority of involving the educand in the design of educational processes. For this reason, the teacher is the actor who gives the possibility of effecting changes, opening up to different positions, and attributing meanings to collaborative creations, without losing sight of the curricular and institutional goals designated by the university or training program. Thus, "pedagogy based on that disposition towards co-authorship and interactivity implies the termination of one model of teacher and the birth of another in which the teacher is democratic and expansive in outlook" (Aparici and Silva 2012, p. 57).

For learning in this style, a change in the positioning of the teacher is essential because he or she goes from being the central axis to the idea that the entire group is needed to motivate and bring the educand closer to a creative, flexible, and reflexive process through interaction and the communicative opportunities offered by ITC. This vision of the teacher is translated into student prosumers; more than recipients and consumers of information, they become people who produce meaning to connect interests, problems, and uncertainties that are representative of the reality constructed by the cultural, cognitive, and behavioral mediations experienced in everyday life.

This educational paradigm, aimed at learning and not at teaching, has gained strength through the implications of ITC, more precisely due to the rise in the social web, thus leading to new thinking on the forms and practices of the teacher in the higher education setting. In relation to the above and interpreting what Salinas (1997) has stated, the following student-teacher interactions can be distinguished in prosumer situations: modifications in learning resources, the active involvement of the student, individualized experiences, collaborative experiences, and problem-solving.

By learning simultaneously, teachers and educands, meta-learning becomes a form of approaching knowledge, a fundamental aspect of higher education that, according to Araya (2008), strengthens the design of curricula constructed by pairs and among pairs to modulate educational processes that are connected to students' experiences and outcomes. In this vein, the impact of the invisible economy or of knowledge projects onto higher education some education obligations that are more reflexive and critical and that represent diversified ways of change-based learning positions, which constructivism has not been able to reach and where competencies begin to make incursions without any positive traces.

In the second part of the results and discussion, the transformation of teacher competencies is presented. Much of what is involved in changing teacher attitudes and aptitudes in pedagogical contexts based on b-learning education has to do with development by competencies (Valzacchi and Asinsten 2004). These are shown through specific studies on "changes in concepts of learning" that have been conducted by UNESCO. Competencies can be defined as abilities or prospects of interaction and behavior for the implementation of knowledge (Aguado and Arranz 2005).

In this dialogic order of educational ideas, efforts should be directed towards generating the competencies of the teacher-prosumer and any knowledge worker who wants to participate in the "educational revolution" focused on aspects such as teaching values for participation that allows citizens to grow as individuals and as a society, multimedia literacy (Horizon 2012), gamification (game-based learning), creativity, data analysis (augmented learning), the organization of collective intelligence and digital intuition: methodologies, tools for "giving meaning." In summary, all of these aspects are for significantly developing competencies for web-based learning.

In this world transformed by the aforementioned scenarios, there is space for a painstaking review of the competencies that the prosumer should acquire, just as the IFTF (2011); Reig (2012) and Casap (2015) propose similar abilities that should be developed to create new professions. Beginning with expertise developed over the course of this study and in accordance with the discussions of Reig (2012) and Casap (2015), Table 1 shows the transformation of teacher competencies in b-learning contexts, which are then absorbed through contexts of change and lead to new teacher-prosumer competencies. Table 1.

Giving meaning is the capacity to determine the meaning of what is being expressed. With technological development, machines are taking over the capacity of memory, routine manufacturing, and the employment of services; thus, there will be a growing demand for the abilities in which machines are not effective, those high level abilities that cannot be codified by machines, the so-called sensorial abilities for decisions, and the abilities that help create a unique vision that are fundamental for decision-making. Giving meaning is the ability that allows the world to be understood

Table 1. Transformation of b-learning teacher competencies to the teacher-prosumer

B-learning teaching competencies	Contexts of change	Teacher-prosumer competencies
Pedagogical Disciplinary Didactic AVA design Socio-communicative Technological Content creation and organization Content creation and organization	Social web Augmented society Learning technologies Empowerment technologies Intelligent systems Computational world	Virtual collaboration Transcultural New media literacy Design-oriented mentality Cognitive load management Social intelligence Adaptive thinking Decision-making Computational thinking

when it becomes intangible in some manner. This occurs when the environment is rapidly changing, presenting surprises that one is not prepared for or when facing adaptation problems rather than technical issues to be solved (Heifetz et al. 2009).

Social intelligence is the ability to connect with others in a deep and direct manner, to detect and stimulate desired reactions and interactions. In a social manner, intelligent employees are capable of quickly evaluating the emotions of those around them and adapting their words, tone, and gestures. This will always be a key ability of educators; it is necessary to collaborate and construct relationships of trust, but it is even more important to collaborate with large groups of people in different contexts. Emotionality and social intelligence have been developed over millennia in groups, which represents a comparative advantage over machines. Social intelligence broadens the range of action of emotional intelligence; going beyond one person, it refers to the capacities that the individual develops together with two or more people: It is what occurs when they connect, opening new spaces and branches of medicine to study these social interactions. This is the case of social neuroscience, a discipline charged with analyzing the relationships between the brain and social behavior. (Goleman 2007)

Original and adaptive thinking is the ability to think and find solutions and answers beyond what is dictated by memory or pre-established paths (as Reig (2012) expresses, intuition, flexibility, observation, and change, permanent beta, etc.). Adaptable thinking is centered on training in "how to think instead of what to think." Adaptive thinking is different from lateral, creative, or out-of-the-box thinking; it is defined by the conditions in which it is produced, the conditions or limitations that should be taken into account to generate a solution sought from within. In this study, adaptive thinking is defined as a set of abilities that involve negotiation and consensus-seeking, the capacity for effective communication, analyzing ambiguous situations, using abilities to resolve creative problems – in summary, to empower critical thinking. The need to promote adaptive thinking that promotes innovation turns the teacher into an apprentice; it allows going beyond preconceived notions formed by experience in the comfort zone and recognizes testing and responding to complex and changing situations with greater flexibility.

Transcultural competencies are the ability to operate in different cultural environments (it is necessary to employ the role of the anthropologist in social media). In a globally-connected world, it is necessary to generate a set of abilities to be able to operate in any environment in which one finds oneself. Doing so requires specific content, not only linguistic abilities but also the capacity to adapt to changing circumstances and the capacity to detect and respond to new contexts.

Computational thinking is the ability to translate large quantities of data into abstract concepts and to understand data through reasoning. It is also related to intuition, flexibility, observation, and change, in permanent beta. It is the process of change that is involved in formulating problems and solutions so that they are represented to be efficiently performed in an information processing system.

New media literacy, or media literacy, is the capacity to critically evaluate and develop content that uses new forms of communication and to take advantage of media for persuasive communication with regard to format but especially with regard to the interactive social character that approaches the traditional social sciences. For centuries, literacy has referred to the ability to read and write; now, the majority of information emerges from a system of technologies interwoven with media. The capacity to read many forms of media has become an essential ability in the 21st century. Media literacy is the capacity to access, analyze, evaluate, and create media.

According to Rheingold (1993), transdisciplinarity goes beyond bringing together researchers from different disciplines to work together on multidisciplinary teams. It means educating researchers who can speak the language of multiple disciplines—biologists who understand mathematics and mathematicians who understand biology.

The design mindset is the capacity to envision, represent, and develop work tasks and processes to obtain the desired results. Sensors, communication tools, and the processing power of the computational world will bring with them new opportunities to adopt a design focus in our work. Future teachers will need to become experts in recognizing the type of thinking required by different tasks and to make adjustments in the work environments that they wish to improve. This type of thinking is centered on the process instead of the product. Put another way, it is centered on problem-solving, but it does not begin with any particular solution in mind; it is a balancing act between logic and the creative aspects of problem-solving. A process of logical thinking works well when we have existing knowledge to build upon, whereas a creative thinking process is required to create new understandings and to construct problems in a different manner from what has been done before.

It is important to manage the cognitive load, understood as the capacity to discriminate and filter information in order of importance and to understand how to maximally take advantage of cognitive functioning by using a variety of tools and techniques (from the documentarian to the content "curator" to productivity experts). A world that is rich in information flows in multiple ways and from multiple devices, bringing the issue of cognitive overload to the forefront. Sometimes, learning implies great effort, even cognitive suffering. The reason is that working memory is very vulnerable to the overload created by studying and performing increasingly more tasks. Therefore, cognitive load refers to the total quantity of mental activity imposed on working memory in a moment. The cause of the excess demand on working memory comes from the great quantity of new information emitted by different information systems, beyond what a person can process.

Virtual collaboration is the capacity to work productively, maintaining commitment, and demonstrating presence as a member of a virtual team. ITCs make it easier than ever to work, share ideas, and be productive despite physical separation. However, the virtual work environment also requires a new set of competencies. As the leader of a virtual team, teachers need to develop strategies to involve and motivate a group. One lesson is that techniques that are borrowed from games are extremely efficient in the participation of large virtual communities (gamification and serious games). The members of AVA also must become experts in the search for environments that promote productivity and well-being.

4 Conclusions

One of the main problems when involving the figure of the prosumer in the context of higher education is the persistent industrial model of education founded on the transmissionist paradigm that prolongs specialized technical-technological training more in line with the demands of consumption and the axiom of factory production implied within a transfer culture instead of a transformation culture. In this sense, universities, their methodologies, and pedagogical discourses are circumscribed within a prevailing notion of the work of the teacher wherein the educand acts passively in the classroom without any consideration given to dialogue. Similarly, the impact of ITC has been relegated to furthering this paradigm, using its conceptual and practical tools to favor unidirectional communication and an interaction biased towards the precepts of an educational community that is reluctant to accept the possibilities of change through a critical and reflexive stance vis-à-vis the use of ITC.

Thinking with the communicative action of the prosumer is incoherent with the culture of “recycling” media held by educational institutions in which there are diverse methods of accessing information and giving an interpretive value through digital literacy. Conversely, this recycling culture is used to create a bifurcation in formality, one that demonizes the discourse of media technologies and their noxious effects on both teacher and educand concentration as well as the informal space used to explore different types of information. It is clear that without direction from the formal educational scenarios, it is not possible to acquire strategies and habits that accompany metacognition as a cognitive, cultural, and attitudinal bridge between these two educational possibilities.

Specifically, one of the paths of change is based on the need to implement the social web and all its richness of information, interaction, and feedback in the task of education. However, the resources that are offered in this alternative are being used in a manner that is disconnected from the pedagogical, curricular, and educational perspectives that have emerged as new scenarios of discussion through lines of research. Thus, there is evidence of a lack of a coherent transition process in implementing the potential of the social web in the educational realm. Instead, the application of the social web has largely centered on generating virtual classrooms and virtual environments, with teacher participation as a central pillar and educands as receivers of information without the possibility of adapting or modifying the learning environment to support their own individualities and educational interests.

Educational institutions should adapt their models to the constant presence of technology and face the challenge of training teachers (in accordance with IFFT, 20011) in the development of abilities such as critical thinking, perspicacity, and analytical ability, the integration of new media for literacy in educational programs, including experiential learning that prioritizes social competencies such as the capacity to collaborate, work in groups, read social signals, and respond in an adaptive manner, promote the broadening or expansion of learning beyond adolescence and young adults to the age of adulthood, and integrate interdisciplinary training that allows students to develop abilities and knowledge in a broad range of topics.

The changes presented as results of this study suggest that there is a need to add more technological resources to what is being taught versus what is being learned. It is not very realistic to think that educational institutions are in danger of disappearing; on the contrary, it is necessary to rethink and to strengthen them, to permit change from the cognitive to the technological, from students to teachers, from the medium to the content. Educational and teaching institutions are called upon to be the motor of innovation, but innovation is not simply a technical question; rather, it is more about understanding how people and societies function, what they need and what they want. The adaptation of learning comes from reinvention and adaptation to situations. "America will not dominate the 21st century because of its manufacturing of cheaper computer chips but by reimagining how computers and other new technologies interact with human beings." This does not in any way represent a detriment to the need for technological training, but it suggests that as one works more with computational systems, the most valuable abilities will be those that are exclusively human, those that computers still cannot achieve.

References

Aguado, D., Arranz, V.: Desarrollo de competencias mediante blended learning: un análisis descriptivo. Revista de Medios y Educación **26**, 79–88 (2005)

Alonso, M.: El plan de Marketing digital (El consumer se ha transformado en prosumer). IE Business School, Madrid (2011)

Aparici, R.: Silva, M.: Pedagogía de la interactividad. Revista digital la educ@ción **145**, 51–58 (2012). http://www.revistacomunicar.com/index.php?contenido=detalles&numero=38&articulo=38-2012-07

Aparici, R.: Principios pedagógicos y comunicacionales de la educación 2.0. Revista digital la educ@ción **145**, 1–14 (2011). http://www.educoas.org/portal/La_Educacion_Digital/laeducacion_145/articles/Roberto_Aparici.pdf. ISSN 0013-1059

Araya, D.: The democratic turn: prosumer innovation and learning in the knowledge economy. In: Peters, M.A., Britez, R. (eds.) Open Education and Education for Openness (2008)

Area, M., Pessoa, T.: De lo sólido a lo líquido: las nuevas alfabetizaciones ante los cambios culturales de la Web 2.0. Revista digital la educ@ción **145**, 13–20 (2012). http://www.revistacomunicar.com/pdf/preprint/38/01-PRE-12378.pdf

Bernstein, B.: Class, Codes and Control: the Structuring of Pedagogic Discourse, vol. 4. Morata, Madrid (1990)

Casap, J.: Google's Global Education Evangelist World 2015 (2015). http://bie.org/object/video/pbl_world_2015_jaime_casap_keynote

Ferrés, J., Piscitelli, A.: La competencia mediática: propuesta articulada de dimensiones e indicadores. Revista digital la educ@ción **145**, 75–82 (2012). http://www.revistacomunicar.com/index.php?contenido=detalles&numero=38&articulo=38-2012-10

Giurgiu, L., Bàrsan, G.: The prosumer – core and consequence of the web 2.0 era. Revista de informática Soc. **5**(9), 53–59 (2008). http://www.ris.uvt.ro/wp-content/uploads/2009/01/giurgiubirsan.pdf

Giuseppe, P., Gil, J.: Un proceso de construcción participada del perfil docente en una red de Instituciones de Educación Superior de América Latina. Revista de Docencia Universitaria **12** (2), 121–148 (2012)

Goleman, D.: Social Intelligence. The New Science of Human Relationships, New York (2007)

González, K., Padilla J., Rincón, D.: Roles, functions and necessary competences for teachers' assessment in b-learning contexts. Procedia – Soc. Behav. Sci. **29**, 149–157 (2011)

González, K., Rincón, D., Contreras, L.: Caracterización y ejemplificación del docente-prosumidor desde la web 2.0 en educación superior. Revista Virtual Universidad Católica del Norte. **40**, 53–68 (2013)

Heifetz, R., Grashow, A., Linsky, M.: The Practice of Adaptive Leadership: Tools and Tactics for Changing Your Organization. Harvard Business Press, Boston (2009)

Horizon: Informe Edición para la enseñanza universitaria 2012. The New Media Consortium, California (2012)

IFTF: Future Work Skills 2020. EEUU. Institute for the Future for the University of Phoenix Research Institute (2011)

Islas, J.O.: El prosumer. El acto comunicativo de la sociedad de la ubicuidad. Palabra clave **11**(1), 29–39 (2008)

McLuhan, M.: Comprender los medios de comunicación: las extensiones de ser humano. Paidos, Buenos Aires (2009)

Padilla, J.E., González, K., Rincón, D.: El docente en contextos b-learning. Universidad Militar Nueva Granada, Bogotá, D.C (2012)

Reig, D.: Socionomia. Deusto, Barcelona (2012)

Rheingold, H.: The Virtual Community: Homesteading on the Electronic Frontier. Addison-Wesley, Reading (1993). EEUU

Salinas, J.: La educación en la sociedad de la información. Santillana, Barcelona (1997)

Sánchez, J., Contreras, P.: De cara al prosumer, producción y consumo empoderado a la ciudadanía 3.0. ICONO **10**(3), 62–84 (2012)

Sautu, R., Boniolo, P., Dalle, P., Elbert, R.: Manual de metodología. Colección Campus Virtual, Buenos Aires (2005)

Soep, E.: Generación y recreación de contenidos digitales por los jóvenes: implicaciones para la alfabetización mediática. Revista digital la educ@ción **145**, 93–100 (2012). http://revistacomunicar.wordpress.com/2012/02/29/generacion-y-recreacion-de-contenidos-digitales-por-los-jovenes-implicaciones-para-la-alfabetizacion-mediatica/

Strauss, A., Corbin, J.: Bases de la investigación cualitativa. Técnicas y procedimientos para desarrollar la teoría fundamentada. Editorial Universidad de Antioquia, Colombia (2002)

Toffler, A.: La tercera ola. Plaza & Janes S.A., Bogotá (1980)

Valles, M.: Técnicas cualitativas de investigación social reflexión metodológica y práctica profesional. Editorial síntesis, Madrid (2003)

Valles, M.: Ventajas y desafíos del uso de programas informáticos (e.g. ATLAS.ti y MAXqda) en el análisis cualitativo. Una reflexión metodológica desde la grounded theory y el contexto de la investigación social española, pp. 1–26 (2002). http://public.centrodeestudiosandaluces.es/pdfs/S200105.pdf

Valzacchi, J., Asinsten, J.: Implicancias del procesamiento didáctico en los entornos virtuales de aprendizaje. Buenos Aires, Argentina (2004)

Learning Technologies Applications

EDMODO: Experiencing a Global Education Network

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Abstract. Currently there are many possibilities to incorporate Information and Communication Technologies (ICTs) into the classroom, which help students to become active participants in their own learning process. This research describes a practice developed with undergraduates being prepared to become teachers of English as a Second Language in the south of Brazil. The experiment proposed the usage of a global educational network called Edmodo, which is still an uncommon reality in many schools. The objective is to create a site in which the teacher and the students can share ideas, suggestions, post comments as well as widen their knowledge of digital tools. According to the theories of Computer Assisted Language Learning (CALL) another benefit is the improvement of the students' proficiency in the second language. The authors believe that teacher trainees who explore technological tools during their formation are more likely to incorporate them in their very own practice as teachers.

Keywords: Teachers' formation · Digital tools · Edmodo

1 Introduction

Lately technology has been changing our lives mostly improving medicine, ways of communication and providing access to information. Related to education there are nowadays many apps and platforms designed to facilitate learning and the teachers' job itself, like planning, correcting students' tasks and giving feedback. Nonetheless the usage of technology inside classrooms by teachers is still in low speed and rare in practice. This has been observed in many schools within the last decade.

One of the possible reasons must be related to teachers' formation which still seems to be very traditional, ignoring new possibilities of engaging practices and repeating old models. Human beings have the tendency to reproduce behaviors, so, if technology is not used during the formation of such professionals, they are more likely to not use it once they are inside a classroom and leading their students learning process.

Considering this, the authors proposed how to introduce opportunities to use the web 2.0 and the constitution of a Personal Learning Environment (PLE) in a teacher training course in English as a Second Language. According to Silveira, Bassani and Barbosa [4].

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Web 2.0. is based on a participatory architecture, in which the individual can use, create, recreate and share content utilizing different applications. Recent research points towards the use of Web 2.0 applications in education from the perspective of Personal Learning Environments (PLE). A PLE is organized with basis on traditional experiences that constitute formal education and new experiences enabled by ICT, especially Web 2.0 applications.

To achieve this goal, one of the technologies being used in the educational context was chosen: a social network for education. Through these nets it is possible to carry out a learning proposal to beyond the walls of the classroom and including technological resources in educational tasks, leading into a hybrid learning system. Thus, it also explores ubiquity in the learning process. Santaella [12] defines ubiquity as 'the attribute or state of something or someone that is defined by the power of being in more than one place at the same time.'[1]. Therefore, by using social networks the learning process is enlarged by involving different tools and spaces.

In this article, there is a special interest in the possibilities promoted by the Social Educational Networks which are 'nets related to the educational context, supporting concepts such as students, teachers, activities, school, among others' [1]. It presents experiences with the usage of an educational network in a pedagogical practice with a group of students in Higher Education in a course of Teaching English as a Second Language in the Vale do Rio do Sinos region, located in the south of Brazil.

The practice was proposed and developed by the teacher in a subject of the course and the main motivation was to have a space to share content and present an option of a Personal Learning Environment to the students because the teacher noticed in the previous semester that the students did not have any idea about these possibilities. Our challenge was to create an interaction not only student to student, but first, student to technology, student to environment, student to a space where they would appropriate themselves about technology, their possibilities and hopefully, use them in their own practice as teachers.

Materials which were constituted by digital resources available on the internet, for example, websites, games, as well as short teasers and questions that the teacher would like to address the students, providing a new place to share experiences between the teacher and the students, so that the formal moment of the education would be extended were also part of the experience. Hence, the option of using an educational network was taken to spread the interaction present in the physical classroom and to have a site where these exchanges would happen. The aims were: (a) to gather various suggestions in an educational network, (b) to build a sharing environment which could be accessed by granting a permission, (c) to ensure that the participants were made up by the chosen group of students, (d) to multiply opportunities of contact between the people involved and, at the same time, (e) also to allow the students to post tips, digital resources and/or questions, making them able to become active subjects on their own learning process so that they would build their PLE.

[1] Version by the authors.

2 Background

The researcher in educational matters Vygotsky [14] related psychology to education, developing studies about pedagogical issues building theories and investigating. The focus of his study was the importance of social interaction and the historical dimension of mental development. Human development, according to this author, is determined by socialization. When a subject interacts with their sociocultural environment and/or modifies it through their behavior, this subject will also influence the environment in the future. Moreover, and considering the diversity of the educational scenery, to assure that the learning process occurs effectively, two elements are needed: meaningful learning and autonomy of the subject in developing knowledge [10]. The technologies associated to the learning process of the subject can facilitate these points, as they are present in the current society.

In this context, the social networks are suitable to promote interaction and collaboration among the subjects, providing a computational environment offering support to investigate how these social technologies add to the learning process in a collaborative space. To Leffa [8] the social networks can be a great tool, but '… it is not social networks alone that improve language teaching, but the usage it is made of them' (see footnote 1). Consequently, the simple existence thus denomination of a social network does not guarantee it as an aid. Only the usage, the practice done by its subjects is what certifies it as an effective tool, presenting characteristics such as interaction, share, coauthorship, among others.

A main concept to this study is the noun interaction, consequently the verb interact. Alex Primo observed their appearance in many contexts related to computing and realized that their meaning could be very different. Therefore, he came up with two definitions that apply to this experience: mutual interaction and reactive interaction. In few words, the first is 'characterized by interdependent relations and negotiation processes in which each subject participates in the inventive and cooperative construction of the relation, affecting themselves mutually' [11] and the second is 'limited by determined relations of stimulus and response' (see footnode 1) [11]. Moreover, the Oxford Dictionary [7] defines interaction as (1) 'to communicate with somebody, especially while you work, play or spend time with them' and (2) 'if one thing interacts with another, or if two things interact, the two things influence each other'. The similarity between the dictionary and Primo is that both mention effects on the subjects and this is the expectation of this experiment: to use digital tools during the students' formation so that, hopefully, they will be able to use them in their own practice.

In association with, another very important concept is hybridism, which refers to 'the interconnection of the physical spaces of circulation with the virtual spaces of information through which the users of mobile devices are connected' (see footnode 1) [12].

Thus, the meeting of the teachers with their students, which usually happens weekly, can happen more frequently, transforming the moment of physical distance in an opportunity of real communication, even though virtual. The share of ideas, knowledge, suggestions becomes permanent yet not at the same time, but asynchronous. Hybridism to authors such as Santaella [13] and Barbosa [2] is also related to ubiquity or ubiquitous learning in the meaning that learning may happen in any place, any time at any space.

Ubiquity is possible just because nowadays our lives are surrounded by many devices, being a computer/laptop almost indispensable in our day-by-day routine. The Computer Assisted Language Learning (CALL), together with Mobile Assisted Language Leaning (MALL), deals with learning languages using a variety of technologies, from CD-ROMs to cell phones. These areas have joined efforts with Second Language Acquisition theories in the research of how gadgets can be useful and effective to the students' development of a second language. Franco [6] mentions that the learning of a language is seen as a socialization process in specific discursive communities. Under this point of view, students should be encouraged to participate in authentic social interaction so that they can participate in communicative situations out of the classroom context. This is possible through the collaboration between students in authentic tasks and projects whereas learning simultaneously the content and the linguistic form (see footnote 1).

From this perspective of language acquisition, a computer (and technologies in general) can be used to promote interaction between the subjects involved and a facilitator to the language learning process.

3 Experience Report

The practice occurred in a class of Higher Education in a Teaching English as a Second Language course constituted by seven students from which three already work in schools. The teacher shared her concern related to a lack of a means which worked as a storage of ideas and activities, suggesting the usage of a tool called Edmodo to solve this issue. See the initial page from Edmodo in the following Fig. 1.

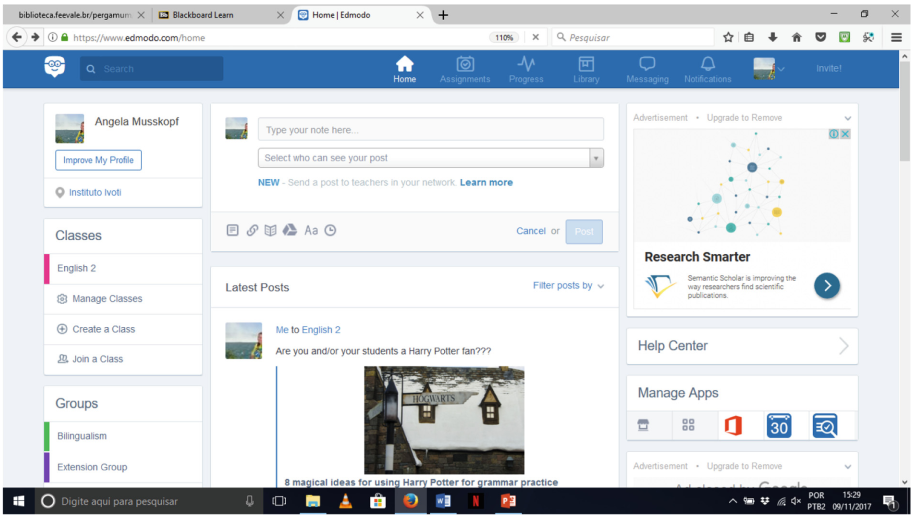

Fig. 1. Edmodo initial page

3.1 Methodology

For this practice, a platform called Edmodo[2] was chosen. On their website [5], this definition is available: Edmodo is a global education network that helps connect all learners with the people and resources needed to reach their full potential. The intention was to search for a freemium[3] platform so that the students could also use it to manage their classes.

According to the Centre of Learning & Performance Technologies[4] Edmodo is listed among the Top 200 Tools for Learning 2017, appearing in the 75th position and it is the only learning platform for schools that is mentioned. When considering the sublist Top 100 Tools for Education (EDU) 2017, its position is the 41th. Moreover, Edmodo is a partner of Cambridge University Press which is very important to the Institution where this practice occurred since it is a Preparation Centre and venue for the proficiency tests of the University of Cambridge since 2012. Furthermore, the fact that Edmodo does not have so many distractors like Facebook and that it can be used by children, which is not allowed by Facebook's policy, reinforced the certainty of the choice.

Some features added weight to this decision: the possibility to create (a) a private group managed by the teacher, (b) tests, (c) polls, (d) assignments and (e) follow students' performance by a gradebook. Furthermore, the resemblance to other social networks such as Facebook which was known by the students. Edmodo provides an interface of interaction, debates, socialization of activities and experiences, becoming the meeting point of the students among themselves and between them and their teacher.

The study was developed in October and November 2017, period in which the class called English 2[5] was generated and the students were informed of the code to access it. As the language used in class was English, it was stablished that the posts would also be done in this language. At least once a week, the teacher posted content and after a while students were also invited to post not only their opinions, but content, too. All data was collected from the platform since it is recorded in the class created by the teacher.

3.2 Practice – How It Was Implemented

The teacher did 16 posts[6] constituted by eight various types: (1) suggestions of activities to be used with their students, (2) explanations and exercises to develop the students' English knowledge about topics studied in the classroom, (3) a message for the Teacher's Day, (4) articles to be read and commented, (5) an invitation to

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[2] EDMODO. Teach more. Learn more. Available at: <https://www.edmodo.com>. Accessed in: 05 dez. 2017.

[3] Term used to refer to websites which allow people to receive basic services for free but require them to pay to have access to all services.

[4] http://c4lpt.co.uk/.

[5] The site can be accessed at https://www.edmodo.com/home#/group?id=25444517.

[6] All activities and links are available at: https://www.goconqr.com/pt-BR/p/11844934.

participate on a webinar from the University of Cambridge about vocabulary, (6) a poll, (7) a quiz and (8) an assignment.

A summary of each post is provided below.

1. Digital Tools – Six digital tools suggestions to facilitate the teachers' day by day.
2. Webinar – Invitation to participate on a webinar: when words do not get in the way! – vocabulary activities to facilitate learning.
3. Verbal Tenses – Prince Harry has his popcorn nicked by a toddler (present simple x present continuous): gap filling video activity.
4. Present Perfect – Print and cut slips with lyrics containing present perfect structures. Students order while listening to the songs.
5. Prepositions – Crabs commercial (movement prepositions and adverbs): gap filling video activity.
6. Reported Speech – Kids say the funniest things. Watch the video and write on the worksheet in the indirect speech.
7. Past Perfect – Explanation and online exercises on the topic since the students showed difficulty.
8. Message: Teachers' Day – A video message congratulating these professionals for their day.
9. QR activities – Creating mobile worksheets with QR codes. Suggestions on how to use QR codes in the classroom.
10. Article – Can a computer teach children to read and write? Read, post opinion and comment classmates opinions.
11. Halloween – Haunted house: gap filling video activity.
12. Harry Potter – Eight magical ideas for using Harry Potter for grammar practice.
13. Survey – Teacher's survey: a yes/no question about Edmodo using its own quiz tool.
14. Quiz - The teacher created a quiz using a tool from Edmodo: multiple choice questions on prepositions.
15. Indirect questions – Various explanations about the topic with links to exercises posted by the students.
16. Assignment – Students read a book and present its content through diverse ways: acronym, crossword, sentence, summary, character description, mind map, picture net. This was created using an Edmodo tool and the students used other tools to present their task, such as Goconqr and online word.

The posts can be divided into three principal areas according to their purpose:

a. Suggestions – these posts are related to activities the students can use in their own practice; they involve video, songs, and technology usage.
b. Language development – the subject in which the practice occurred is aimed to improve the students' knowledge of English. Therefore, it was important to involve this issue in the posts.
c. Discussions – these were similar to a forum; students reflected about a topic, posted their own opinion and commented on their classmates' postings.

The Table 1 provides an idea of the areas of each post:

Table 1. Areas of each post

Areas	Posts
(A) Suggestions	1, 2, 3, 4, 5, 9, 11, 12, 16
(B) Language development	3, 6, 7, 11, 14, 15, 16
(C) Discussions	10, 13, 16

Post number 8 does not appear because it was a message in honor to the Teacher‘s Day in Brazil.

Although each post can be linked to a specific purpose, all of them could be considered valuable in terms of language acquisition since the students were using the second language in real communication tasks as stated by approaches to language in social contexts. Moreover, according to Chapelle [3], when learners receive feedback from the computer on their production, they have the opportunity to notice gaps and correct errors' and 'technology dramatically extends and changes the breadth and depth of exposure that learners can have with the target language and interactive events in which they have the opportunity for language focus.

The first access was during a class using Chrome books available at the establishment. There was no need to create individual accounts since the institution has a partnership with Google and all students get a Gmail account, which is suitable to access Edmodo. The first posts were accessed in the classroom so that students would be guided in both logging in and exploring some of the possibilities of the platform.

The students were asked to post explanations and exercises about a topic studied in the classroom (indirect questions). This was used by the teacher as an aid to the students who were absent that day so that they would have a possibility of catching up. Even the students who were in the class were asked to read and do the exercises as a way of checking their understanding. The following picture shows the post done by one of the students (Fig. 2).

The assignment proposed was about a reading book; each student chose one according to their level of English and they were challenged to present the content of the book to the class. The teacher suggested some options such as a mind map, an acronym, a description. For this task, all students used other available tools: the online word (from Google Drive options) and a site which allows a creation on mind maps called Goconqr[7], also accessed by a Gmail account. This kind of task allowed the teacher to address comments and grade the students' work. Also, there was a homework task involving this reading: students were asked to write 5 different sentences comparing the books each one read to the ones of their classmates and post it. As comparison would be the next topic, this task would be used as a lead-in activity.

[7] Available at: www.goconqr.com.

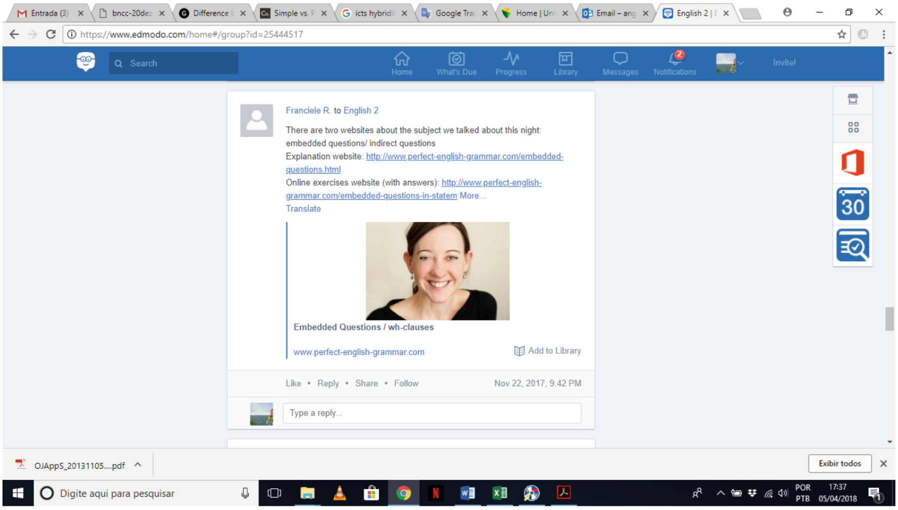

Fig. 2. Student's post

4 Results

The interaction of the students in the created space was surprising. According to Leffa and Freire [9] 'learning in both ways on distance or face to face is only possible when there is a mechanism to mediate both or more agents' (see footnote 1). Analyzing the participation of everyone involved, teacher and students, interaction was clearly developed during the period of this study. A moment to represent this was the comments of the students about one of the texts the teacher posted. A part of the discussion can be seen in the following Fig. 3.

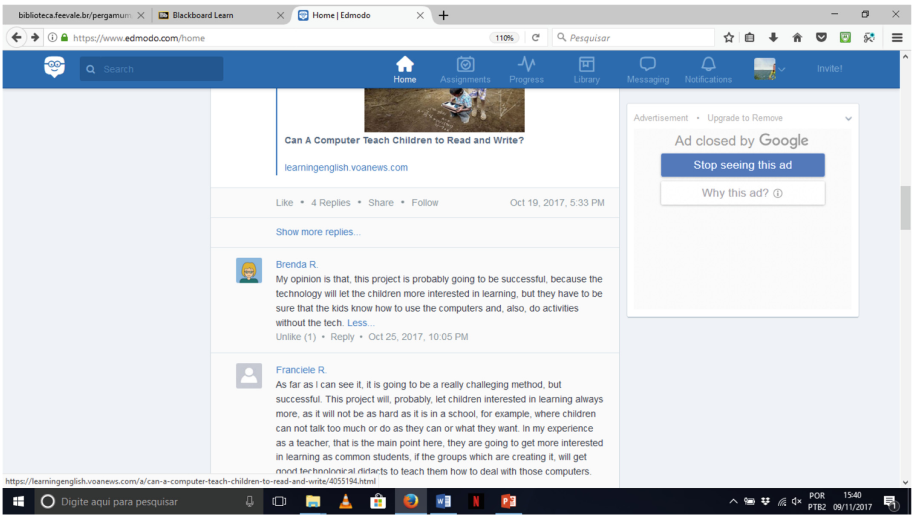

Fig. 3. Article discussion

There were contributions in both contexts, inside and outside the classroom. In the first, students talked about the posts and their helpfulness, demonstrating their engagement and excitement about using the tool. In the second, the class was extended beyond the walls of the school, since students accessed the content from their home. Still referring to Leffa and Freire [9], ‘the distance becomes present and the present becomes distant, turning the learning process into a hybrid and unique process, present while geographically distant’ (see footnote 1). This extension of the classroom mentioned by these two authors was achieved in this experiment since the access and interaction occurred in both moments inside and outside the institution.

The quiz addressed to the students asked their opinion about Edmodo. None of the students knew this tool before the teacher presented it and all of them answered they liked to use it.

The students also explored some other possibilities that Edmodo offers. For example, a student shared that she took an English test suggested by the platform and in her point of view it was considered very interesting.

Related to the usability of the tool, the students considered the possibility of editing a commentary already posted of extreme importance. In such virtual space composed by a closed group with people who know each other, personal exposition is a must and some students were concerned about using English in writing and committing mistakes. Nevertheless, the initial discomfort and unsureness were left behind when the students were informed they could edit what was already posted.

5 Final Considerations

Interpreting the practice results, it is possible to affirm that the created space became the meeting point of the group, which was the original intention of the research. The structure and usage of Edmodo were easy to understand and basically deductive. Other options offered by the platform unveiled innovative ideas and contributed in the professional development of the future teachers. Based on the students’ reaction, interaction and usage of technology during this experience, the authors truly believe they have contributed to a change in the state of the art concerning to the technology and its implementation during the teachers’ training course. One reason to this statement is the fact that students were using some of the tools while doing tasks for other disciplines as mentioned by them during an informal talk.

However, the possibilities were not exhausted in this short amount of time. On the contrary, besides the teacher, students also realised that there are many other tools that Edmodo presents and that can be explored to get the most out of it.

Yet, the decision to choose Edmodo was successful: it fulfilled the study purpose. By experimenting this tool, the students were able to foresee the usage of it in their own professional practice. Additionally, according to Chapelle [3] ‘the emphasis in CALL today is on the pragmatic goal of marshalling professional knowledge in a manner that is useful for creating learning opportunities and demonstrating successful learning’. The practice with the students showed that they had various moments outside the classroom in which they were able to get in touch with the second language they are trying to master. Edmodo was the social environment allowing students to use English to communicate with their classmates, expressing their opinions and sharing thoughts and suggestions besides fulfilling the teacher's task posted at the platform. Through this, the social usage of the language was implemented and, as mentioned orally by students, they received peer correction and were able to rewrite some mistakes in a safe and friendly context.

The usage of ICTs inside the classroom can be very challenging to teachers. They used to be the possessors of knowledge and the ones who were supposed to have all the answers to the students' doubts. The truth is young students are more used to technology than teachers, thus educators may feel vulnerable, threatened and even ashamed of their lack of knowledge on how to deal with technology. Teachers will have to learn how to deal with this digital era people are living in and more than never must not only admit to but really put into practice the famous statement known all over the world: teachers learn with their students, too.

On the other hand, technologies can be taken as the trigger for a different role for both, students and teachers: the former should be able to explore possibilities, be more autonomous, organise their own PLE to become better professionals and benefit from the available options. The latter should act as mediators, guiding students in their learning process, allowing them to share the knowledge they bring with them when walking into a classroom, standing side by side and not in front of them anymore as it used to be. Teachers are still important, though some might say they have a bigger role as they are now expected to rise up the right questions and suggestions to help their students to reach the answers instead of giving them.

One of the challenges raised by the usage of technologies in the classroom could be referred to as a divergency between study and leisure, both parts of cyberculture: the communication via social networks appears to be much more connected to leisure and enjoyment time to the typical circumspection of the study time and improvement of linguistic and/or professional knowledge. Hence, the usage of educational network brings the opportunity to explore the elements of a social network but in a more focused space, oriented to elements taking part of the learning process. Considering the development of future teachers thus their usage of digital technologies in their schools, it is completely utmost to help them to incorporate it in their practice, widening to beyond the usual ones known by students.

References

1. Arnold, R.: Um modelo de gamificação para redes sociais educacionais. Dissertação (Mestrado) – Universidade Feevale, Novo Hamburgo, RS (2017)
2. Barbosa, D.N.F., Bassani, P.B.: Em direção a uma aprendizagem mais lúdica, significativa e participativa: experiências com o uso de jogos educacionais, tecnologias móveis e comunidade virtual com sujeitos em tratamento oncológico. RENOTE. Revista Novas Tecnologias na Educação **11**(1), 1–10 (2013). http://seer.ufrgs.br/renote/article/viewFile/41622/26404. Accessed 05 Dec 2017
3. Chapelle, C.A.: The relationship between second language acquisition theory and computer-assisted language learning. Mod. Lang. J. **93**(1), 741–753 (2009)

4. Educação e tecnologia: parcerias 3.0 [livro eletrônico]/organizadores: da Silva Rosado, L.A., et al. Editora Universidade Estácio de Sá, Rio de Janeiro (2014)
5. EDMODO. Teach more. Learn more. https://www.edmodo.com. Accessed 05 Dec 2017
6. de Paiva Franco, C.: A tecnologia no ensino de Línguas: do Século XVI ao XXI. Revista de Divulgação Científica em Língua Portuguesa, Linguística e Literatura. Ano 06 n. 12 – 1, Semestre de 2010
7. Hornby, A.S.: Oxford Advanced Learner's Dictionary of Current English, 8th edn. Oxford University Press, New York (2010)
8. Leffa, V.: Redes Sociais: ensinando línguas como antigamente. In: Araújo, J., Leffa, V. (Org.) Redes sociais e o ensino de línguas: o que temos a aprender? pp. 137–153. Parábola Editorial, São Paulo (2016)
9. Leffa, V.J., Freire, M.M.: Educação sem distância. In: Mayrink, M.F., Albuquerque-Costa, H. (Org.) Ensino e aprendizagem de línguas em ambientes virtuais, pp. 13–38. Humanitas, São Paulo (2013)
10. Moreira, M.A.: Aprendizagem significativa. UNB, Brasília (1999)
11. Primo, A.: Interação mediada por computador. Sulina, Porto Alegre (2007)
12. Santaella, L.: A ecologia pluralista da comunicação: conectividade, mobilidade, ubiquidade. Paulus, São Paulo (2010)
13. Santaella, L.: Comunicação ubíqua: repercussões na cultura e na educação. Paulus, São Paulo (2013)
14. Vygotsky, L.S.: A formação social da mente, 4th edn. Martins Fontes, São Paulo (1991)

Try to See It My Way - How Students View the Use of Lecture Capture

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Abstract. Learning technology has been a major focus of educational research for several decades and much has been written about its potential for transforming higher education internationally. Increasingly, universities are not only supporting various learning technology but mandating adoption by teaching staff. Despite this, there is still relatively little research on users' attitudes to these systems and a lack of understanding of how the systems are used in practice. In previous work we investigated staff attitudes to technology adoption, discovering a much wider range of concerns and barriers to effective use than generally acknowledged in existing studies. In this paper we consider a student perspective on the use of one particular technology: lecture capture. Qualitative data was collected from final year undergraduates and analysed to provide insight into the way they use recorded lectures and to understand their views of the benefits of the system. Although perspectives on the use of these video resources differ between students and staff, when asked to confront and respond to concerns expressed by lecturers, the students showed a level of maturity and understanding in their appreciation of the issues. However they raised issues concerning reciprocal empathy from staff of their own concerns.

Keywords: Learning technology · Lecture capture
Student perception

1 Introduction

The use of learning technologies of one sort or another is now so commonplace in many universities that it hardly seems to merit attention. Indeed, some institutions are on their third or fourth successive virtual learning environment having entered the market as early adopters and updated as new platforms and technologies have emerged. The potential benefits to educational administration are obvious, with tasks such as providing timely feedback and communicating with students greatly streamlined by the functionality of online systems. However,

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these technologies are not just administrative tools; they are platforms intended to support learning. It is therefore vital that their educational affordances are understood and that appropriate pedagogies are developed and evaluated allowing systems to be used to best effect in the support of learning and to allow better systems to evolve.

In learning technology research there has been much excited speculation about the potential of technology to bring innovation to teaching and learning. Writing in 2002, Sharples noted the wide landscape of possibilities for technological transformation in learning, but equally warned of the challenges posed by the way that technology would disrupt existing classroom practice [22]. The term "disruptive educational technology" has since been widely used in this context [6]. Often, its use conveys a positive anticipation of how tools might allow novel and previously impossible educational approaches to emerge. There is less emphasis placed on the high element of challenge which Sharples predicted would arise when existing preconceptions about teaching practice were questioned.

Since the time of Sharples' writing, technology has permeated educational practice worldwide. Yet it appears this is not always accompanied by an approach which embraces the disruptive potential or encourages the development of novel pedagogy. Discussing e-learning policies, Conole notes the widespread inclusion of "rhetoric about the potential technologies offer for education - personalisation, flexibility, adaptively, and engaging, authentic environments" (p. 13) that is rarely matched by their use in practice [5]. It is easy to set out a policy, not so simple to implement it. Further, the concern that use of technology is not demonstrably improving student outcomes has been an ongoing theme, and the "no significant difference" website documents hundreds of studies since 1928 showing no appreciable difference in outcomes between traditional and non-traditional approaches to learning [20],?.

While the technology may be new, in many cases the teaching methods are the same. Although educational research literature reports many apparently successful case studies of innovative educational technology use, this is the tip of the iceberg and generally presents the activity of the most engaged and enthusiastic staff [24]. Often, staff reproduce the teaching methods they experienced as learners, with little appetite for experimentation and much scepticism concerning the technology [23].

Staff may be hesitant, but the literature reports that students are conversely keen for the introduction of technological innovation and embrace the new ways of working it supports. They are often referred to as "digital natives" suggesting they welcome the use of educational technology in a way that their teachers may not. Conole et al. state: "students are comfortable with technology and see it as integral; are on the whole sophisticated users - using different tools for different purposes" [7, p. 523]. It appears that a gap in expectations and experience has grown between the providers and the consumers. But what are the differences and how have these arisen? What do students think about the current uses of technology to support their education and (how) do they think it really helps their learning? Do they appreciate the concerns that staff may have and are any of the concerns seen to be legitimate?

While several studies have recently emerged which investigate how students use educational technology, little has been done to uncover how they view the technology or how they understand the link between technology and their own learning. Further, there is currently little which attempts to align the perspectives with a view to understanding the differences and bridging the gap. In previous work we have conducted qualitative research to better understand staff use of educational technology and the reasons behind their behaviour [23,24]. The current work aims to develop a deeper understanding of the student perspective by analysing qualitative data relating to the use of one particular technology: lecture capture.

The following section provides a brief review of relevant literature. The methodology for the current study is then presented followed by the results emerging from analysis of the data. Section 5 discusses the results and their relationship both to the staff perspective and to previous findings.

2 Previous Work

The review considers the perspectives of both students and staff relating to learning technology in general and lecture capture in particular. We also provide a brief overview of the current role of lecture capture referring to previous key studies.

2.1 How Students Use Technology

Students entering university straight from school in many countries will be accustomed to using technology both socially and as part of the learning process. Schools commonly use a range of technologies including virtual learning environments (VLEs) and electronic white-boards, and some provide tablets for students' personal learning [3]. Despite the importance of understanding how learners use technology and the learning processes involved, there is very little work to investigate this from the students' perspective. Over a decade ago, the SOLE project collected data on attitudes to VLEs use from over 800 students spanning five different subjects [26]. The findings at that time were that students greatly appreciated having all their materials in one place, but that participation in the communication channels was more problematic. The authors suggest that there are differences between subjects in what students need from an online system and how they interact with it. The subject-specific nature of the relationship was also noted in a longitudinal study of student attitudes carried out by Kirkwood and Price at a similar time [15].

Familiarity with technology has increased and a more recent study by Conole et al. considers what, how and when online resources are used by modern e-learners [6]. Students appreciated the flexibility of online resources and, although many of the uses were unsurprising, the study noted that students often found their own ways to communicate and were developing social networks to enhance their studies. Enterprising students also set up their own course websites and provided each other with alternative forms of support. Ways in which technology enables a shift in the way that students work is also observed by Holley and Oliver who found that work outside the classroom is not just enabled, it is obligatory [12]. While learning "any time, anywhere" is generally presented as positive, some students experienced significant issues in managing their technology-mediated learning in their own time and space. It is also reported that much education-related technology usage by young learners is extremely mundane and does little to help develop the necessary cognitive or pedagogic skills necessary for successful learning [2].

2.2 The Staff Perspective

Despite the potential benefits offered by the introduction of technology there is a good deal of evidence to suggest reluctance from many academic staff. This is observed by, for example, Blin and Munro who note that opposition continues even though the learning technologies staff are expected to use are becoming more user friendly [1]. It is another area of potential dissonance that institutions adopt and often mandate technologies that many staff are reluctant to use. Conole notes a worrying gap between policy and practice and urges a framework of adoption in which one of the key factors is teachers being able to recognise "what's in it for them" [5].

Recognising the benefits to personal practice is necessary, but research suggests a weight of negative factors which such persuasive measures must overcome [24]. Despite the claims that modern educational technology is easy to use, fear of using it and concerns that it will fail at a vital moment are prevalent. With specific reference to lecture capture, a surprising number of staff express an aversion to being recorded, whether it is on video or just voice. This may be related to the issue of experimentation whereby teaching staff are often given little time or support and yet bear all the risk (poor student feedback, damage to career) if things go wrong [28].

Some staff are adamant that blanket use of technology is not pedagogically sound (for example, with the use of lecture capture). Indeed, it seems highly likely that the best activities and approaches for different subjects, different students and different situations will vary. However, given the lack of understanding in this area it is difficult to either make or refute an argument based on pedagogy. There are certainly concerns that use of technology is viewed by some students as an excuse to avoid other academically beneficial activity. This debate is notable concerning lecture capture, with many staff fearing that students will not attend lectures [23]. Evidence for and against this actually happening is equivocal, and the discussion more nuanced than the simple implication implies [14]. Nevertheless, lack of attendance continues to be a widespread concern [24].

2.3 The Student Perspective

Many authors have explored students' acceptance of various different learning technologies, with the general message being a very positive one. A wide range of findings have been reported relating to learners' perceptions of benefits including appreciation of the flexibility provided by online learning, the opportunities for better communication, the convenience of tools for preparing assignments and the benefits of finding resources other than those provided by their lecturers [7]. Coupled with this, an assumption that students are "digital natives" has led some writers to suggest that students now learn best with ever-increasing provision of technology and that institutions are holding them back by failing to keep up with this demand [19].

Although students are generally reported as embracing technology and as wanting staff to extend use of educational support systems, some authors urge caution in assuming universal positive acceptance by learners. Students have been found to dislike VLEs, seemingly because of poor design and implementation, or because they were used as an "extra" rather than as a central platform for a course [7]. A number of authors also question the assumption that students are "digital natives" who can therefore use technology effectively for educational purposes. Such studies indicate that there is a large variation between students' skills (which is, unsurprisingly, to some extent subject-specific), that the range of technologies used is fairly limited, that little functionality of the tools is used, and that most students are still learning in a very traditional way despite making use of resources provided online [16,25].

Holley and Oliver studied the effect of educational technology on students' out of school learning and found that, although the e-platforms provided allowed flexibility to work at home, they also required students to develop time and space in their own lives and environments to incorporate the necessary study time [12]. They note that the possibility of study outside the learning institution becomes a requirement. For all students this necessitates a different set of learning skills and for some it causes significant stress. These findings are particularly interesting in the light of other research which indicates that students are reluctant to blur the boundary between their social and academic use of technology [9]. Other work indicates that a "digital dissonance" in understanding appropriate uses of technologies in different spheres (social, educational etc.) develops in children of school age [4].

Research on students' attitudes and skills relating to educational technology thus provides a number of mixed messages. At the very least, these conflicting findings indicate that we should be cautious about making and acting on general assumptions about how students work and what they find helpful for learning. It also indicates that it may be misleading to characterise (as is often seen) the difference between student and staff perspectives as, on the one hand, digital natives who embrace technology-supported learning and (on the other hand) reluctant adopters who will embrace the use of technology if its benefits are made clearer. A better understanding of the (range of) perspectives in the two groups is needed in order for educational technology to be used more effectively on both sides.

2.4 Lecture Capture

The current work explores students' perspectives relating to lecture capture. In many institutions it is now common, particularly in large undergraduate classes, for lectures to be routinely recorded and made available for students' personal use [17]. Several studies have mapped students' perceived and actual usage of the recordings, revealing a number of interesting findings. For example, patterns and times of usage have been reported in several studies [18],?. Gorissen et al. found that students' perceptions of how much and in what way they viewed recordings different substantially from the true record shown in system logs [10]. In general, students thought they watched much more of the videos than was actually the case.

Many studies have reported a widespread student demand for lecture capture, however there are conflicting results on whether this provision results in improved learning or not [18]. One issue raised by several authors is that learner characteristics may have an influence on outcomes. For example, Holbrook and Dupont point to learner maturity as an underlying factor in good study practice and learner success [11] However, Owston et al. obtained results suggesting that neither high-achieving nor low-achieving learners achieve the benefits that those in the middle ground experience [18]. A further, but fundamental, confounding element in this is that introduction of lecture capture in itself is unlikely to be the issue. It is how it is used by the teacher (integrated as part of the overall learning experience) and by the learner (employed in ways that will best suit their own effective learning patterns) that will produce benefits. It is therefore important to understand the different ways in which students incorporate the materials provided into their learning, the aspects which they find helpful and those they do not. Further, given the concerns held by staff on the issue of lecture capture we were interested in finding out how students view these potentially negative issues in the context of their own learning.

3 Methodology

To explore students' perspectives, generate a deeper understanding of the issues involved and suggest areas for further exploration it was decided to conduct a qualitative study. Our perspective is essentially a phenomenological one: we wish to explore students' experience of the use of lecture capture videos and the integration of these into their every day studies. As described by Van Manen, this type of research uses open-ended methods of data collection rather than limiting or closing down avenues which occurs when using closed questions or presenting pre-existing theories [27]. Data is collected from a small number of subjects (usually no more than ten) to provide different perspectives on a similar life experience. The methodology for deriving meaning from the data follows four steps: bracketing (the laying aside of preconceptions), intuiting (reviewing the data to discover emergent understanding), analysing according to emergent codes and describing the findings [21].

In the current study volunteers were invited from final year Computer Science students studying at a UK university. The decision was made in this study to investigate the views of experienced, effective learners who can provide a perspective of using the video resources across four years of study, including some modules which do provide lecture capture videos and others which do not. We note that other groups of students (such as freshers and students with less learning experience) may well provide different perspectives. While the longer term intention is to collect data from a much larger and diverse group of students, this initial study aims to provide rich qualitative data and deeper reflective insight which can inform some of the themes to be investigated more widely.

Six students responded and all are included in the results presented.

It was further decided that open ended questions provided online would allow the respondents to give considered, free-form responses and to include their own thoughts and experiences arising from a series of general prompts. The questions related to:

- the practical use of the videos (when, where and how);
- how the use of videos fits into the student's learning;
- how the availability of videos alters the student's pattern of behaviour;
- how the student views and would respond to staff concerns.

Responses were coded according to the these four initial categories and emergent themes are identified and discussed below.

4 Results

Responses are firstly reported here according to the four major thematic areas noted above. The discussion following this, expands on emergent issues and reflects on the relationship of the findings here to previous work.

4.1 How the Videos Are Used

Even in a small group of just six students it was noticeable that usage of the videos was very different. Three instances of when they viewed the videos were offered by all students (and accord with previous findings). These were: if a lecture was missed; to review difficult parts of a lecture; during revision. Three of the students review the video after each session. Another student said they would like to do this but found it impossible as the term progressed because of pressure of work. A further student said that they knew they would not have time to watch and so their preferred strategy was to binge watch the whole of a module once term is finished. Although this strategy is not generally document in studies of lecture capture, it provides an interesting parallel with the way that many young people watch television shows [13].

None of the students said they would watch a whole video through at real-time pace. Three made the point that it was very beneficial to be able to speed up to 1.25 or 1.5 of normal speed, identifying the difficult areas to slow down for and repeat. Half of the students also said that they used the videos in order to make their own notes. One stated that, for him, developing a good, complete set of their own notes was the main aim of using the videos and, having achieved that, they would be able to use their notes for revision. This is an issue on which existing literature is divided, with some studies finding that students use the videos to make notes, others that they do not [8],?. Our group appears to be similarly divided in their approach.

Two students said they watched all of the videos during the term time. One said about half, and a further respondent said a quarter. Two reported that they only accessed a few videos to check things they did not understand. However, most of the students said they watched more after the course had finished, either by binge watching as mentioned above, but mostly at revision time.

4.2 Role in Student Learning

All the participants were clear that they felt the provision of lecture videos helped their learning. Several pointed to the ability to review the difficult parts of a lecture as their main benefit, referring to technical topics in particular. One student noted recordings were particularly helpful "where there is a lot of mathematics from previous modules that I've had to look over and remind myself of (eigenvalues, eigenvectors etc.)". Another said: "it's nice to be able to pause and try a few numbers". However, the point was also made that the availability of videos did not help students achieve higher grades in the longer term, but it did facilitate and speed up the development of their understanding of the material.

Although all respondents were high-achieving, experienced students, several made the point that they "find it very difficult to keep up in lectures with listening/writing at the same time". It is likely (and even more so with larger classes and for students from earlier years) that despite lecturers' best efforts, many in the class are left behind at different points in lectures. Four of the respondents independently used the word "invaluable" to describe their feeling towards lecture capture.

Many students still seem to be using very traditional methods of learning, as with those who said that their own notes were ultimately their main resource. But recordings helped them develop the best set of notes possible for learning and revision.

Another point raised was that "the recordings allow me to first try and understand a topic before seeking assistance from the lecturer". This accords with previous research and is an aspect worth emphasizing to staff in relation to Conole's "what's in it for them" key motivator [5].

One student provided some insight into how they used the recordings at revision time by using them as an antidote to getting in a "revision rut". They felt that interspersing traditional revision techniques with watching the videos helped them mix up their revision activity and kept them more engaged and focused on the material they were revising. Although revision was mentioned by all students, only this one discussed the strategies they employed or what part in their revision the videos played. It would be an interesting aspect to explore this in further work.

4.3 Altering Behaviour

In terms of their behaviour and attendance, students stated that they would only miss lectures for reasons they considered legitimate. They had variously missed lectures for: illness, hospital appointment, attending a student research conference, lecture clash with another module and when they'd made a "silly mistake" (getting the time of the lecture wrong). Several commented that they (and other students) were fully aware that attending lectures is better for learning and that they would not see the availability of recordings as a reason not to attend (although others might). However, a number of the participants did also say that they would skip a lecture if pressure of coursework became too great. This was obviously not a decision they took lightly, but a considered strategy to help them manage competing demands on their time.

A further point raised by several students was the need to attend job interviews. This is becoming increasingly time-consuming with many employers now demanding five or six rounds of assessment. As noted by one participant: "we have to attend assessment centres and interviews (which can sometimes take up to two days due to travelling and overnight stays)". It is clear that, for these committed and engaged students, there were legitimate reasons why attendance at class was impossible on a number of occasions. However, it also emerges that they believe staff do not always appreciate the issues they face. With respect to attending job interviews, one participant said "I think it may not be seen as much from the lecturer point of view", but to him the option to catch up on missed lectures while returning to university on the train had allowed him to keep up to date with his work. Another student discussed the decision to miss a lecture in order to complete an assignment for another module. He said: "I know this can be seen as a silly trade-off" but given the pressure of work he felt it was the best decision for him at that point. The overall picture for this group of students was that they were making considered, strategic decisions about their learning and time management. A further example was provided by a student who lives off-campus requiring quite a long drive in. If there is just one lecture that day then three hours of his time are needed for a one hour session. Similarly, another student talked about their "chopped-up" timetable where considerable amounts of "dead time" comes between lectures - and the spaces for self-study on campus were limited and often noisy.

4.4 Considering Staff Concerns

Lecture capture is not used for all modules in these students' institution, and there has been a very heated campaign by the student body to make it mandatory. However, the participants in this study, while endorsing the view that videos should be available for all lectures, also demonstrated a good deal of empathy for staff and for the concerns they might have. Discussing the issue of recorded presentations, one student said “with the few I have done, I know it is scary”. Several appreciated that some staff feel uncomfortable about being filmed or even just audio-recorded. Some had been told by a staff member that lecture capture would not be available because the lectures were “not polished presentations”. Again, the students displayed patience and understanding with this view, even though they clearly did not think it was a legitimate reason. One student said “staff are human too and they make mistakes”. The students’ opinion however was that as long as the videos were kept as internal resources then the value of the basic information for them far outweighed any mistakes or lack of polish. Indeed, one student said: “students can identify more mistakes from the recordings which can then be passed on to the lecturers allowing them to rectify it or explaining it further”.

All of the students realised that the main concern for teaching staff was that students would stop attending lectures. Again, they discussed this honestly with some feeling that it would negatively impact attendance. However, they again showed understanding that this is not a simple trade-off but depends very much on the content of the teaching session. One respondent felt that: “if the lecturer treats the lecture as an hour to read as many pages of notes as possible, then lecture capture is useless”. If the teaching session is simply an “information push” then students may see little benefit in attending in person when they can watch the same thing at home. Several students went further in offering ideas of the type of activities that make them value face to face sessions. These included in-class exercises and interactive elements, discussion and gapped slides. Although these are all simple activities and adjustments it seems that some teaching is still very much focused on a “traditional” lecture in which the lecturer talks and perhaps offers the opportunity to answer questions at certain points. Hence the (sometimes minimal) pedagogic changes which add value for student attendance are not always in evidence.

5 Discussion

Our overall findings relating to the way that students use lecture capture generally confirm previous results on technology use. Interestingly, this includes issues on which previous studies were divided (such as the effect on student note-taking) where our respondents were also observed to have differing approaches. The most significant point emerging is that students have diverse ways of using the resources provided by lecturers. Each of the students recognised the ways in which they learn best. Their responses indicate that they do not always manage to put into practice the strategies they know are best for their leaning, but that does not mean that they are ignorant of what those strategies are. In some case, such strategies might be viewed as general “best practice” (as in continuing to attend teaching sessions) but others are very specific to individual students (such as binge watching videos). As lecturers we should therefore be cautious about assuming that students are using the resources we provide in a particular way. Nor is it the case that “one size fits all” when it comes to learning strategies.

One interesting point merging is that the students do not want to be passive learners: several raised the issue of wanting to be able to contribute: to share, augment and comment on the resources provided. One specific example of this was the desire to link useful resources that they had found to relevant parts of the video and slides. Even more impressive was their desire to help the lecturer and future students by feeding back issues with the slides. This was offered in a spirit not of blame but of collective responsibility. It is true that these students were in their final year and thus more mature than students in lower years who might not be expected to have such empathetic views. But it is striking that they are keen to take responsibility not just for their own learning but in a more collegiate way. This contrasts with the views expressed by many staff who feel they must bear the full burden of being both subject expert and technology expert, and all associated risk [24].

The previous point is perhaps best summed up by the respondent who said that "staff are human too". Many students are perhaps more understanding and forgiving of the issues and pressures staff face than is often acknowledged. In contrast to this, the students felt that their own constraints were not always taken seriously by staff, as evidenced by statements such as "it may not be seen as much from the lecturer point of view". It is clear however that the competing demands on students time are far from "not much". The issue of job interviews raised by our respondents points to the gruelling process (sometimes five or six rounds) required for each position applied for. In combination with the travelling required to attend the assessments and interviews it is clear that even conscientious students face difficult time management decisions. Whether lack of empathy is the case or not (that is, do staff really hold such dismissive views of students' issues) is a matter for further investigation. However, anecdotally and through personal encounter it does appear that for many staff the overriding concern of "will they still come to my lecture" may not be fully considerate of the strategic decisions many students are forced to make.

6 Conclusion

Better understanding of our students can help in many ways. One way indicated by our findings is the practical issue of what we provide and how we provide it. For example, if students need off-line access or better indexing to particular sections of a video then these are practical improvements which could be introduced.

The work reported here also indicates that staff may not fully appreciate the constraints faced by the majority of students, perhaps envisaging the "ideal student" who is studying full time, has few extra-mural responsibilities and for whom competing academic demands should not be problematic if only they would manage their time better. At least, this appears to be the view of the students. Understanding these views better can allow us either to reassure students or, if they have foundation, to address how better support can be provided and how staff awareness can be improved. Teaching in a way that makes false assumptions is unlikely to result in the most effective learning and so addressing this is an important issue.

In future work we plan firstly to gather more data from students, looking in particular at students at different points in their studies to see if their maturity as people and in learning is an influencing factor. Secondly, we intend to explore further the suggested gap between the student perspective and that of teaching staff in order to better understand some of the themes emerging from the current work.

References

1. Blin, F., Munro, M.: Why hasn't technology disrupted academics' teaching practices? Understanding resistance to change through the lens of activity theory. Comput. Educ. **50**(2), 475–490 (2008)
2. Buckingham, D.: Beyond Technology Children's Learning in the Age of Digital Culture. Wiley, Hoboken (2013)
3. Chiu, T.K.: Introducing electronic textbooks as daily-use technology in schools: a top-down adoption process. Br. J. Educ. Technol. **48**(2), 524–537 (2017)
4. Clark, W., Logan, K., Luckin, R., Mee, A., Oliver, M.: Beyond web 2.0: mapping the technology landscapes of young learners. J. Comput. Assist. Learn. **25**(1), 56–69 (2009)
5. Conole, G.: Bridging the gap between policy and practice: a framework for technological intervention. J. e-Learn. Knowl. Soc. **6**(1), 13–27 (2010)
6. Conole, G.: MOOCs as disruptive technologies: strategies for enhancing the learner experience and quality of MOOCs. Revista de Educación a Distancia **39**, 1–17 (2013)
7. Conole, G., De Laat, M., Dillon, T., Darby, J.: 'Disruptive technologies', 'pedagogical innovation': what's new? Findings from an in-depth study of students' use and perception of technology. Comput. Educ. **50**(2), 511–524 (2008)
8. Copley, J.: Audio and video podcasts of lectures for campus-based students: production and evaluation of student use. Innov. Educ. Teach. Int. **44**(4), 387–399 (2007)
9. Czerniewicz, L., Brown, C.: Strengthening and Weakening Boundaries Students Negotiating Technology Mediated Learning. Taylor & Francis, London (2010)
10. Gorissen, P., Bruggen, J., Jochems, W.: Analysing students' use of recorded lectures through methodological triangulation. In: Uden, L., Corchado Rodríguez, E., De Paz Santana, J., De la Prieta, F. (eds.) Advances in Intelligent Systems and Computing, pp. 145–156. Springer, Heidelberg (2012). https://doi.org/10.1007/978-3-642-30859-8_14
11. Holbrook, J., Dupont, C.: Profcasts and class attendance-does year in program matter? Biosci. Educ. **13**(1), 1–4 (2009)
12. Holley, D., Oliver, M.: A private revolution: how technology is enabling students to take their work home. Enhanc. Learn. Soc. Sci. **1**(3), 1–31 (2009)
13. Jenner, M.: Is this TVIV? On Netflix, TVIII and binge-watching. New Media Soc. **18**(2), 257–273 (2016)
14. Karnad, A.: Student use of recorded lectures: a report reviewing recent research into the use of lecture capture technology in higher education, and its impact on teaching methods and attendance (2013)

15. Kirkwood, A., Price, L.: Learners and learning in the twenty-first century: what do we know about students' attitudes towards and experiences of information and communication technologies that will help us design courses? Stud. High. Educ. **30**(3), 257–274 (2005)
16. Margaryan, A., Littlejohn, A., Vojt, G.: Are digital natives a myth or reality? University students' use of digital technologies. Comput. Educ. **56**(2), 429–440 (2011)
17. McGarr, O.: A review of podcasting in higher education: its influence on the traditional lecture. Aust. J. Educ. Technol. **25**(3), 309–321 (2009)
18. Owston, R., Lupshenyuk, D., Wideman, H.: Lecture capture in large undergraduate classes: student perceptions and academic performance. Internet High. Educ. **14**(4), 262–268 (2011)
19. Prensky, M.: Turning on the lights. Educ. Leadersh. **65**(6), 40–45 (2008)
20. Russell, T.: The "No Significant Difference Phenomenon", 5th edn. The International Distance Education Certification Center, Chicago (2001)
21. Shank, G.D.: Qualitative Research: A Personal Skills Approach. Pearson Merrill Prentice Hall, Upper Saddle River (2006)
22. Sharples, M.: Disruptive devices: mobile technology for conversational learning. Int. J. Contin. Eng. Educ. Life Long Learn. **12**(5–6), 504–520 (2002)
23. Sinclair, J., Aho, A.-M.: Investigating the experience of moodle adoption through expert voices. In: Uden, L., Liberona, D., Feldmann, B. (eds.) LTEC 2016. CCIS, vol. 620, pp. 90–102. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-42147-6_8
24. Sinclair, J., Aho, A.-M.: Experts on super innovators: understanding staff adoption of learning management systems. High. Educ. Res. Dev. **37**(1), 158–172 (2017)
25. Thompson, P.: The digital natives as learners: technology use patterns and approaches to learning. Comput. Educ. **65**, 12–33 (2013)
26. Timmis, S., O'Leary, R., Weedon, E., Harrison, C., Martin, K.: Different shoes, same footprints? a cross-disciplinary evaluation of students' online learning experiences: preliminary findings from the SOLE project. J. Interact. Media Educ. (Des. Dev. Discipl. Spec. Issue) (13) (2004)
27. Van Manen, M.: Researching Lived Experience: Human Science for an Action Sensitive Pedagogy, 2nd edn. The Althouse Press, London (1997)
28. Walder, A.M.: Obstacles to innovation: the fear of jeopardising a professorial career. Br. J. Educ. **3**(6), 1–16 (2015)

Learning System Development

A Review of Approaches to Rethink Learning in Different Contexts

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Abstract. Learning systems during last decades are about to transform from isolated and specific singular ego-systems [30] with closely defined and clearly measurable learning-inputs and – outputs into networked environments for guidance and innovation, to develop holistic competences and to create future as social development. Connecting interdisciplinary contexts, larger amounts of very heterogeneous learners from formerly independent cultural contexts and developments, and building on technology and digitalization, they become a specific cultural space and environment of their own [36]. Traditional learning-scenarios are called into question and new cultures of learning are formed. Also, boundaries between science and organizations weaken and dissolve. This paper pursues to use the potential of combining theories of learning and change, to analyze innovative learning-approaches, to separate the contrast of incremental (sustaining) versus disruptive innovations and to use examples from the contexts of academic, vocational and organizational learning-processes.

Keywords: Learning system · Innovation · Learning technology
Learning theories · Theories of change · Learning-scenarios · Multi-stakeholder
Interdisciplinary learning environments · Learning in networks
Learning networks

1 Introduction

Learning systems are about to develop towards national or even global networked environments for learning-processes, using real life problems as motivational tasks and connecting heterogeneous stakeholder from various systems, aiming at the development of holistic and interdisciplinary competences to co-create knowledge and shape new cultures of learning. They become broader scope training programs, use new technologies and real-life business cases, and this breaks up former boundaries and generates a wider heterogeneity. Such learning environments provide a framework and a repertoire of conscious and unconscious practices, enable collaborative action, and shape culture [2]. Consequently, this challenges traditional approaches, and transforms processes of learning and teaching. It requires workforce re-skilling and a re-definition of core-competences, a toolbox of digital and analog devices, and media literacy of all

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parties involved; it also needs to consider a theoretical framework which combines different angles of view on processes of learning and change.

This paper pursues to analyze which kind of skills and competences learners and teaching and supporting staff need to gain additional benefits from innovative learning scenarios. Therefore, it will use the potential of combining adequate theories of learning and change (Sect. 2), to discuss and analyze the role and pedagogical quality of technology and digital tools and the importance of collaboration and network (Sect. 3) to create innovative learning-approaches, which can be analyzed as being disruptive or incremental (Sect. 4). As boundaries between science and organizations will get weaker, Sect. 5 will give a review on recent approaches of innovative learning scenarios in the contexts of academic, vocational and organizational learning-processes. It will go into some of them in more detail, to separate and discuss the contrast of incremental (sustaining) versus disruptive innovations.

2 Combining Learning Theories to Reach Emergent Concepts

To analyze different approaches as "new forms of education […] beyond literacy and numeracy, to focus on learning environments and on new approaches to learning for greater justice, social equity and global solidarity" [38, p. 3], it seems promising not to focus on singular theories, but to combine theories that look at these complex processes from different angles. Gregory Bateson's Learning Theory [1], George Siemens' Connectivism [32] and Otto Scharmer's Theory U [31] provide a framework which combines the implementation of cognitive processes of a raising awareness of contexts [1], a (not only technological) redesign of how we teach, learn and come to know [32] and modes of learning by sensing and actualizing emerging future possibilities [3]. Connecting these different ways to cope with learning and knowledge and heterogeneity, could lead to emergence and be of great value to discuss recent and find new strategies to turn (ego-) learning scenarios into (eco-) learning-systems.

All of the above listed theories brought about various forms of learning- scenarios, all of them aiming to innovate and enhance learning-settings, to include more contexts and stakeholder and to "activate our capacity to lean into the emerging future [to…] cultivate curiosity [and] compassion". Nevertheless, they emphasize or focus on different aspects of learning, use different lenses to look on learning-processes and the development of knowledge. Depending on the organization and their learning goals, the innovations concentrate on specific contexts of learning and generate different models of learning scenarios and -environments. So, for example MOCS are mainly used by universities, while CAPS (Community Awareness Platform Strategies) are examples for learning-scenarios which aim to develop strategies for political, economic, and social change [4]; U.Labs, which base on Otto Scharmer's Theory U focus on organizing global professional movements of consultants, change agents and educational actors, while in Living Labs (ENoLL n.d.), urban areas serve as technology-assisted research environments, where user co-create urban artifacts and local services. All of the mentioned examples can be seen as different stages of movements from isolated ego-systems of either academic research or vocational education towards learning-eco-systems, where stakeholder from all connected systems co-create strategies for innovation and trigger social-ecological transformation (compare [35]).

3 The Role of Learning Technology and Digital Tools for Learning-Environments

The internet as an ubiquitous infrastructure for communication and coordination, multiplies the heterogeneity within learning-environments once again. It connects formerly independent developments of various cultural contexts, which now mutually reinforce, interdigitate and influence each other. Here, specific digital cultural spaces and environments emerge.

Digitalization offers plenty tools to connect learning communities situated in different local places, but also crucially change the environment where learning-processes take place. This raises the heterogeneity within the system and defines a new learning culture. Distance learning environments do not mean only literally locations. This paper defines environment: *the composition of learning scenarios (traditional classroom-lectures; various forms of blended-learning; e-Learning without presence sessions), forms (collaborative, cooperative and autonomous, individual learning), elements and tools constituting these different scenario (software, hardware, learning-platforms, social networks), and the heterogeneity of participants, here understood as the mix of different (learning) cultures.*

MOOCS, CAPs, U.Labs and LivingLabs (see section two) are recent examples which re-think learning-environments, to “innovate and reinvent the existing model of online learning” (Scharmer [34]). They represent approaches of innovative learning-settings and –scenarios and implement a well-designed and reflected inclusion and combination of digital tools. The environment defines which tools, be them analogue or digital, will constitute additional benefits for both, learners and guiding teachers. According to Professor Handke [11] they vary on a scale between mere augmentation of traditional settings and a complete virtualization, while it is of crucially importance to decide if and how to convert elements and actions of teaching into digital forms [11] - carefully and adapted to different affordances. Due to fast paced innovations in technological solutions, they are permanently changing and enhancing, and it is crucially important to see them as tools which serve to support and enhance learning-scenarios and didactics – flexible and exchangeable - and not as a fixed solution itself.

In accordance with the above mentioned theories and their different angles of view, some “digital tools”, like E-Portfolio, Weblogs, or LMS (Learning Management Platforms), focus on Didactics, and mere cognitive “solutions”, while others, like Agile Project Management, or SCRUM, or Design Thinking, focus on innovation, imagination and creativity. Blended (or Inverted) Scenarios are examples how scenarios can be re-thought, combining elements from analog and digital settings. The most important purpose of blended learning is, to offer opportunities for learners by using different methods to become self-sustaining, sustainable, and developing throughout life so that the present and future learning become more effective, more efficient, and more interesting [39].

As educational innovations, learning technologies offer new opportunities to learn, to generate and manage knowledge and abilities related to “real life problems”. They can also be differentiated according to their referenciality, communality and algorithmicity [36]. While referenciality allows individuals to become an active (constitutive) part of a socially negotiated, established, and shared meaning based culture, specific forms of communality alter, adapt and transform them into new synthesis and emergence [36]. Algorithmicity transforms unmanageable crowds of data and information into forms and dimensions which can be handled by human perception. They make information accessible, create preconditions for a capacity to act and create new dependencies [36].

3.1 Pedagogically Good Digital Material

In Fig. 1, criteria of pedagogically good digital material are presented, basing on empirical findings. The figure is based partly on the studies made by [29] and Reeves [26] and the thoughts of Naaranoja, Niemelä and Ilvesoksa [22]. The criteria can be traced also from the usability studies of Nielsen [23, 24] and the dimensions of the sense making of Jonassen [17, 18].

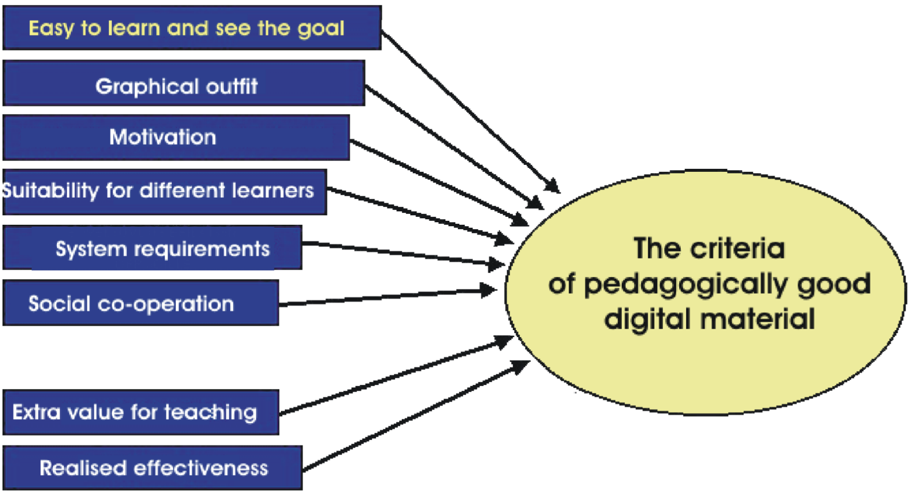

Fig. 1. The criteria of pedagogically good digital material.

The issues are not in an order of importance. However, one can claim that the easiness of seeing the goal and learning to use the environment are one of the most important criteria. Suitability for different learners mirrors the different learning styles of individuals and the different prerequisite knowledge levels. Digital material that takes care of social co-operation viewpoint contains for example (1) motivating the group behaviour, (2) engaging in the prepared learning environment, (3) supporting multimodal discussions [15]. The digital material of a course enables the student to take varied learning paths according to the skills of learners. Realized effectiveness of learning reveals the quality of the learning material. The digital material also provides extra value for teaching.

3.2 Collaborative Innovation Management

Successful innovation management in learning-scenarios requires teamwork and creative learning as well as transcultural strategies of knowledge creation in all fields of education, professional praxis, collective learning and development. It bases on digital media and networking strategies and challenges not only students but also the teaching (and learning) staff. There are still many challenges in creating the digital learning environments. Some of the challenges have to do with pedagogical implementation, technical support, and teachers' increased workload, and some with low budget. A joint development of learning technology environment is important since [11]:

- It is waste of time to produce similar materials all over the world. This is especially important for small countries like Finland and Germany.
- Joint efforts can lead to better start ups with greater resources, both financial and knowledge
- Pedagogical implementation can be improved by using the vast experience into consideration already in early phases
- The workload can be divided
- Knowledge management can be improved by co-operation between multi-stakeholders, like teachers, researchers and vocational- or field-experts
- Co-operation between business line and educational institutes is improved simultaneously
- Technical innovations may be utilized in a larger scale.

The most crucial aspect in regard to effectiveness is that the digital material should support the evolving of the co-operation skills. Co-operation is needed also to support the learning process. At this point it can be helpful to develop the competence to see problems from different angles.

Reviewing literature on recent approaches, we did not yet find any open access teaching material that is built on the idea to utilize team-based learning.

The literature recognizes the following type of teaching staff collaboration methods: Agreeing how to approach the issue from different angles (e.g. Inter-disciplinary teaching strategies for mental health law [14], joint observation [21], using students in teaching team [27], parents helping to learn [3], project based learning support [28] and distance learning supporting team [9]. The important factors in teaching teams are the right collection of expertise, team work ability and enough time for team to collaborate.

4 Efficient and Sustainable Learning Innovations

4.1 The Learning System Innovations

Technology based innovation during last decades have been mostly linked with digitalization. Various forms and models of MOOCs like xMOOCs (Augmentation – see [12]), cMOOCs (following Connectivism, see [34], but also numerous combinations and variations (compare [33] and [34]) as well as digital learning platforms and digital games are examples of technology based innovations. The less talked innovations that require technology might be laboratory tasks where a more developed system is constructed in order to give the learners a possibility to understand a complex environment, or to simulate real business tasks. To make technology-based innovation efficient and sustaining requires not only an understanding of how to use technology, but also of the context(s) of the learned issue, and of the herewith connected and therefore required process of learning.

When we pursue to link the business in education it is important to understand the business case but also to understand the process of learning. When we use real life challenge in education, the challenges are even larger, as companies not only need to know the students' ability to work, but also have to know how to motivate the students to find data, to learn skills and to develop competences. In all the above cases, one single person is seldom a virtuous in all the required areas. Especially talking about complex tasks and activities, requires various experts, like topic-experts to help students to solve the given problems and to acquire the needed theoretical knowledge, and communication-experts to teach the students how to communicate the results for the companies.

4.2 Disruptive Versus Incremental (Sustaining) Innovations

Donaldson [7] differentiates between innovations being sustaining, and innovations being disruptive. While sustaining innovations base on existing approaches and/or models, and try to improve those, disruptive innovations do not aim to improve something, but represent innovating system of its own and – at least in the beginning – often are just easier to handle, more cost-efficient, and often even of lower quality than established ones. But due to an easier usability and lower costs they sometimes succeed to improve and then to reach a quality on a higher level than those of the systems being or becoming dispersed. But on the other hand, if such disruptive innovations are not able to reach a high quality fast enough they run into danger to be »absorbed« by the traditional systems which hinder the innovation to be-come disruptive, by integrating it in the existing system. Many approaches of Online- Settings and E-Learning-Scenarios are examples of changing possible disruptive approaches into sustaining, respectively incremental innovations, when organizations use technological tools, to improve their teaching- and learning-settings, to reach more and/or new customers (compare Siemsen [34]).

Although innovation sometimes involves a discontinuous shift, most of the time it takes place in an incremental mode, often used in quality development. As disruptive or new-to-the-world innovations are only 6–10% of all innovations projects, the contribution shows, how cumulative gains in efficiency can be much greater over time than the ones based on singular or occasional radical changes [37]. The contributions show, how disruptive innovations like MOOCS don't catch on with mainstream users until quality catches up to their standards [5]. All of the above listed examples of innovative learning settings and scenarios (MOOCS, CAPs, U.Labs, LivingLabs) support vision-creation and planning, the increase of access, and mutual learning of stakeholders [19], but they use different ways (basing on the learning-theory they are connected with) and different angles of view to re-think learning-environments, to "innovate and reinvent the existing model of online learning" [30].

Therefore, educational innovations in the digital age will be discussed according to the specific qualities of disruptive and incremental innovations (like the use of technology, their linking of different contexts/stakeholder, their learning design, or their method of measuring/defining success) used in education. Table 1 can be used to discuss and compare them to each other.

Table 1. The learning system innovation may be either disruptive or incremental

	Disruptive innovation	Incremental innovation
Technology based innovation	MOOC	Sharing knowledge in learning platforms Learning games Inverted-/flipped classroom scenario
Linking business in education	Real life business challenge in education	Use of business case in education Shift from input/output orientation to throughputs
Learning setting/scenarios	Completely virtualized scenarios	Blended learning; inverted settings
Assessment/testing/measuring results	Competence Fields instead of measurable criteria	Shift focus from input-/output-orientation to throughputs (from … to process)

5 Examples of Current Digital Learning Programs and -Scenarios

There are plenty of learning programs that EU has been funding and many of the results are publicly available. The following examples show efforts on different levels and from different contexts to develop the skills of teachers and share stories of successful use of new technologies. In Sect. 5.4 some of them will be described in more details to explain their analytical correlation to the above table.

5.1 Examples of Learning for Children

We have selected four different kind of learning programs to represent information technology use in learning.

- The MENTEP[1] (MENtoring Technology-Enhanced Pedagogy 2015–2018) "project addresses the need in Europe for teachers able to innovate using ICT in their classroom and for improved data on teachers' digital competence. Based on this premise, MENTEP investigates the potential of an online self-assessment tool to empower teachers to progress in their Technology-Enhanced Teaching (TET) competence at their own pace" [20].
- The eTwinning[2] action was launched in January 2005. Nowadays, eTwinning offers a platform for staff (teachers, head teachers, librarians, etc.), working in a school in one of the European countries involved, to communicate, collaborate, develop projects, share and, in short, feel and be part of the most exciting learning community in Europe [8].
- Innovative Technologies for Engaging Classrooms, iTech[3] 2011–2014 [16] main results were a scalable scenario-led design process for developing digital pedagogy; the Future Classroom Toolkit and accompanying training provision; an extensive library of Future Classroom Scenarios, Learning Activities and Learning Stories Living Schools Lab[4] that is open to be used by everybody.
- There are digital learning games for children in the internet done by companies[5].

5.2 Context University

Universities all over the world innovate the learning material development. The list represents some types of development efforts in Finland and Germany:

- Finnish applied science universities have created open society named DIGMA[6] where everybody is able to use and further develop the joint learning material [6].
- real life business cases are used in Finland e.g. in the Kykylaakso Bio-Hub[7] at Applied Science University of Tampere, where the students have started companies and collaborate with several companies and authorities.
- at Vaasa University of Applied Sciences and Novia have collaboratively organized so called tandem[8] teaching where the Swedish speaking students learn Finnish and Finnish speaking students learn Swedish. This can be seen as a teaching method where the focus has shifted from input-/output-orientation to throughputs. Tandem, as a method for learning languages, was first used in Germany and France in 1963. Tandem language learning have in common is the fact that there are people with different native languages who cooperate according to the principles of reciprocity and autonomy.

1 http://mentep.eun.org/.
2 https://www.etwinning.net/en/pub/index.htm.
3 http://itec.eun.org/web/guest/home.
4 http://lsl.eun.org.
5 http://www.oppijailo.fi/lapset_ja_nuoret.
6 https://moodle.amk.fi/.
7 http://tamk-blogi.tamk.fi/tehokas-ja-kaytonnonlaheinen-bptn-kulttuurikylpy/.
8 http://www.puv.fi/fi/study/news/korkeakoulutandemilla_kieli_haltuun/.

- in Germany, the Philipps University is a traditional "brick and mortar" university where Jürgen Handke, Professor of English and Computational Linguistics, developed and implemented the Virtual Linguistics Campus (VLC)[9], the world's largest e-learning platform for linguistics and his "Inverted Classroom Mastery Model" [11].
- oncampus, a subsidiary company of the Fachhochschule Lübeck, Germany, took further steps by not only developing solutions to implement digitalization into their offers for their "traditional" students but also a completely virtualized "World of Learning"[10] for their students as well as for different other target-groups.

5.3 Context Vocational and Organizational Learning

Vocational and organizational learning all over the world is pursuing to improve the learning methods in order to make learning agile and efficient. The list represents some types of development efforts in Finland and Germany:

- the BKK Akademie[11] in Rotenburg, Germany is the corporate educational institution for apprenticeship, and corporate vocational learning programs for the (recently roundabout 80) company-health-insurance-funds in Germany (in German BKK is BetriebsKrankenKasse). Recently they are about to redesign their concept of apprenticeship, and corporate vocational learning programs, by employing an educational scientist, to re-think, re-develop, conduct and evaluate a future-oriented and sustainable learning concept seen from a perspective of lifelong learning, a raising heterogeneity and digitalization.
- use of a mobile application in Finnish and German vocational schools has supported the idea that mobile learning supports workplace learning (Virnes et al. 2017).
- in Finland there is a Business mentors association[12] which organizes voluntary persons, business mentor who are willing to share their expertise and experiences with new or old entrepreneurs.
- Yleisradio Ltd., the Finnish broadcasting company organizes different kinds[13] of blended learning activities especially collective learning activities annually. The purpose of these activities is to enhance adoption of a more multimedia- and user-centered mindset within the organization. They use different kinds of pedagogical practices in these learning events, such as group discussions, artefacts, stories, coaching and user testing, the purpose of which was to build the participants' capability to plan multimedia projects and develop their expertise. The practices and artefacts of the agile teams together constructed the epistemic culture and knowledge construction system of the domain.)

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9 http://linguistics.online.uni-marburg.de/qualify/certified_courses_direct.html.

10 https://www.oncampus.de/.

11 https://www.bkk-akademie.de/.

12 http://www.botniamentors.fi/briefly-in-english.

13 https://yle.fi/aihe/artikkeli/2017/08/28/yle-perustaa-journalismin-akatemian-ja-vahvistaa-tutkivaa-journalismia).

5.4 Analyzing Approaches in Regard to Being Disruptive or Sustaining Innovations

Table 1 can be helpful to discuss and analyze approaches of innovative learning-setting. This will be shown, using examples of the above listed approaches:

The Learning Platform World of Learning[14]
In regard to the technology based innovation, oncampus can be described as disruptive development, it changed the idea of eLearning as additional offers into a completely virtualized version of MOOCs which vary on a scale between free courses and courses liable to pay costs. This is also a disruptive-innovative way to link business in education, bringing together learner and trainer from various stakeholders and organizations and using completely virtualized scenarios. Also, the Assessment and Testing is a disruptive development, ranging from badges and training certificates up to Bachelor- and Master-study-degrees and offering different solutions for a large scale of learning-processes and interests.

The BKK Akademie in Rotenburg/Fulda, Germany[15]: Re-thinking Apprenticeship and Vocational Learning and Corporate Vocational Learning Programs
The idea of changing the concept of learning-offers by including elements of eLearning, offering digital tools to support self-organized learning and to switch scenarios towards blended- and inverted settings is an incremental innovation which includes the experiences of different learning places (in Germany apprenticeships take place partly in the organizations, partly at vocational schools, and for the apprentices of company health insurance funds additionally at the BKK Akadmie as corporate educational institution). Re-thinking and redesigning the concept of education not as an "inhouse-solution" but by including theories and the experience from educational science by employing an educational scientist from "outside the system", to build networks with other organizations (from academic and from vocational systems) can be described as a disruptive innovation which links educational science with business, and which aims to develop and evaluate new holistic methods of learning, teaching and testing for a target group with a raising heterogeneity and permanently changing learning-demands (in regard to content, but also to methods and competences).

Teaching Language in Finnish Universities
The idea of teaching Swedish or Finnish by making the students to teach each other is disruptive at applied science university context while a student is able to be at the same time master of his/her own mother tongue but then on the other hand learner in the other language and in addition is able to learn at the same time some general concepts when talking about his/her own subject field to somebody who comes from another field. Though the method has been used earlier when teaching exchange students the use in applied science university is disruptive.

The collaborative learning material creation at the best is incremental when large working groups share the learning material and the given resources are small. The

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14 https://www.oncampus.de/.

15 https://www.bkk-akademie.de/.

totally new way of teaching in large teacher teams from many different universities might be difficult.

Finnish Vocational/Organizational Context
The company based teaching scenarios can be disruptive development when the new networking with other learning organization give new ideas for the company development. The vocational schools in Finland are fighting with too little resources and this has created challenge to develop new ideas but in this kind of setting it is challenging to be more than incrementally innovative.

6 Conclusions

Joint efforts provide a possibility to develop network-based learning-environments, -scenarios, and material. The consortiums motivate and encourage to continue the efforts, though a sound digital material is a challenge and the link between material and the use of it is only a part of the challenge. The other challenges are in creating well modified projects to support a highly heterogeneous group of learners in institutions and organizations with different teaching goals and to support the learning of different disciplines.

The current strategies of building up more and more complex learning contents with business-based problems need even more collaboration with teachers and scientists and new types of strategies to develop these learning-eco-systems where stakeholders from all connected systems co-create strategies for innovation and trigger social-ecological transformation.

We need more research on the collaborative, multidisciplinary teacher and student teams that teach and learn in different settings. The teaching team needs to learn to share knowledge and create joint programs that supports project and research-based learning.

References

1. Bateson, G.: The logical categories of learning and communication. In: Steps to an Ecology of Mind, pp. 279–308 (1972)
2. Becker, L., Montiel Alafont, F.J.: Warum in interkulturellen Projekten das wahre Leben tobt. In: Becker, L., Gora, W., Wagner, R. (eds.) Erfolgreiches Interkulturelles Projektmanagement, Düsseldorf (Symposion) (2015)
3. Business mentors (2018). http://www.botniamentors.fi/briefly-in-english. Accessed 16 Mar 2018
4. Buick, D.: Interdisciplinary team teaching to support twenty-first century learning skills. J. Initial Teach. Inquiry **2**, 28 (2016)
5. CAPS Initiative: Collective Awareness Platforms for Sustainability and Social Innovation. Hg. v. European Commission (2017). Online verfügbar unter https://ec.europa.eu/digital-single-market/en/collective-awareness. zuletzt geprüft am 09 Mar 2017
6. Christensen, C.M., Raynor, M.E., McDonald, R.: What is disruptive innovation. Harvard Bus. Rev. **93**(12), 44–53 (2015)

7. DIGMA: Open digital material (2017). https://moodle.amk.fi/?lang=en. Accessed 30 Dec 2017
8. Donaldson, J.: Massively open. How massive open online courses changed the world. [North Charleston, South Carolina]: [CreateSpace Independent Publishing Platform] (2013)
9. eTwinning: eTwinning platform (2017). https://www.etwinning.net/en/pub/index.htm. Accessed 30 Dec 2017
10. Gibbs, G.R., White, S.: Going the distance: supporting a teaching team to move to distance learning. A Case Study. How ready are academics for the 'Only Connect'world? (2014)
11. Grzega, J., Schöner, M.: The didactic model LdL (Lernen durch Lehren) as a way of preparing students for communication in a knowledge society. J. Educ. Teach. **34**(3), 167–175 (2008). https://doi.org/10.1080/02607470802212157
12. Handke, J.: Patient Hochschullehre. Vorschläge für eine zeitgemäße Lehre im 21. Jahrhundert. Tectum Verlag, Marburg (2014)
13. Handke, J.: Handbuch Hochschullehre Digital. Leitfaden für eine moderne und mediengerechte Lehre. Tecum Verlag, Marburg (2015)
14. Handke, J.: Konstruktive Disruption statt Evolution (2016). https://www.youtube.com/watch?v=b7Eg_7jD_6M
15. Hanson, L., Fitzpatrick, R., Abo-El Ella, S.: Inter-disciplinary teaching strategies for mental health law. Int. J. Law Psychiatry **39**, 1–5 (2015)
16. Hauan, N.P.: Learning science in interactive exhibitions. Frameworks for design and evaluation of material for exploratory learning experiences. Doctoral dissertation (2017). http://hdl.handle.net/1956/15590. Accessed 21 Mar 2018
17. iTech: Innovative Technologies for Engaging Classrooms (2017). http://itec.eun.org/web/guest/about. Accessed 30 Dec 2017
18. Jonassen, D.H.: Supporting communities of learners with technology: a vision for integrating technology with learning in schools. Educ. Technol. **1995**, 60–63 (1995)
19. Jonassen, D.H., Land, S.M. (eds.): Theoretical Foundations of Learning Environments. Lawrence Erlbaum Associates, New Jersey (2000)
20. Silvo, I.: Journalismiakatemia (2018). https://yle.fi/aihe/artikkeli/2017/08/28/yle-perustaa-journalismin-akatemian-ja-vahvistaa-tutkivaa-journalismia. Accessed 10 Mar 2018
21. Juujärvi, S., Pesso, K.: Actor roles in an urban living lab: what can we learn from Suurpelto, Finland? Technol. Innov. Manag. Rev. (2013)
22. Learn and enjoy (2018). http://www.oppijailo.fi/lapset_ja_nuoret. Accessed 20 Mar 2018
23. MENTEP: MENtoring Technology-Enhanced Pedagogy (2017). http://mentep.eun.org/home. Accessed 30 Dec 2017
24. Mtika, P., Robson, D., Fitzpatrick, R.: Joint observation of student teaching and related tripartite dialogue during field experience: partner perspectives. Teach. Teach. Educ. **39**, 66–76 (2014)
25. Naaranoja, M., Niemelä, R., Ilvesoksa, O.: Lessons from the development of computer based learning environment in Finland. In: BEAR Conference (2002). (Unpublished paper)
26. Nielsen, J.: Advances in HCI, vol. 5. Intellect Publishers (1995)
27. Nielsen, J.: Usability Engineering. Academic Press, New York (1993)
28. Nokelainen, P., Tirri, H.: In Verkko-opetuksen sisältötuotanto osatutkimuksen tilanne (2002). http://dll.hamk.fi/dl/dl1/index.html. Accessed 29 Oct 2002
29. Reeves, T.: Evaluating What Really Matters in Computer-Based Education (1994). http://www.educationau.edu.au/archives/cp/reeves.htm
30. Rosenfeld, B.: Team teaching buddies: Student teaching in the era of edTPA (2015). http://digitalcommons.uconn.edu/cgi/viewcontent.cgi?article=1003&context=nera_2014

31. Ruggiero, D., Boehm, J.D.: Project-based learning in a virtual internship programme: a study of the interrelated roles between intern, mentor and client. Comput. Educ. **110**, 116–126 (2017)
32. Saarinen, J.: Verkko-opetuksen sisältötuotanto osatutkimuksen tilanne (2002). http://dll.hamk.fi/dl/dl1/index.html. Accessed 29 Oct 2002
33. Scharmer, C.O., Käufer, K.: Leading from the Emerging Future. From Ego-System to Eco-System Economies, 1 edn. Berrett-Koehler, San Francisco (2013). (A BK currents book)
34. Scharmer, O.: A global action leadership school in the making. In: The Huffington-Post (2014). http://www.huffingtonpost.com/otto-scharmer/reordering-from-within_b_5038368.html. Accessed 26 Mar 2014
35. Siemens, G.: Connectivism. Learning conceptualized through the lens of today's world. Online verfügbar unter (2007). http://www.elearnspace.org/presentations/connectivism_online_OCC2007.ppt. zuletzt geprüft am 09 Feb 2014
36. Siemsen, S., Jansen, R.: Connectivism and interactionism reloaded: knowledge networks in the cloud: a theoretical approach to a shift in learning through connectivism and MOOCs. In: Uden, L., Sinclair, J., Tao, Y.H., Liberona, D. (eds.) LTEC 2014. CCIS, vol. 446, pp. 1–12. Springer, Heidelberg (2014). https://doi.org/10.1007/978-3-319-10671-7_1
37. Siemsen, S.: Learning, knowledge and competence in global online-universities: how terminology shapes thinking. In: Uden, L., Liberona, D., Welzer, T. (eds.) LTEC 2015. CCIS, vol. 533, pp. 28–42. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-22629-3_3
38. Siemsen, S.: Universities in the present age. In: Tagungsband DGFE 10 Internationale Jahrestagung Organisation und Netzwerke. Universität Hildesheim (Upcoming 2018)
39. Stalder, F.: Kultur der Digitalität. Suhrkamp Verlag, Berlin (2016)
40. Tidd, J., Bessant, J.: Managing Innovation: Integrating Technological, Market and Organizational Change, 4th edn. Wiley, Chishester (2009)
41. UNESCO: Rethinking education. Towards a global common good? UNESCO Publishing, Paris (2015). http://unesdoc.unesco.org/images/0023/002325/232555e.pdf. Accessed 21 Oct 2017
42. Wahyuningsih, S., Satyananda, D., Ghosh, A.: Implementation of blended learning innovation in graph theory application course to face the education challenge in the 21 st century (2018)
43. Salmela, E.: Korkeakoulutandemilla kieli haltuun (2014). http://www.puv.fi/fi/study/news/korkeakoulutandemilla_kieli_haltuun/. Accessed 12 Jan 2018
44. Weber, S.: Organisationsnetzwerke und pädagogische Temporärorganisation. In: Böttcher, W., Terhart, E. (eds.) Organisationstheorie in pädagogischen Feldern - Analyse und Gestaltung, pp. 253–269. VS Verlag für Sozialwissenschaften, Wiesbaden (2004)

Design and Application of a Creative Strategy Based on the Method of Problem-Based Learning (PBL) in Engineering Students

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Abstract. This document describes the implementation and results of the method: problem-based learning (PBL), conducted at the Faculty of Engineering of the "Universidad Distrital" (Colombia), as a strategy that encourages creative skills in students. Initially a theoretical and referential framework is developed, associated with traditional teaching, ABP, ICT and creativity in the classroom. Subsequently, an approach to the existing problems is carried out in a case study: course of applied mechanics, belonging to the area of design and manufacturing in engineering. This proposal raises the evolution of the traditional teaching, currently practiced, to a methodology that allows greater participation and responsibility by students in their own learning and presents an opportunity to develop creative skills. Finally, it presents a series of statistics and observations derived from the results of this work.

Keywords: PBL · Creativity · Training engineers · TIC · Innovation

1 Introduction

Nowadays, the world is undergoing profound changes; environmental, economic and social changes, etc., in which the education sector is not alien. And this from the latter, where the engineering can play an important role by giving its contribution to solve the multiple problems generated. For this, they require awakening creativity of students, which is to be encouraged innovation, which translates into entrepreneurship, development of prototypes and practical solutions that improve the quality of life of people [1].

In this sense, universities, faculties, and especially engineering programs, have under-taken the task of generating both academic and administrative changes in order to meet standards of quality, quality accreditations, for which reason bother to form highly trained professionals, academic, scientific and technological, and creative, innovative and entrepreneurial [2].

Likewise takes greater importance the use of new technologies (ITC) that with an appropriate pedagogical approach [3], we can help teachers find new ways to teach, they banish bad rote knowledge and motivate the students, increase their interest and

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attracted by the learning and application of science. In this sense it collects greater importance the role of faculties of engineering, since become key stage to promote creativity, innovation, competitiveness and change, the context of which invites to analyze how to teach engineering [1].

This work was developed with students of the course: applied mechanics, which is called the mechanics of materials or strength of materials in mechanical, civil, mechanical engineering or related academic programs. The course has such as particularity a high repetition of students, very above the average of the other courses in the Faculty of engineering of the “Universidad Distrital”.

2 Theoretical Framework

Such as the manifest [4] the accelerated rhythm of change in science and engineering because the advances of technology and the challenges and identified trends that arise, make that high levels of adaptability and ingenuity is required for complement a strong knowledge of the domain and technical excellence in learning. Therefore, it is necessary to integrate the software tool to the pedagogy of the classroom, that is, the use of computers to carry out simulations, networking with the purpose that the student note, comment, study and ask questions/suggestions to the different exercises and project application and selection of mechanical elements. This type of technology can help motivate students to create developments that help the society in a specific problem, that, while not necessarily must be a high level of complexity, if it allows you to gather the tools, integrate them with put knowledge and propose an engineering solution.

In this sense, society demands the needing to be able to teach students to learn, to innovate, to generate products and effective responses. It is important to create an innovative college education that fosters teaching activities of quality and form students in skills and take them as the backbone in university education.

2.1 Traditional Teaching

The teaching through a traditional method as it is done in applied mechanics, is characterized by a work in which the teacher teaches a series of concepts, the student tries to assimilate them and at the same time they are evaluated by quizzes and partial. In this, the student is a passive actor, who only uses group work in some cases at the time of study for evaluations written from textbooks, and the notes taken in lectures. Thus, many leaders, academic and practical believe that traditional approaches in education, as a dependency in the textbooks, mass instruction, lectures and multiple-choice tests, are obsolete in the age of information. Therefore, raised differences in the roles of teachers, students and learning when a traditional or virtual methodology is developed. Figure 1, briefly illustrates a comparison of education TIC-based, with respect to the traditional [5].

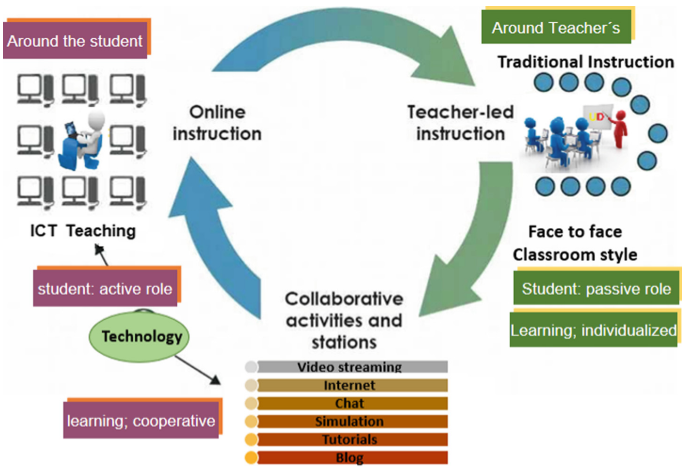

Fig. 1. Functions and interactions in traditional and virtual education [6]

2.2 Approach to PBL

The PBL (problem-based learning) is defined as a methodology focused on learning, research and reflection that students follow to reach a solution to a problem posed by the teacher.

Usually in the educational process in engineering, the teacher explains a part of the subject, and for the evaluation of a final percentage of subject, propose a work in which students must apply the knowledge acquired on the subject during the semester. In this sense the PBL is presented as a methodology so that students acquire the same knowledge received by means of a master class (fictitious problems) but now acquire them and apply in from a real problem solving. Authors how [7] define the PBL as “a method of learning based on the principle” to use problems as starting point for the acquisition and integration of new knowledge. In this methodology, the protagonists of learning are the students themselves, who assume the responsibility of being an active part in the process.

Thus, the PBL helps the student to develop and work diverse competencies. Between them [8], highlights: problem solving, story decisions decision-making, teamwork, communication skills (argumentation and presentation of information) and the development of attitudes and values: accuracy, review, tolerance…” This methodology favors the possibility of interrelating subjects or academic disciplines, in which students work in small groups. To try to solve a problem, the students can (and it is advisable) need to resort to knowledge already gained in different courses. This helps students to integrate their learning [9] into a coherent “whole”.

2.3 Conceptual Approach of Creativity

The term creativity through the years has received various interpretations, of course different depending on the field of action to which it is intended to apply, so much so that [10] describe the concept of creativity as “extremely versatile” and “by its own nature, resists being bounded by the usual definition system" [10]. Other authors say that; creativity is a term that depends on the perspective that is conceived, for many authors, this can be defined from various points of view, some usually it defined as skill, aptitude, ability, and many others as a process for resolution of problems or as a result of something new [11]. For his part [12], think that creativity as a result of the original and new, summarized the relevant definitions that are shown in the Table 1.

Speaking of creativity also it is necessary to differentiate it from other concepts that can generate confusion. As it is the case of concepts: imagination and innovation. In this regard, Robinson emphasizes the difference between imagination, creativity and innovation. For him, the imagination is the ability to evoke in the mind things that do not arise from our senses or as Robinson explains, "Imagination is the ability to bring to mind the things that are not present to our senses" [13]. Thus, it is possible that the imaginations not come into the real world. Creativity, on the other hand, means to do something. "To call someone suggests creative are actively producing something in a deliberate manner." People are not creative in the abstract; they are creative in some […]. Creativity is to put your imagination to work. In a sense, the creativity is applied imagination" [13]. Under this perspective, this defines innovation as the process of the implementation of new ideas. According to the author, the innovation is applied creativity.

Table 1. Definitions of creativity (Adapted from [12]).

Author	Concept
Roger (1972)	The activity that makes arise to a new product of relations that proceed, on the one hand, the individuality of the person and, for another, 28 from materials, events, people or circumstances of his life
Mirabent (1980)	It is the ability to produce and communicate new information in the form of original products
Wallis (1987)	Disposition towards promotion, activation and assimilation of external encouragement that promote the receptivity of new ideas
Fromm (1989)	It is the manifestation of the individual, who has done things that his previous experience was not relationated yet, finding the result of their stimulating and rewarding
Steiner y Gary (1992)	It is the ability to develop and implement new and better solutions
Feist (1999)	It is the conduct of original models or beings accepted by the community to resolve situations
De la Torre (2000)	Ability and attitude to generate new ideas and communicate them
Lowenful y Lambert	It is the conduct of original models or beings accepted by the community to resolve situations

2.4 Creativity and ICT in the Classroom

The generation of today of engineering students has been found immersed in a digital world since birth. So much that are considered 'digital natives', by which the use of ICT tools and immersive environments, facilitates the appropriation of knowledge and creative capacity. According to Cárdenas Guerrero, "one of the advantages that have ICT for the student in the creative development process is that it can feel that you are having fun and playing, while the produce and learn effectively" [14]. Therefore, the teaching-learning process must evolve to train engineers creative, able to work in different fields, tackle work unpredictable in the future due to the conditions of the environment and technology, and able to take decisions. Many consider that the human being is, by nature, creator, but it has to be developed, has grown; In short, it has become progressively himself to integrate into a world subjected to a process of continuous change, where no longer enough learn the elaborate culture, they everywhere are demanding new answers to urgent problems [15].

As mentioned TIC should be introduced into the classroom and mix with traditional teaching to facilitate the incursion of the student in the creative environment, in the "learn to learn" to be every day more competitive in nowadays global market [16]. Indeed, the awakening of creativity in students is an essential in the development of a country since it influences the social and technological level of its habitants.

University education is usually very inflexible, rigid structure in terms of teaching methodologies, therefore increasing the question of: how can be able to encourage the creativity of their students? A set of factors that contribute to developing creativity as a child can be enumerated: the educational climate of the class, the attitudes of the teacher, the didactic methodology, the resorts and techniques; In short, it should teach thinking. With this intention, many authors have formulated a series of relevant questions to the pedagogy of creativity, to be present, namely: providing minimum information to get creative products; is created, but not in a vacuum, having contact with the working material can stimulate the creative imagination; provide techniques to express your thought, your imagination, your creativity…; creating situations and motivating activities; lead to observation and reflection in order to cause the creation; awakening an attitude of search, curiosity, desire to know…

2.5 Creativity and Innovation in Engineering in Colombia

Different authors have addressed the issue to identify the reasons why not encourage these competencies in the engineers. Such as is the case of [17] who need to use creative strategies that contrast with the traditional ones in order to achieve greater motivation in students, in such as a way that the learning process is more stimulating. Others state that it is the type of engineer graduated of the University who influences the way of generating creativity and innovation of their trainees, due to universities are not homogeneous.

There are high quality and reputable national and international universities, but also there are "garage", usually of low costs and that for reasons of market moving to the best quality [18]. Therefore, according to [2] the teacher tends to reproduce teaching methods which has received in his training, which does not favor the search for innovative approaches that allow give the prominence and dominance of the teacher to the students. Then, so that there are not changes in the teaching and learning of engineering model, this continues to perpetuate obsolete ways of teaching that do not respond to the needs of current demanding socio-economic environment.

The Table 2 shows the endogenous and exogenous factors that affect positively or negatively on the education of engineers in Colombia. They recommend, that to have a positive stage in 2020 should be undertaken actions such as: incorporate methodologies based on creativity and innovation in the processes of training of engineering, insertion of teachers in training of high level (Master's degrees and doctorates) related to innovation, creativity and entrepreneurship that allows to improve cognitive skills and practices in these areas, the formation of engineers promoting critical and creative capabilities that make them address the real problems from diverse perspectives, resulting in a wide range of possible solutions. It is about engineers school develop other skills, like creativity and teamwork.

Table 2. Variables that impact positively or negatively on the education of engineers in Colombia [2]

No.	Description
1	Conception and quality of curricula, pedagogy, laboratories, facilities and management problems
2	Creativity, innovation and entrepreneurship viewed as elective courses and not as part of the process of formation
3	Engineer training is guided towards solving problems "in a creative way"; However, that creativity is not promoted in the process
4	Lack of knowledge or techniques and methodologies oriented to creativity, innovation and entrepreneurship
5	Outdated and a little bit relevant programs with the needs of the country and global competitiveness
6	Teacher in the process of formation of high level
7	Improvement of the academic curriculum
8	Downgrade of engineers, non-renewal of knowledge (license of by life against periodic renewals)
9	Brain drain, personal in formation of high level not returning to the country

3 Method

Research correspond to a kind of qualitative research, make descriptive records of the phenomena that are studied using techniques such as participant observation and interviews not structured; that is to say, the researcher is an observer of the reality where occur events.

3.1 Context of the Research

The course has groups that have on average 40 students, time intensity of 4 h per week to masterclasses of exhibition type and 4 laboratory practices. Both theoretical training and practice are evaluated through different instruments, being the most used: quizzes, partial, workshops of exercises of textbooks and the final work for the application of the themes seen in the semester. To this should be added the needing to develop excessively long classes to get closer to the goal of representing the student exercises moderately clear and understandable and, in most cases, the teacher has few curricular time [19]. In addition, few times students do collaborative work group, due to the traditional teaching methodology or the teacher explains the theme, proposes and solves exercises from textbooks and the student in their autonomous working hours is dedicated to solve of exercises and study books guide or partial resolved related thematic leaving aside the search of a solution to simple everyday problems or perhaps engineering.

According to the work titled: "the process of recognition of teaching and learning methods 2014" carried out by the program of industrial engineering of the Universidad Distrital (Fig. 2a), in almost all areas of the work of the teacher tool It is the board and marker (traditional teaching); the eight areas in which program, it shows that there are missing audiovisual resorts or another methodology that helps the development of the class that is subdivided. Although the fact that the course in question possesses laboratories (belongs to the area of design and manufacturing) allows students to understand a little more the phenomena.

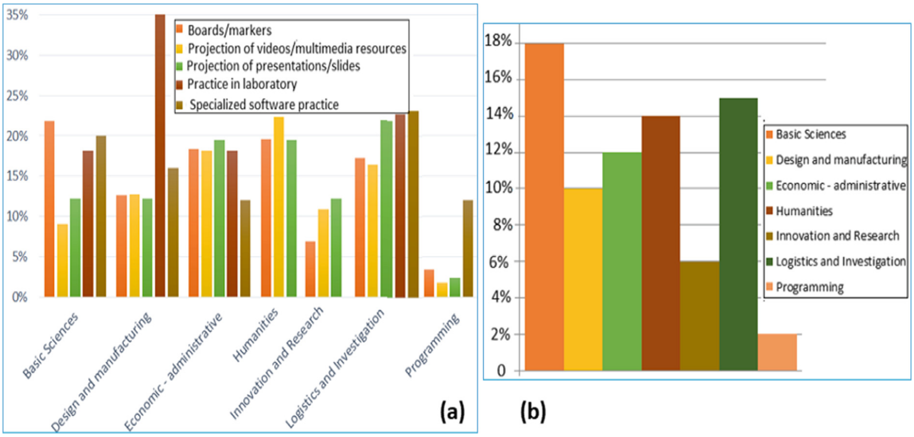

Fig. 2. (a) types of strategies of teaching in Engineering Industrial UDFJC. (b) collaborative works by academic areas in Industrial Engineering, UD source: process of recognition of methods of teaching and learning-2014

Likewise, it was shown that teachers of Engineering Industrial use few collaborative work and strategy study and innovation of improvement for students (Fig. 2b) and although the work is used in all areas as form of final evaluation of their courses, this is for the application of the concepts seen in class, but not is one innovation of some process or phenomenon, neither produces or encourages creativity to propose solutions to the real world in many cases.

3.2 Strategy Implemented in Applied Mechanics

For this project for integration of ICT and PBL in the pursuit of creativity and innovation in students, it was created a virtual course of applied mechanics is integrated with traditional teaching. The General characteristics of the phases of learning of the development of the course with virtual support are made in the following way (Fig. 3a). The first phase called of recognition consists of create contexts and environments for which the student is involved in the initial processes of learning. The second phase, deepening is to create situations and activities conducive to the appropriation of concepts; the last called of transference are situations and activities designed to be added values of productivity to the knowledge that is learned. This integration is known as b-learning, allowing integrating also the hours of direct work (master classes), collaborative working hours (consultants online or face) and hours of autonomous work (by the student).

In this work were used various technological tools, such as: an online course that was designed by the Moodle platform v2.0 (contains videos of development of exercises of the themes seen in class, summaries of slides in PowerPoint (for each thematic block, books and related articles, software for the development of engineering problems and its collaborative works of the semester); a design software Solidworks (to create in 3D and simulation, static and dynamic); multimedia applications available on the web (problems of physics simulators); web sites (video channels in which student can appreciate the settlement of exercises similar to those developed in class), software, FEA, (analysis simulation of elements of the planned design).

3.3 Planning Process PBL

The topic to be addressed is the problem of mobility of people in the city of Bogota (Colombia) through a device in which at least three people can be transported, and also it has to be friendly with the environment through a redesign or design innovation. For their part, students work in small collaborative 6 student groups where they acquire knowledge, acquire responsibilities, solve conflicts themselves that group for the achievement of the objectives of a work engineering real.

This planning allowed define the course of mechanics applied as one where it was possible to integrate courses such as: engineering drawing, materials engineering, mechanical and chemical processes; enabling needs of students who, in many cases, fail to see the implementation of these.

Were raised as objectives of the implementation of the PBL during the semester: know and calculate the components of power transmission (pulleys, chains, gears, screws, between others.) for industrial use, to define criteria for design, appropriate material for a device for transport of people friendly with the environment; and highlight the aspects of innovation and sustainability of the proposals. So we have that student should observe, to try and understand; based on this understanding should devise a solution to the observed situation, it should be design taking into account the restrictions, and it can materialize it in a functional prototype [20].

The phases of the development of the methodology of the PBL project (Fig. 3b) begins with the stage of observation and understanding of the problem as a stimulus for learning, in which it is necessary that all team members understand the problem; so the teacher can attentive to the discussions of the groups and, if some particular topic requires special attention, discuss it with all groups in common. The following steps within this stage up to the definition of the problem in particular by the Group of students, seeks students to propose the problem brainstorming to solve, they show conceptions they have and that others should learn.

The next stage called design is where students carry out the process of design of the device to the accompaniment of the teacher, teacher's advice different in the course depending on the design of the device to design, group discussions, allocation of tutoring of students and application of the proposals formative assessment and assessment of media and resorts. The group will have the requirement to put in evidence aspects of innovation and sustainability of the proposals that incorporate ICT in their development.

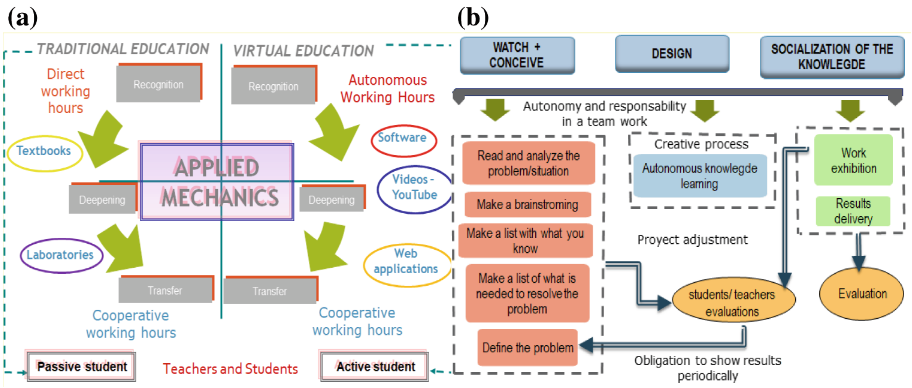

Fig. 3. (a) Phases of learning in the course of applied mechanics (B) Stages of project development

The last stage called socialization of knowledge, the student had to simulate the draft prepared in the software, as well as drawing up plans and more visual forms that facilitate their understanding and analysis. Also covers the phase of formal evaluation (written/class), which intends to change of paradigms in which the "perfect" student already is no who gets a good score in the final exam, product of learn rote, concepts and equations (traditional learning) if not the "perfect" student is that who has acquired the needing knowledge from the collaborative work and autonomous. Likewise, it has developed its creative and innovation for the development of a product that solve a real problem of the society.

4 Results

The Fig. 4, shows the work of groups of students, in which is displayed the prototypes designed to taking account of: The normativity existent in transit and transportation in Colombia, environmental, quality, ergonomics, ASTM, ICONTEC; the efforts and deformations which will be submitted each of the constituent elements of the products of different loads and reactions that will be submitted. The same calculations must use to profiles with commercial dimensions. Most of the designed prototypes are promoted by its occupants. The power transmission is carried out by: trains of gears, drive chains and gears, toothed time and synchronous belts. In some cases, energy is provided by an electric motor that will help boost the prototype depending on the ground conditions. In the Fig. 4b and c are showing examples an analysis of finite element analysis (FEA) and other dynamic simulation software Solidworks for the case of loads, efforts and displacement in the rear train of the prototype and the simulation of transmission of movements.

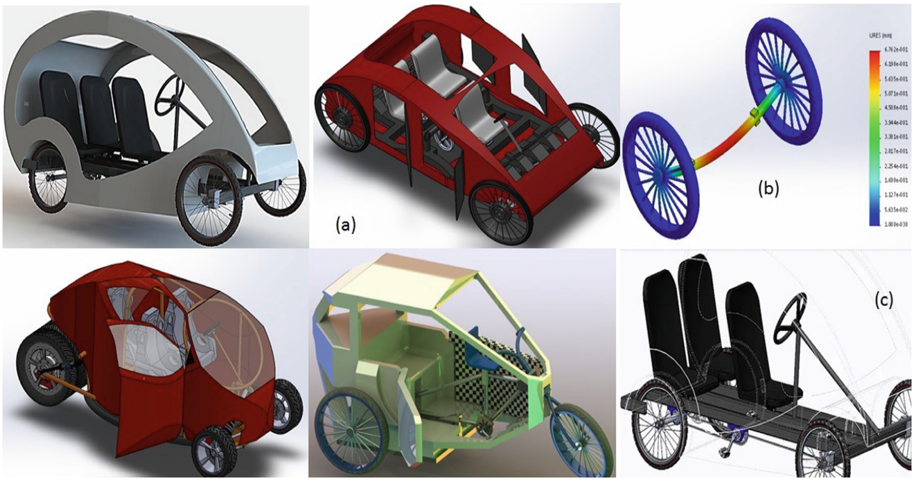

Fig. 4. (a) Result of collaborative final prototype (B) (c) analysis of dynamic finite element static analysis source: students of applied mechanics 2017-I

In order to evaluate the results of the application of the methodology as learning strategy was instrumental in gathering information. It was organized in 4 blocks of questions covering: pedagogical-didactic aspects, aspects related to the organization of the project, the level of learning of theoretical content, procedures of evaluation of the course and recommendations or observations.

It was investigated to identify what are some consequences generated by traditional education. Most manifest to be good relatively, but it has certain shortcomings evident in Fig. 5a, which origins monotony, lack of interest, lack of applicability of theoretical concepts, between other. Summarizing, the lack of application of theoretical concepts leads to think that it needs to energize the process of teaching of the course with the incursion of other methodologies that awaken the creativity of students and encourage greater degree of satisfaction in the learner.

The Fig. 5b shows the distribution of response, with regard to the question options: do you consider that in this work acquired a major appropriation of knowledge and development of its creativity? The highest percentages, 52% and 32% respectively, were observed fairly and fully in agreement. Evidence, methodological change is good to promote creativity and give opening towards new ways of solving real problems that lead the student to act in their professional field. Thus, the uses of new strategies help to counter the problem of students not be active in their learning, motivated by the traditional models of teaching and, above all, because it is not appreciated the usefulness of this learning for performance in the examinations; as these normally reward learning rote or mechanical. Finally, Fig. 5c, shows that students are satisfied with the methodology (ICT, virtual course, PBL, collaborative work). The percentage of dissatisfied is only 7% of the sample. They also express that the methodology should be used in other engineering courses.

To be a pilot project of application only for a semester, showed good academic results (Fig. 5d). All students finished the course, although some reproached it. In the period of application of the PBL (2017-I), the results were better than in previous semesters. It is worth mentioning that in periods (I-2016 and 2016-II) looks an improvement since they began to implement ICT in the classroom, but without a methodology specific. The score average obtained in the year 2014 and 2015 (only traditional teaching) was 3.2; in the year 2016 (incursion of ICT) was 3.39; and in the period 2017-I (PBL, ICT pilot project) was 3.72.

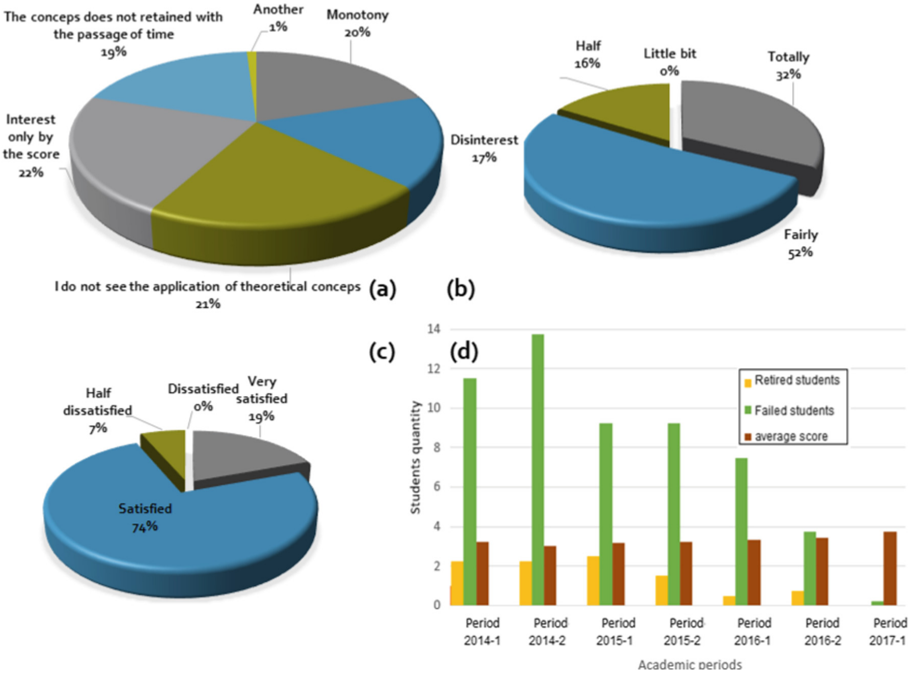

Fig. 5. Some results from the survey: (a) Consequences of the methodology of teaching traditional (b) PBL improves creative skills (c) Satisfaction with the methodology used (d) Statistical period 2014–2017 for 4 courses of 40 students in average

5 Conclusions

The PBL method provides students aspects to manage knowledge, such as: the search for relevant information to solve the problem, study or review themes seen previously that found no application in time; also it teaches them guidelines to work collaboratively, but with the collaborative group work (constructivist model) does not warranty that students work collaboratively, since the members of the group may think that it is better distribute work to then join the parts of everyone in a final report (traditional teaching).

It is possible to start a change in the methodology of teaching-learning process, by other that foster creative skills and self-learning in students, not only in the course of mechanics applied but in other industrial engineering program, Because, usually the teacher tends to reproduce teaching methodologies received during their training. The result of the pilot shows the PBL a better academic performance of students with respect to the methodology in which the teacher exposed subjects and exercises in class (traditional) and satisfaction of teachers involved in the process of collaborative work orientation.

Although we obtained very good results in this method implementation PBL in engineering students, was also obtained information that shows the needing to differentiate the characteristics of each course, previous posts learning and possible modeled trends evolutionary method PBL, around the promotion of creative skills and independent learning of students, in order to make the student an active participant in the learning process and enabling the transformation of the teacher as a Manager of learning.

References

1. Acofi: Asociación Colombiana de Facultades de Ingeniería. Encuentro Internacional de Educación en Ingeniería (2016). https://www.acofipapers.org/index.php/eiei2016/2016/schedConf/presentations. Accessed 04 Apr 2018
2. Gazabon, D.: Creativity, innovation and entrepreneurship in the training of engineers in Colombia. A prospective study. Rev. Educ. en Ing. **10**(19), 90–104 (2015)
3. Esquembre, F.: Fislets: enseñanza de la física con material interactivo. Pearson Educación, Madrid (2004)
4. Litzinger, T.: Engineering education and the development of expertise. J. Eng. Educ. **100**(1), 123–150 (2011)
5. Arias, A.: Educación a distancia y educación virtual: una diferencia necesaria desde la perspectiva pedagógica y la formación del ser humano. Rev. Investig. UNAD **9**(3), 205–220 (2010)
6. Contreras Bravo, L.E., Rodriguez Molano, J.I., Tarazona Bermudez, G.M.: B-learning and big data: use in training an engineering course. In: Tan, Y., Takagi, H., Shi, Y. (eds.) DMBD 2017. LNCS, vol. 10387, pp. 221–233. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-61845-6_23
7. Barrows, H.: A taxonomy of problem-based learning methods. Med. Educ. **20**(6), 481–486 (1986)

8. De Miguel, M.: Modalidades de enseñanza centradas en el desarrollo de competencias. Orientaciones para promover el cambio metodológico en el Espacio Europeo de Educación Superior, Primera. Ediciones de la U. Oviedo, Oviedo (2005)
9. Servicio de Innovación Educativa de la Universidad Politécnica de Madrid, Aprendizaje Basado en Problemas (2008)
10. Diaz, H.: Tics, Talento y Creatividad: la escuela y el entorno. Desafíos de la educación en el Siglo XXI. http://educared.fundaciontelefonica.com.pe/desafioseducacion/2011/09/30/tics-talento-y-creatividad-la-escuela-y-el-entorno/. Accessed 06 Apr 2018
11. Camacho, I.: Desarrollo de la creatividad de los docentes en formación mediante el uso de metáforas en entornos virtuales de aprendizajes. Edutec **1**, 14 (2013)
12. Ramos, H.: Educadores creativos, alumnos creadores: Teoría y práctica, 1st edn. San Pablo, Bogotá-Colombia (2006)
13. Robinson, K.: Out of Our Minds: Learning to be Creative. Capstone Publishing Ltd, Mankato (2011)
14. Taranenko, O.: Creatividad y TICs : un reto en el aula - Actitudes y percepciones del profesorado de ELE en Islandia. Universidad de Islandia (2014)
15. Del Moral, M.: Las TIC en el ámbito educativo. Educar **1**, 33–52 (1999)
16. Ausín, V.: Aprendizaje Basado en Proyectos a través de las TIC. Una Experiencia de Innovación Docente Aprendizaje Basado en Proyectos a través de las TIC. Rev. Innovación Docente desde las Aulas Universitarias **9**(10) (2015)
17. Barcos, M.: Las estrategias creativas como factor de cambio en la actitud del docente para la enseñanza de la matemática. Rev. Univ. Investig. **4**(2), 10 (2003)
18. Moreno-Collazos, J.: Evaluación de la percepción de un grupo universitario de docentes frente a la educación como fenómeno social en Colombia. Rev. Electrónica Educ. **20**(3), 1 (2016)
19. Pineda, J.: E-moderating and e-tivities: the implementation of a workshop to develop online teaching skills in in-service teachers. Profile Issues Teach. Prof. Dev. **18**(1), 97–114 (2016)
20. Hernández, J.: Formación para la innovación con TIC: un proyecto conjunto facultad de ingeniería – empresarios. Rev. Educ. en Ing. **5**(9), 12–20 (2012)

Computer-Based Accessible Testing System for Students with Visual Impairments and Learning Disabilities

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Abstract. Print-disabled individuals (e.g., visually impaired and specific learning disabilities) rely heavily on accessibility features for information input. For students with print disabilities, lack of accessibility to printed material creates a barrier for getting appropriate education and taking standardized online tests. Although various accessible testing software exist in the market, there is no standardized accessible testing system for high-stakes state-mandated tests. In this paper we present the design, implementation and evaluation of an accessible testing system (ATS) for high-stakes state-mandated tests. We also present results from various pilot studies of ATS which prove its efficacy.

Keywords: Visual impairments · Learning disabilities
Accessible testing system

1 Introduction

According to recent statistics, 8.1 million Americans have partial or total visual impairment [4], and 2.4 million American public school students identified with learning disabilities [1–3], that prevent reading ordinary print material. We refer to these disabilities collectively as print disabilities. People with print disabilities are uncompetitive in today's high-tech, information-laden society. Fields of Science, Technology, Engineering, and Mathematics (STEM) are often closed to them [6,8,15].

Print-disabled students rely heavily on accessibility features for information input. For students with print disabilities, lack of accessibility to printed materials creates a barrier for getting appropriate education and taking high-stakes online tests.

Due to this lack of access, the unemployment rate among people with print disabilities is more than double their non-disabled counterparts nationwide [13,14]. Various studies put the unemployment rate among disabled individuals around 32% [5,12,14]. People with disabilities are also significantly underrepresented in STEM related fields [6–8]. In 2012, about 11% of undergraduate

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students and 7% of graduate students reported a disability [11]. This initial interest is rarely realized as an actual career in a STEM-related field. Further evidence of the shortage of individuals with disabilities in STEM fields comes from a National Science Foundation study finding that less than 350 persons with disabilities received Ph.D.s in Science/Engineering each year during the period 1999–2009 [10].

One problem in providing people with print disabilities equal access to STEM fields involves accurately conveying mathematical knowledge. Speech, which is frequently used, is problematic because of inherent ambiguities. To illustrate, consider the following simple algebraic expression: $\frac{1}{1+2}+2$. Typically, this expression is read aloud as: "one over one plus two plus two" but it is ambiguous with multiple interpretations (specifically, $\frac{1}{1}+2+2$, $\frac{1}{1+2}+2$, and $\frac{1}{1+2+2}$). This example is only one of a multitude of similar ambiguities inherent in conveying mathematical information aurally.

Another source inhibiting equal access involves rapidly producing audio renderings of mathematics based material. Current conventional audio interventions for students with print disabilities rely on the assistance of human readers or laborious by-hand human recording into digital media of tests, training manuals and other informational sources. Due to the expense and time-consuming nature of this work, many students receive books and tests 4–6 months after the print versions are available. Moreover, productive employment of people with print disabilities is hindered by the lack of rapid rendering of job-related mathematical and technical material.

Although various accessible testing software exist in the market, there is no accessible testing system available for high-stakes and state-mandated tests with a wide range of standardized accessibility features. The lack of a standardized accessible testing software for high-stakes and state-mandated tests makes it impossible for print-disabled students to pursue higher education and get better jobs. Identifying this need, a major testing company in United States, hired GH, a leading accessibility company, to develop a standardized accessible testing system for high-stakes and state-mandated tests. The author worked as a software engineer on this project. Due to the legal contracts the names of the testing company, state-mandated tests, and states where those tests were conducted may not be disclosed. In this paper, we will refer to the testing company as a major testing company. ATS pilot studies were conducted in two states. We will refer to these states as State A and State B.

ATS provides students with print disabilities greater access to standardized achievement, high-stakes and continuing education state-mandated tests. The high quality speech and accuracy of pronunciation, along with supporting documents and graphics provides a more productive and efficient testing mechanism as compared to current testing methods of a sighted person reading the test aloud, or prerecorded audio on digital media with no supporting graphic material.

This paper is organized as follows. In Sect. 2 we present the rationale behind the design philosophy of ATS and the accessibility features included in ATS.

Sections 3, 4 and 5 describe the technical details of implementation of ATS. Results from pilot studies and surveys are presented in Sect. 6. We conclude the paper by discussing future directions in Sect. 7.

2 ATS Feature Set

There are two sets of data which form the basis of the rationale behind the design philosophy of ATS. The first is based on State A mandated test study and the second on the collaborative work of Department of Education and assistive technology people of various states, and a major US-based high-stakes state-mandated testing company. The design decisions for the current ATS are based on the feedback obtained from the students and proctors in the State A study. Since students with different disabilities require different accessibility features, the cost of adding all of these features to online testing is infeasible. As a result the major testing company contacted various personnel including people from school districts, assistive technology, Department of Education as well as GH, to decide on the set of most common accessibility features. As a result of these discussions, the consensus was reached to include the following accessibility features in ATS: magnification, contrast change, read aloud and synchronized highlighting.

2.1 Basic Premise of ATS Application

ATS is an application similar in appearance to the testing software of the major testing company. It runs on Windows operating system and provides accessibility features to the end user. The ATS receives test data and state information (explained later in Sect. 3) from the testing software of the major testing company, renders the test for student using a variety of accessibility features, and reports the results and state information back to the database of the major testing company. The ATS runs 'inside' the software of the major testing company as a plug-in.

The main window of ATS consists of three areas: the top toolbar, the test content display area in the middle and the bottom toolbar. All of the features of ATS are accessible through mouse clicks and keyboard shortcuts.

2.2 ATS Screen

Figure 1 shows a typical screen shot of ATS. Following is a description of the top and bottom toolbars of ATS (Fig. 3).

2.3 ATS Accessibility Toolbar (Top Toolbar Buttons)

The ATS top toolbar is the Accessibility Toolbar, which provides the majority of the accessibility features to the user. Figure 2 shows the ATS Accessibility Toolbar. Following is a description of the various accessibility tools in this toolbar.

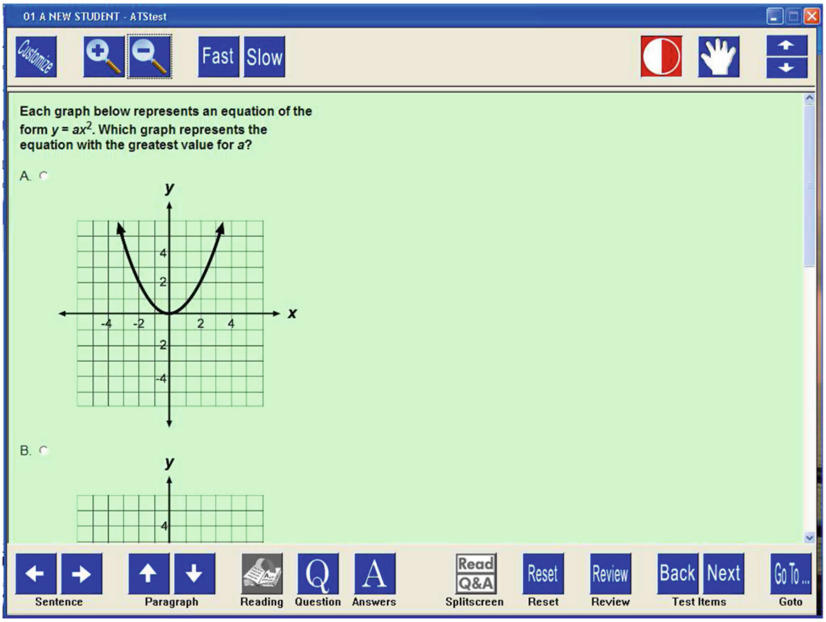

Fig. 1. ATS screen shot

Fig. 2. ATS Accessibility Toolbar

Fig. 3. ATS Testing Toolbar

Fig. 4. ATS Navigation Toolbar

Customize. This button opens the Customize dialog box, which allows users to select different accessibility features according to their needs. Currently the features that a user can select include text-to-speech (TTS) voice type, volume of TTS voice, rate of TTS voice, contrast colors and cursor size.

Zoom In/Out. This feature provides a variable level of zoom control to the user. There are two buttons for this feature (one for zoom in and one for zoom

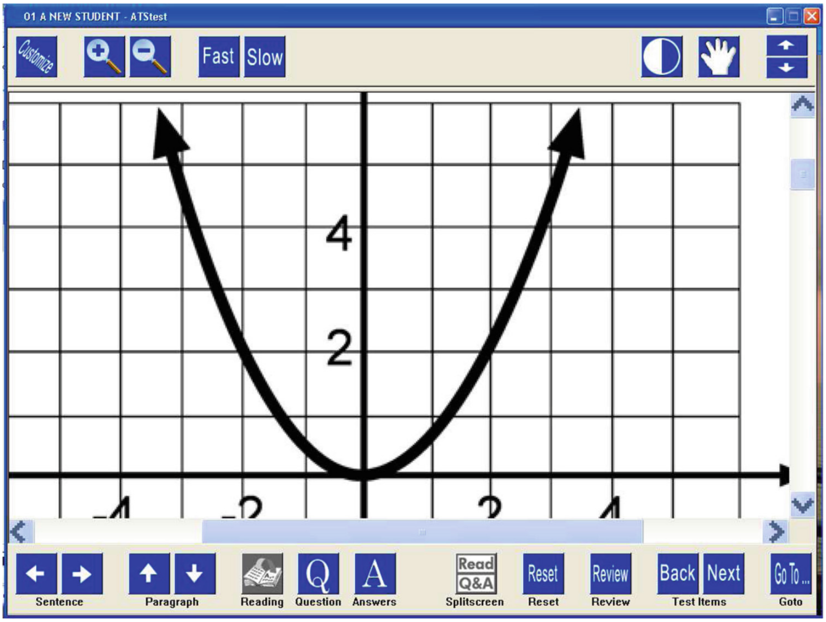

Fig. 5. ATS content at higher magnification

out). The different zoom levels used are $1\times, 2\times, 3\times, 4\times$ and $5\times$. Figure 5 shows the high magnification feature of ATS.

Speech Rate Control. The original design concept of ATS included two sets of voices. The first allows the text content of the test to be spoken and is called the Narrator Voice. The second allows the User Interface of the test to be spoken and is called the Application Voice. Currently we have implemented the Narrator Voice and are working on the implementation of the Application Voice. In the final version of the ATS the Speech button may actually involve two buttons (one for each voice) or two menu/keystroke settings to allow the student to turn each voice on or off as needed.

Contrast Switching. This button turns the high contrast scheme on or off. The contrast scheme allows the user to see differing colored text on a variety of backgrounds. The colors for the contrast control can be set per-user in the Customize dialog box. An example of these contrast presets is yellow text on black background with red sentence tracking and blue highlighting as shown in Fig. 6.

Tracking. This is a feature which provides synchronized 'follow the bouncing ball' word tracking for the student at a variable rate. The word tracking is

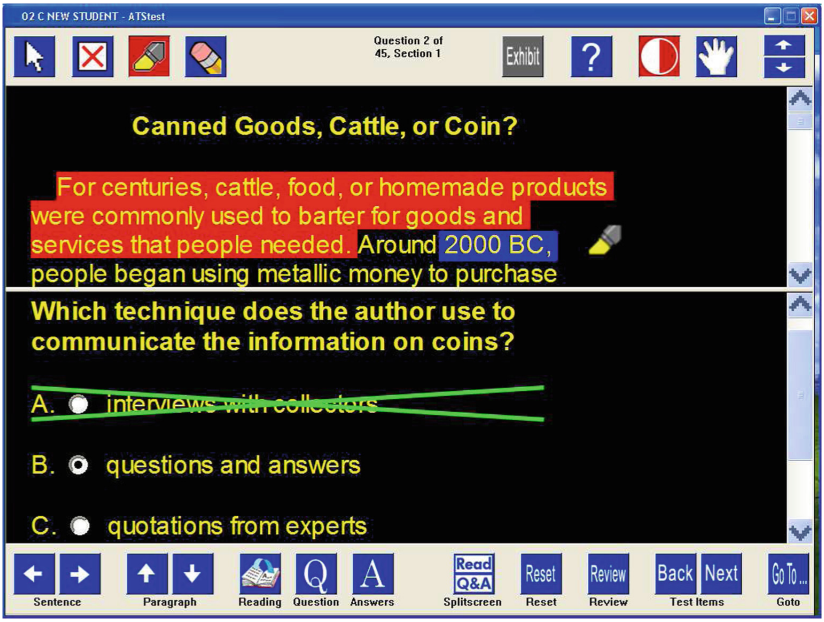

Fig. 6. ATS main window with high contrast settings enabled (Color figure online)

synchronized with the speech. Note that the color of the tracking element is designed not to interfere with the contrast settings. Currently, sentence-level tracking has been implemented, however, future versions of ATS will include word-level tracking as well.

Pan. This button allows the user to turn on and off the Pan hand tool, which allows the user to grab and move enlarged test content around.

Spin Dialog Button. The large button sizes were specially designed keeping in mind the needs of the targeted disability audience. This led to the problem of not being able to accommodate all the buttons including the Accessibility and Testing tool buttons on one toolbar. One alternative was to increase the size of the toolbar, however, this would have resulted in limited screen area to display questions. A compromise between keeping the screen area and the buttons larger was reached by creating a spin dialog button. This button alternates the top toolbar between the Accessibility toolbar and the Testing toolbar. Based on our experience with the intended disability audience, some of the most commonly used Accessibility buttons were also made available on the Testing toolbar in order to reduce the number of times a student may have to flip the top toolbar.

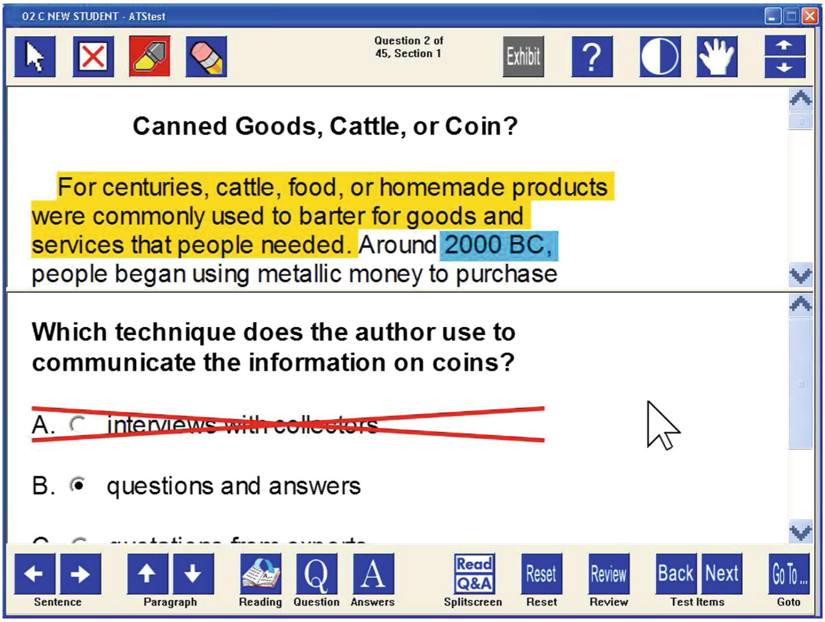

Fig. 7. ATS main window with sentence-level tracking, highlight, eliminated choice and large pointer cursor (Color figure online)

2.4 ATS Testing Toolbar (Top Toolbar Buttons)

The Testing toolbar contains the following buttons from the original software of the major testing company: Pointer, Eliminate Choice, Highlighter, Eraser, Exhibit and Help. Two of the most commonly used Accessibility buttons, Contrast Switch and Pan, were also added to this toolbar.

2.5 Test Content Area

The middle area displays the test content using current settings for magnification (zoom) and colors (contrast). Horizontal and vertical scroll bars will appear in the test content area when the size of the area is insufficient to contain the test content. Some test items use a common passage, such as a reading passage or poem. When the passage is first encountered (as the examinee proceeds through the test), the entire test content area is used to show it. When the examinee proceeds to the first test item that refers to the passage, the test content area is split into an upper area and a lower area. The upper area shows the common passage and the lower area shows the test item. The splitter bar that divides the upper and lower areas may be dragged up or down to adjust the relative sizes of the areas. Test content is read using TTS technology. The current sentence is visually indicated by the 'tracking' feature, which changes the background and text color. The tracking and reading aloud features may be enabled and disabled by the examinee via the Customize dialog.

2.6 ATS Navigation Toolbar (Bottom Toolbar Buttons)

The ATS bottom toolbar is the Navigation Toolbar, shown in Fig. 4, which provides the majority of the test navigation features to the student. Following is a description of various navigation buttons in this toolbar.

Next/Previous Sentence. This button allows the user to move back and forth between sentences when reading using sentence-level tracking and/or TTS. This feature is also available via simple and intuitive keystrokes. Note that as the sentence tracking happens the screen automatically pans to bring the current sentence in focus. As a result the students do not have to rely too much on mouse for panning, which is a difficult operation for students with disabilities. Figure 7 shows an example of sentence-level tracking.

Next/Previous Paragraph. Similar to the above feature, this button or keystroke combination allows the user to skip through paragraphs with sentence-level tracking and/or TTS.

Reading. This button allows the user to jump directly to the first sentence on the reading pane when working on a split-pane question involving a reading passage and question. This is very useful for individuals with disability since navigation is often a tedious operation for them.

Question. This feature allows the user to jump directly to the first sentence comprising the question.

Answers. This feature allows the user to jump directly to the first sentence comprising the answer. The combination of the above three features allows the student to quickly navigate a reading passage with multiple associated questions.

Split Screen. This button adjusts the visual display of a split-pane question in a series of cyclical stages. The first stage is the normal 50/50 split. Subsequent presses will cycle between maximizing the Reading Pane, maximizing the Question Pane, and back to a 50/50 split. If the user has dragged the splitter bar to a custom setting then pressing this button will reset the splitter bar at the default position.

Reset. This button clears the selected answer choice.

Review. This button selects an item for review.

Back/Next Test Items. This mouse/keyboard control allows the user to move back and forth between questions.

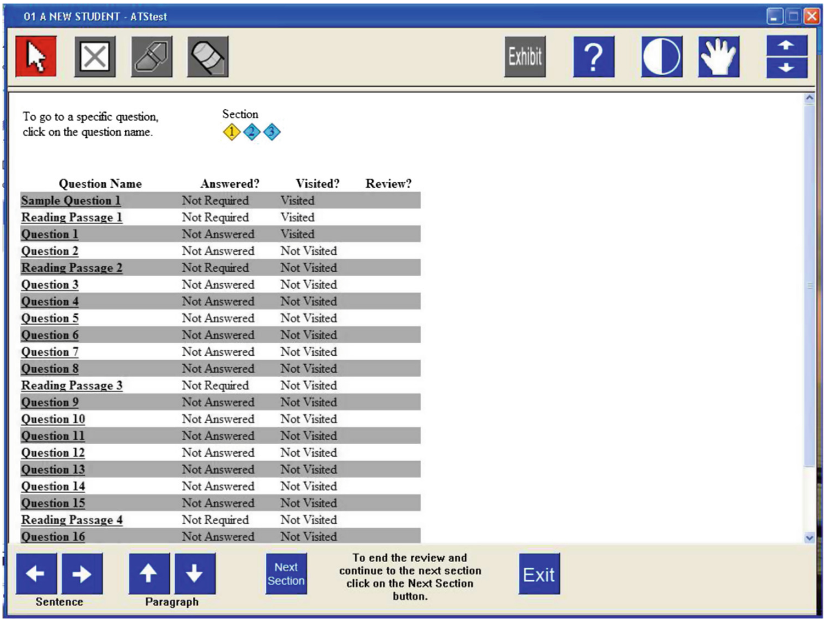

Fig. 8. ATS Review Screen

Go To. This button brings up the Review Screen. The student can navigate to a particular question or section while clicking on appropriate links on the Review Screen. The Review Screen also gives the status of the questions, for example, if they have been visited, answered or marked for review. All accessibility tools work on Review Screen as well. Review Screen has buttons, such as, Exit, Submit and Next Section related to exiting the test, submitting the test or navigating to the next section. A typical screen shot of the review screen is shown in Fig. 8.

3 Design and Development of XML Format for Test Content and Test Authoring Mechanism

One of the major differences in how the original testing software of the major testing company and ATS handle data is that the former displays a GIF image for each test item, however, ATS uses XML for test items. The XML format helps in marking up the test content with special tags for navigation and speech markup correction. The XML schema for question items is based on the IMS Global Learning Consortium's QTI (Question and Test Interoperability) specification.

There are two types of state information that are maintained for each question item, Tool State and Response State. The Tool State XML contains information about TTS rate, TTS volume, TTS voice type, contrast foreground color, contrast background color, sentence tracking foreground color, sentence tracking background color, highlighter color, eliminate choice 'X' color, zoom level, highlighted rectangular area coordinates, and eliminated choices. The Response state contains the answer selected by the student. For a multiple choice question it is the number of the item selected, while for a narrative essay type question it contains the text written by the student.

The Tool State and Response State XML data for each item is first cached locally in the computer on which test is administered and then at regular time intervals is sent to the database of the major testing company over network. This is done in order to restore the Tool State and Response State of each test item in case the locally cached copy is lost.

One of the important design problems from the user interface perspective was whether to apply a subset of the Tool State information of an item to each of the child windows of ATS such as the Exhibit Window and the Help Window. In order to reduce distractions to the student the following Tool state information was applied to all the windows and all the test items: zoom, contrast, TTS volume, TTS rate, TTS voice and cursor size. The intuitive idea behind this decision was that if a student selects a certain zoom, contrast or TTS settings then he would like to have the same settings applied to all the windows and all the test items.

A basic test authoring tool was also developed for teachers to author tests with graphics and mathematical expressions. Image authoring is done at sufficiently higher magnification to avoid distortion at higher zoom levels.

4 Resolution and Sizes

Low-vision students require extra large on-screen buttons. The ATS buttons have a minimum dimension of 56 pixels. For example, the Zoom In button is square and has a size of 56×56 pixels. A minimum size of 56 pixels agrees with the size of buttons in the GH Player, which is in regular use and well-accepted by the low-vision community. However, the large button sizes consume more screen real-estate. In addition, when a test item is magnified much less of the entire item shows on the screen. For these reasons, the ATS requires a minimum screen resolution of 1024×768. This screen resolution was also selected keeping in mind the graphical capability of the computers in the high schools where the major testing company normally conducts online tests.

5 Software Implementation of ATS

ATS is an ActiveX Control written in C++ using Microsoft Foundation Classes (MFC) and the Microsoft Component Object Model (COM). The testing software of the major testing company is written in JAVA. This software acts as a container which hosts the ATS control. COM is used to make cross language API calls from JAVA to C++ and vice versa. We used TeamDev's ComfyJ and JNIWrapper to create Java-C++ COM bridge enabling bidirectional communication between the Java application and the ATS C++ COM object.

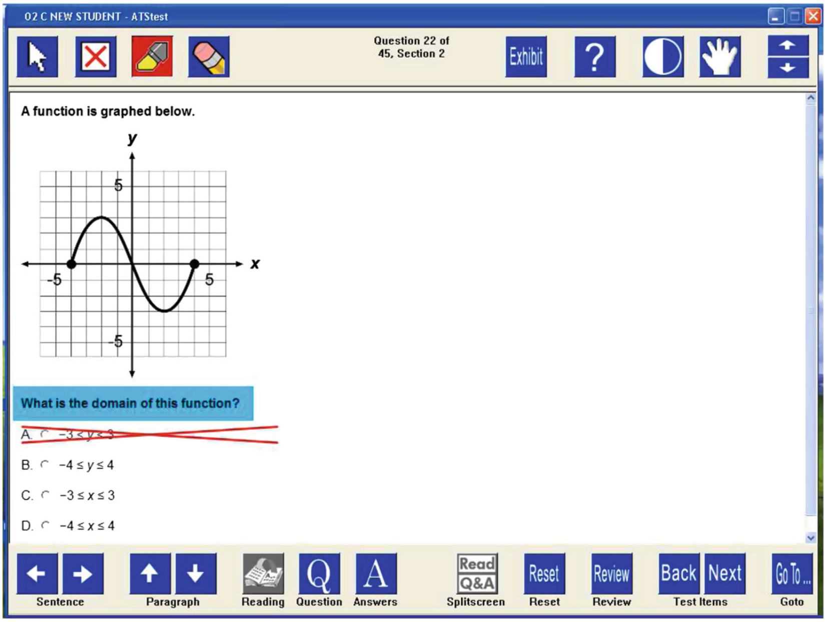

Fig. 9. A test item with an image (Color figure online)

ATS uses Internet Explorer (IE) for visual rendering of XML documents representing questions. It uses MSXML6.0 for parsing the XML documents. Microsoft Speech API (SAPI) 5.0 is used for TTS. SAPI is not intelligent enough to correctly pronounce context sensitive words, for example, it can't distinguish between the different pronunciations of the word 'lead' in the following sentence: how to lead with a lead pencil? Another example is a Chemistry test item which has chemicals such as NaOH. For these words the correct speech markup is added to the XML file to pronounce the words correctly.

In order to recolor images with contrast change, we use LIBPNG software library. Figures 9 and 10 show the recolored image under high contrast mode using this library. For compressing a test item into a binary large object (BLOB), we use ZLIB software library. Each BLOB represents one question item. The set of BLOBs forming the complete test is stored at the major testing company's database and then transmitted over the network to the ATS client at the time of the test.

One important feature of ATS is that it uses Design Science's MathPlayer to render mathematics from MathML. In addition, ATS uses MathSpeak [9] to voice mathematical expressions. MathSpeak is a formal language designed by GH to speak mathematics without ambiguity. Figure 11 shows a sample question with math content in it. Currently we transform MathML to MathSpeak in an offline way, but as a future direction online support for converting MathML to MathSpeak will be included with ATS.

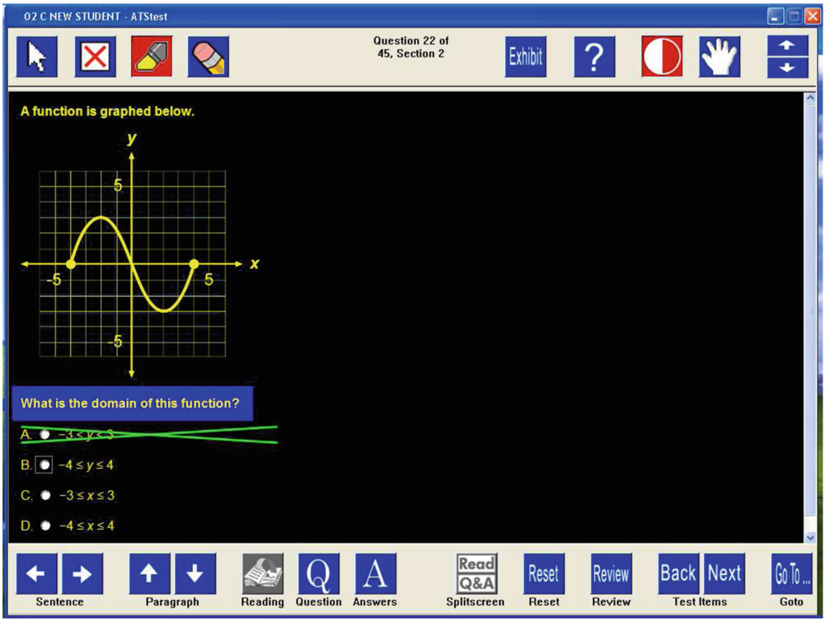

Fig. 10. A test item with an image in high contrast mode (Color figure online)

6 ATS Pilot Studies and Survey Results

In this section we present results from various pilot studies which provide evidence for the efficacy of ATS.

6.1 State A Study

Seven students from seven different high/middle/elementary schools with various kinds of disabilities participated in the first study conducted in State A. The same students participated in the next year's study as well. These students had a wide range of disabilities including vision disabilities, mobility impairments, cognitive disabilities and learning disabilities. There were no blind students in this study, however. One student was in grade 3, two in grade 4, one in grade 5, one in grade 6, and two in grade 8. The fact that ATS was tested and evaluated on students with a wide range of disabilities and grade levels, made the results of this test even more significant.

The students took a test on ATS and afterwards they were given a survey. The response from proctors was also collected through a survey. The survey results are explained below in detail. To sum up the responses, the students, their parents and proctors were head over heels for this product. During the first study, it was surprising to see that the students had much less problem in getting used to the technology than the proctors. During the second study in

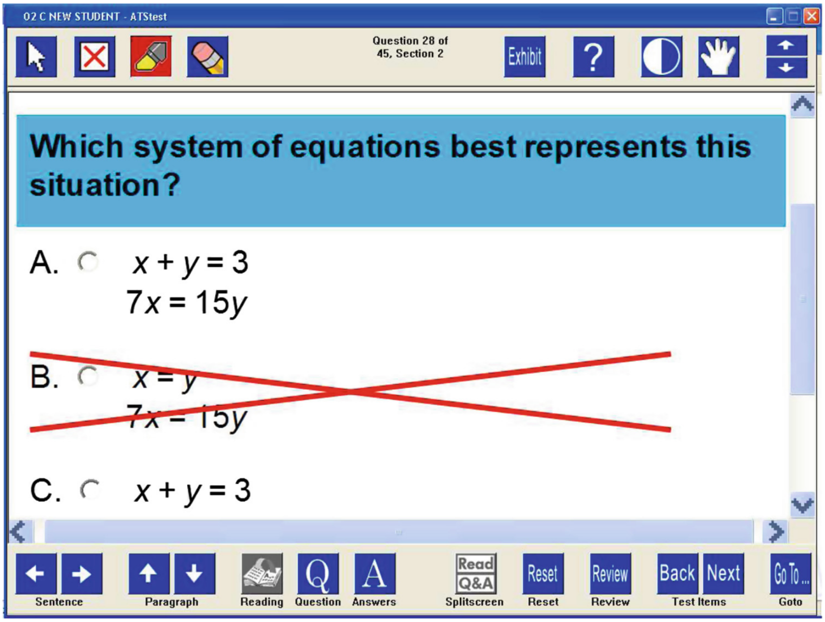

Fig. 11. A zoomed test item with mathematical content

the following year, the students remembered how to use ATS and did not need to be reminded of how to operate it. It might be worth mentioning here that the proctors had to be reminded of how to operate it. This again shows the liking of students for the product.

The survey consisted of six questions and a section for comments. There were three response choices, i.e., agree, no opinion and disagree. Some of the questions included in the survey and the student responses are as follows. Note that one student did not provide any response:

- I was comfortable taking State A mandated test on the computer:
  (5 Agree, 1 No Opinion, 0 Disagree)
- The computer system was easy for me to use:
  (5 Agree, 1 No Opinion, 0 Disagree)
- The questions, pictures and passages were clear and easy to see on the computer screen:
  (4 Agree, 0 No Opinion, 2 Disagree)
- The outside equipment that you plugged into the computer system (e.g., head mouse) worked properly with the system:
  (5 Agree, 0 No Opinion, 0 1 Disagree)

Some of the comments from the students are as follows:

- "It was very easy for me to read on the computer for the State A mandated test and math."

– “The first day I was a little bit scared but now I am happy about doing it. Who ever made this God bless them.”
– “It was easy to use.”
– “It talked too much.”

Some of the questions and responses from the proctor survey are as follows. There were seven proctors from five different schools.

– Students reacted positively to the computer-based administration of the State A mandated test:
(7 Agree, 0 No Opinion, 0 Disagree)
– The equipment of the computer-based test was easy to use:
(7 Agree, 0 No Opinion, 0 Disagree)
– Students were able to navigate easily through the questions:
(5 Agree, 0 No Opinion, 1 Disagree)

It is evident from the State A survey results that the students very much liked ATS. The greatest measure of the effectiveness of ATS came from the fact that all these students passed the State A mandated tests.

6.2 State B Pilot Study

A pilot study was also conducted in a high school in State B. Six students participated in the study. Three of them had learning disability and three were foreign students whose native language was not English. Here, we report on the feedback we got from the learning disabled students. They were given a test which consisted of ten questions. Before the start of the test the students were given a demonstration of ATS. After that, the students were asked to attempt the test. At the end of the test a group discussion was held to get feedback from the students and the proctors. Some of the above mentioned features were not yet implemented at the time of the pilot and have been incorporated after getting the feedback from the students.

The students had difficulty in figuring out the keyboard shortcuts. Part of the problem was that students were not given enough time to get familiarized with ATS. The students found the cursors and mouse pointers to be small and difficult to handle. Larger cursors were later added to the set of accessible features in ATS.

One of the suggestions raised was to make the user interface speak, for example, when the mouse stays over a certain button for a fixed period of time then a voice explains the functionality of the button. Another suggestion was that there was no way of navigating to an arbitrary sentence instead of sequentially navigating to the paragraph and then to the sentence. Later on this functionality was added by the double click over a sentence event. That is when a student double clicks on a sentence, the TTS synchronized sentence-level highlighting will render that sentence. One student liked the fact that the TTS voiced the state of the answer as being ‘selected’ or ‘eliminated’.

Students had difficulty in using the Customize dialog box. They suggested that this dialog should also have all the accessibility features available on the main ATS window such as TTS, contrast change and zoom. Currently work is being done on making Customize dialog accessible. The spin dialog button at the top toolbar was too small and students had difficulty finding it. Later on the size of this button was increased and made equal to the rest of the accessible buttons. Some students remarked that the text written underneath buttons was too small to read. Later on the font size of this text was increased. In addition, tooltips were added to the buttons which display the functionality of the button when mouse stays over a button for a small duration.

The students really liked the fact that all of the features of ATS were accessible through keyboard shortcuts since most of them had difficulty in using mouse. The students also liked the various contrast settings. They remarked that it was quite easy to use ATS once they knew the functionality of the buttons and the corresponding keyboard shortcuts. Other features that the students liked include split-screen, sentence, paragraph and question navigation, highlighter and eliminate choice.

7 Conclusion

Students with print disabilities, such as partial to total visual impairment and learning disabilities, face significant challenges in taking high-stakes state mandated tests that contain STEM material. Although various accessible testing software exist in the market, there is no accessible testing system that provides a wide range of standardized accessibility features for high-stakes state-mandated tests containing STEM content. This paper presents the design, implementation, and efficacy study of an accessible testing system (ATS) for high-stakes state-mandated tests. The surveys and pilot studies provide evidence for the efficacy of ATS. Some of the future directions for this product are: including MathPlayer into ATS, voicing of GUI, improved test authoring tool for teachers to conduct low-stakes tests, and adding tools such as accessible calculators.

References

1. Disability Statistics from the 2014 American Community Survey (ACS). www.disabilitystatistics.org. Accessed 15 Jan 2018
2. American Foundation for the Blind: Statistical Snapshots from the American Foundation for the Blind. http://www.afb.org/section.aspx?SectionID=15. Accessed 15 Jan 2018
3. Annual report 2015: Distribution of eligible students based on the federal quota census of January 6, 2014 (fiscal year 2015). http://www.aph.org/federal-quota/distribution-2015/. Accessed 15 Jan 2018
4. Boursiquot, B.L., Brault, M.W.: Disability Characteristics of Income-Based Government Assistance Recipients in the United States: 2011. US Department of Commerce, Economics and Statistics Administration, US Census Bureau (2013)

5. Economics and people with disabilities. http://www.accessiblesociety.org/topics/economics-employment/. Accessed 15 Jan 2018
6. Falkenheim, J., Hale, K.: Women, minorities, and persons with disabilities in science and engineering: 2015 (special report NSF no. 15–311). National Science Foundation. National Center for Science and Engineering Statistics, Arlington, VA (2015)
7. Goldberg, M., Milleville, M., Donaldson, A., Hill, V., Marino, D.J., Rivera, V., Grindle, G., Sporner, M., Relich, D., Cooper, R.A.: Evaluating and modifying an advanced manufacturing curriculum for people with disabilities. J. Appl. Rehabil. Couns. **47**(4), 36 (2016)
8. Jeannis, H., Joseph, J., Goldberg, M., Seelman, K., Schmeler, M., Cooper, R.A.: Full-participation of students with physical disabilities in science and engineering laboratories. Disabil. Rehabil.: Assistive Technol. **13**, 1–8 (2017)
9. MathSpeak, Core Specification Grammar Rules. http://www.gh-mathspeak.com/examples/grammar-rules/
10. Women, minorities, and persons with disabilities in science and engineering: 2013 (2013). Retrieved January 15, 2018 from http://www.nsf.gov/statistics/wmpd/2013/pdf/nsf13304_digest.pdf
11. Women, minorities, and persons with disabilities in science and engineering: 2015 (2015). http://www.nsf.gov/statistics/2015/nsf15311/digest/nsf15311-digest.pdf. Accessed 15 Jan 2018
12. Siperstein, G.N., Parker, R.C., Drascher, M.: National snapshot of adults with intellectual disabilities in the labor force. J. Vocat. Rehabil. **39**(3), 157–165 (2013)
13. United States Census Bureau: Disability employment tabulation (2013). https://www.census.gov/topics/employment/disability-employment-tabulation/data.html. Accessed 15 Jan 2018
14. U.S. Department of Labor: Disability employment statistics (2013). https://www.dol.gov/odep/topics/disabilityemploymentstatistics.htm. Accessed 15 Jan 2018
15. Wei, X., Jennifer, W.Y., Shattuck, P., McCracken, M., Blackorby, J.: Science, technology, engineering, and mathematics (STEM) participation among college students with an autism spectrum disorder. J. Autism Dev. Disord. **43**(7), 1539–1546 (2013)

Virtual Learning Environments

How to Create an Adaptive Learning Environment by Means of Virtual Organizations

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Abstract. Normally, learning environments provide all participants with the same content and the same activities; this includes knowledge sharing, the addition of material to knowledge domains and pedagogical mediation activities for teachers and students. Thus, these processes do not tend to consider the differences that exist between each student, both in their performance and behavior in the environment. This paper presents a new agent-based environment model, which intends to apply Virtual Organizations (VO) to the field of Learning Management Systems (LMS) to foster collaboration and work between students and teachers. The model is designed as a VO of agents, which adapts that activities and resources available in the LMS to the characteristics of the participants.

Keywords: Learning Management System · Virtual Organizations
Agents · Adaptivity · Virtual learning environments

1 Introduction

Learning Management Systems (LMS) are environments that facilitate pedagogical mediation tools and resources through Internet and optimize interaction between teachers and students. However, the resources that are available to the student are limited in terms of their adaptivity, that is the capacity of the environment to adapt automatically, according to the changes that take place in it.

An adaptive digital system could personalize the teaching process using the data collected during this process with the objective of improving the student's performance [54]. The final goal of adaptive systems is to monitor the student's progress in the teaching process, that is, making sure the students understands the content. If for some reason the system detects that the student encounters difficulties in assimilating the

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content, they may be provided with different resources that will be more suited to their learning capabilities. The levels of difficulty of the content can help students to feel more confident or frustrated depending on their own level of prior knowledge. A student that must solve problems that are too easy for them can feel unmotivated or bored about the topic, and another student that finds it difficult to solve this problem can feel frustrated. The cost of having one teacher for each student is very high and so it is not easy to provide personalized learning [41]. Without any kind of adaptivity in the teaching-learning process, all the students have access to the same content and execute the same activities. Based on the premise that each student is an independent and different human being, adaptivity is the property of the environment that allows each student to have access to a personalized learning [54]. With this motivation in mind, this work aims to demonstrate that Virtual Organizations of agents (VOs) are a technological environment that is capable of performing this adaptation.

Currently, one of the lines of research that the Multi-Agent Systems (MAS) [3–6] are following is directed toward ensuring that these systems become more open and adaptive. An open MAS [26] should allow for interaction between heterogeneous agents, which change over time, and architectures and even different languages. Because of their inherently changing nature, we cannot rely on agents' behaviour when it is necessary to establish controls on the basis of norms or social rules. For this reason, and because of the characteristics of open environments, new approaches are needed to support evolutive systems and to facilitate their growth and runtime updates. The dynamics of open environments is one of the reasons that have encouraged the use of Virtual Organizations of Agents (VOs). A VO [12, 24] is an open system designed for grouping; it allows for the collaboration of heterogeneous entities and provides a separation between the form and function that define their behaviour.

On the one hand, Adaptive Learning Systems (ALS) are studied, whose effectiveness has been more than proven in the learning environments; and on the other hand, the technology used in the learning process, in this case, the Virtual Organizations of agents are analyzed in order to be able to model the system in an adaptive and much more dynamic way. In view of this context, the purpose of this research is to present the design and implementation of an ALS by means of VOs that considers the student's performance, allowing teachers to have access to an adaptive system which they can configure with their own pedagogical model, for any class they have in the LMS. In the next section a review of the background of the main technologies involved is presented, that is, ALS and VOs. Section 3 shows the design of the VOs-based model. The last two sections show some results obtained and final remarks.

2 Background

Adaptive Learning Systems (ALS) aim to increase students' learning abilities, challenging their capacity level rather than discouraging them. A recent study concluded that some adaptive systems were nearly as effective as "one-on-one human tutoring" [31]. Moreover, some ALS consider the learning style of the student, if they prefer text or audio, or video, or an online book. By doing this, the drop-out rates can reduce, the effectiveness in learning can increase, and there are higher results in learning achievements [41]. We can consider the conclusions of recent studies, which included statements such as: "The success of an interactive system, such as the web and its applications, is determined by the satisfaction of users" [44] or "The content and structure of the material available on the web influence directly the user experience and must be adapted to the needs and characteristics of the user" [37]. In general, the results of current studies showed that student satisfaction is related to the flexibility of the course. Thus, researches in adaptive learning environments are important and can improve the students' learning experience.

The problem in many of these studies arises when it is necessary to develop the interactive adaptive system. Currently there are many LMS, but there is no learning adaptation process. The improvements in adaptivity, access and personalization of this type of environment is a line of research that is currently booming [7, 11, 25, 29, 30, 42]. In this regard, agents and multi-agent systems have been used in recent years in the creation of adaptive systems for many types of areas such as e-commerce, energy management, social networks, smart cities, music environments, among others [18, 38]. A multi-agent system is defined as any system composed of multiple autonomous agents with incomplete capabilities to solve a global problem, where there is no global control system, the data is decentralized and the computation is asynchronous [13–17, 28, 29, 32–36, 55]. The concept of agent has its main origin in artificial intelligence, evolving as an isolated computational entity thanks to the influence of software engineering, overcoming the limitations of object-oriented methodologies. The main difference between the concepts of agent and software-object is the autonomy that agents possess. The agents can make decisions, react to external stimuli, change their own behavior and adapt to the needs of the environment. In the case at hand, it is possible to characterize an agent as a computational system that is situated in some environment (in this case the LMS) and can act autonomously in this environment to achieve its design objectives. In a MAS, the data is organized in a distributed manner and there is no global control system. At the same time, distributed multi-agent systems have become increasingly sophisticated in recent years, with a growing potential to handle large volumes of data and coordinate the operations of many organizations [1].

One aspect of special interest for this work is the construction of a system that allows to model organizational aspects and dynamic reorganization mechanisms, in this case, within teaching-learning process. For this, it is necessary to review certain characteristics of the MAS. MASs can be classified as open or closed. The fundamental difference between them is that a closed MAS is created with a fixed structure and objectives, while in an open MAS, agents can enter or exit the system dynamically and have not been designed to share common objectives. In this work, special interest is given to open systems. Open systems exist in dynamic operating environments, in which new components are integrated, or existing components leave the system continuously, and where the operating conditions themselves can change unpredictably. Open systems are characterized by the heterogeneity of their participants, individual objectives and a high probability of disagreement with the specifications [8].

Virtual Organizations (VOs) of agents are considered as an open MAS with roles and norms that regulate their behavior. Topologies and organizational aspects as well as their communication and coordination mechanisms determine largely the flexibility, dynamism and openness that the multi-agent system can offer. The concept of organization is seen as a solution to coordinating the agents and controlling their behaviours and actions. Every organization needs coordination support to determine explicitly how to organize and perform the actions and tasks within it. There are different platforms, that allow for the creation of MAS [10]. Recently, researchers have conducted several studies on VO modelling, focusing on the organizational aspects, they have proposed new procedures and methodologies for the design of open MASs [9, 12, 23]. Some examples of these approaches are Gaia [56], AGR [12], MOISE [23], OperA [9], INGENIAS [47].

A MAS model must be able to define organizations that can be dynamically adapted according to changes in the environment or in the specification of the organization. This dynamic adaptation includes modifications in the structure and behavior of the MAS, such as adding, deleting or replacing components during the execution of the system without affecting it. [6].

If we compare the general characteristics of human organizations and agents, we find a high degree of similarity, which is logical since the organizations of agents are born from human organizations. Agent organizations have the same principles as human organizations; their function is the same as they define a series of global objectives of the entire organization and some particular goals assigned to different groups, that guide the efforts towards the achievement of the global objectives. The services offered, because of the objectives of the organization, are defined as core of functionality that are performed serving other entities or organizations. Detailing the services offered by an organization allows the agents that integrate it to discover them, invoke them, monitor them and even make associations that give rise to new and more complex services.

In this work concretely, it will be necessary to have a heterogeneous architecture to provide all the functionalities required in the learning process. This work tries to support adaptive learning through innovative technologies such as VOs. Specifically, the environment is intended to comply with: (i) a generation of teaching in real time and on demand for individual needs, and (ii), to be compatible with the dialogue of different types of instruction (not only supported by technologies), allowing free discussion between the technology and the student.

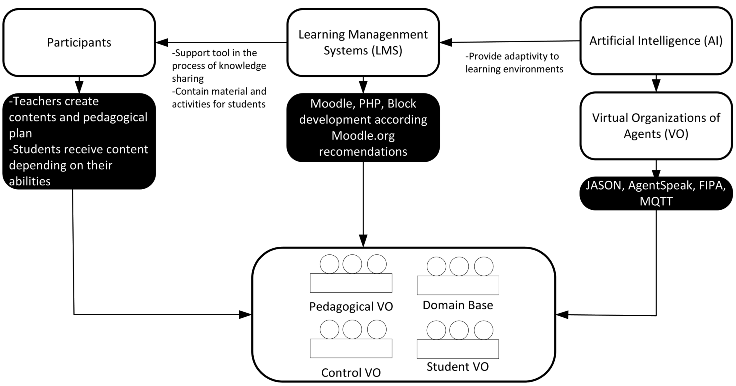

Fig. 1. Selected key technologies

The abstract of this background study and technology selection phase can be summarized in Fig. 1, which shows the three key points of the investigation. As can be seen, the main technology will be an LMS (specifically Moodle) and VOs, and the participants will be teachers as well as students.

3 Proposed System

The proposed technologies are used to design the model that will make up the ALS. The design phase defines the different entities necessary for the virtual learning environment and the way in which they interact. This system is an extended version of an adaptive learning environment model developed in a previous research work [20, 45]. The entities that have been modelled in this case are VOs of agents, which follow the same principles as initial designs but consider the advantages of a system of this type. The application of an organizational design to the multi-agent systems is very useful, since it controls the interactions between agents, providing a series of norms focused on good coordination, and to achieve the general objectives of the organization [23]. The biggest advantage is that the agents can be developed outside the organization and still have all the functionalities (it is a heterogeneous system). For example, it is possible to have an agent that performs a calculation process by using an algorithm and another agent with a different algorithm. The two would be part of the same suborganization (as a calculation department in a real company) but will not affect the rest of the functionalities of the system. It would be possible to perform the calculation with any of the two agents, new external agents could even be used to perform this calculation. A software platform with a base of this type is suitable for systems such as the one proposed in this study in which there are clearly identified, modular functionalities and that require constant interaction between the user (human) and the processes, developed algorithms or techniques (assistance in learning, evaluation, etc.). The system is therefore designed as a heterogeneous system in terms of languages, applications and features (Java, PHP, Blocks, etc.). The following image shows a general component diagram of the platform, together with the modules that compose it (Pedagogical VO, Control VO, Student VO, Domain Base). Below, the specific requirements for each of these modules are described, which will make up a Virtual Organization (VO) each, with different characteristics, rules and structures (Fig. 2).

- The Pedagogical VO is defined by the teacher who creates the activities to performed by the student, defining the flow between them.
- The Domain Base contains the content of the course, provided by the teacher, as well as the environment information, stored in the database. The LMS is represented by the information of profiles, interactions with the environment and the results of the evaluations.
- The Control VO, in charge of the process through the agents access the database obtaining what is necessary to be able to execute its instructions.
- The Student VO, in charge of interacting with students, considering their individual profiles.

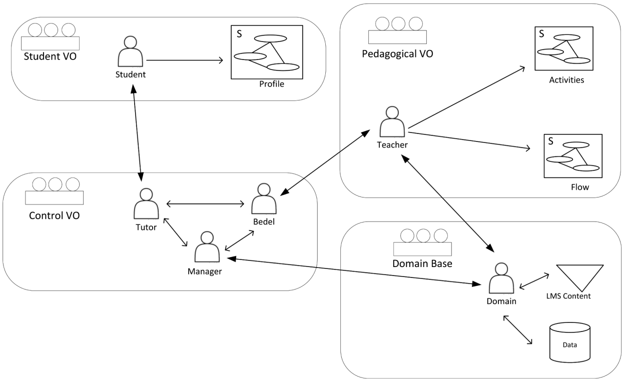

Fig. 2. Virtual organizations of the ALS

The prototype was constructed using the LMS Moodle because it is a flexible and open source tool, which facilitates the development. A Tutor block was created in the LMS Moodle as it is used to configure system agents. Blocks in Moodle are tools that can be developed as plugins to add any new functionality to Moodle LMS. Through this tool, the teacher implements the instructional design of the course by establishing all the possible flows, and configuring the agent, informing the level of difficulty of the contents and the relations between the several items of the learning materials.

The Pedagogical VO is the core in the development of the ALS. The teacher agent provides the contents and course activities to the learning environment and sets up all possible precedence flows between them. After that, the agents can execute theirs plans and perform the pedagogical model designed by the teacher, that will be adapted to the student's interaction with the environment.

After the teacher has provided all the learning material and activates the Tutor block in the Moodle, the student can access this block and can set the order of precedence of the materials and their levels of difficulty. The levels are: basic, intermediate, advanced or general. The general level denotes the material that will be taught to all students alike. The other three levels of learning material can be provided to the student depending on their performance.

The system contains an agent performing the role Manager in the Control OV. This agent is responsible for creating the Bedel and Tutor agents for adaptivity, each time a class is set up or a new student joins an adaptive class. For each class of the LMS courses, there is an instance of the Bedel agent and, for each student, there is an instance of the Tutor agent and Student agent. There is just one instance of the Manager agent for the entire system. It is possible to have an adaptive learning environment which can lead with multiple different courses and multiple student classes of each course. The teacher has complete freedom to previously choose the contents that will be part of the adaptive process and the ones that he will leave as fixed content in the class. The system was designed to accommodate multiple classes of students from each course in the LMS. The Manager agent, in the Control OV, is in charge of controlling if any class has been created in the LMS or if any student joined another class, to instantiate the agents needed. As the LMS works with data that is updated constantly, the Manager agent controls all this information in the system, running asynchronously all the time during system operation.

4 Results

As indicated in Sect. 2, the technologies selected for the construction of the prototype were the LMS Moodle (including PHP language, Blocks and moodle modules) and agents under an organizational design (JASON, Agentspeak, FIPA [14]) (see Fig. 1). On the one hand, Moodle offers some useful resources and tools that can easily be integrated into an adaptive learning environment, resulting in intelligent learning. On the other hand, one of the most important characteristics of agents is their ability to adapt to environment changes. This feature was exploited in this implementation, because of the constant change of the student's data in the system. The agents are capable of providing students with resources and activities that are suited to their performance, and also to update the availability of these resources constantly, each time a new activity is performed by the students. The adaptation of the system occurs through the diverse responses of the agents to the changes of the environment, which are observed through the updates in the database. These responses are provided by the agents after executing their own plans, working according to the information they receive. The agent code was developed using the Jason development platform, interpreter of the AgentSpeak language [27], which is an open source, agent-oriented programming language distributed under the GNU LGPL (GNU Lesser General Public License) and implemented in Java. For the execution of the task to configure the agents by the teacher, a special Moodle block was developed, using PHP, according to the block creation steps recommendation available in the Moodle.org website. The name given to this block is Tutor because it is used by the teacher to configure the Bedel agent. According to this configuration, the virtual environment is adaptive and the student receives messages from a special Moodle user previously registered as Tutor Agent. All instances of the Tutor agents use the Moodle user's profile to send the messages and show the student's follow-up during the course. To configure the Tutor block, the teacher must add this block to the class site (see Fig. 3). Further, the teacher needs to provide all the content that can be used by the students during the course, and then configure the behavior of the agents for that course. First, the difficulty levels of all course resources and activities are defined and, after that, the first resource and first activity of the course must be sett up.

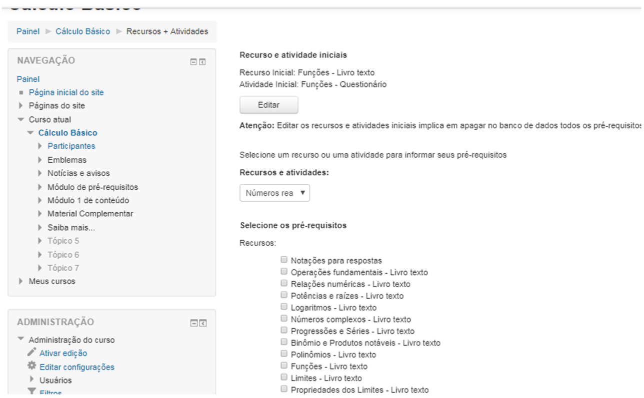

Fig. 3. Configuring the tutor block

The last part of the Tutor block configuration is the selection of the prerequisites for each one of the contents that belong to the adaptive part of the course in that class. For each resource and activity, the other resources and activities available in the class will be presented, with multiple choice option, to select one or more prerequisites and thus generating a Dependency Graph. An example for a basic engineering calculation subject can be seen in the following Fig. 4.

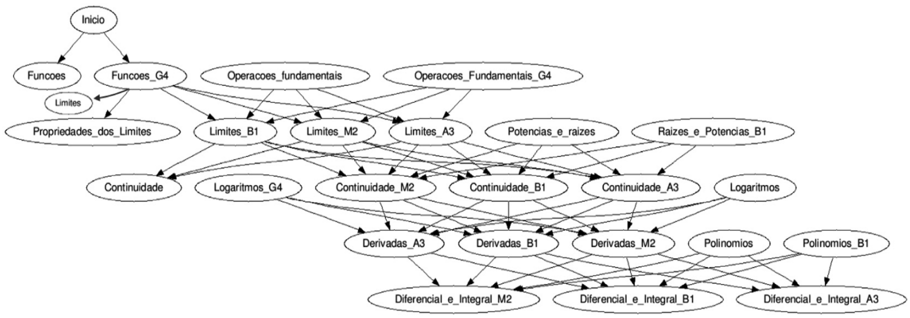

Fig. 4. Dependency graph

This resource is used so that the teacher can visualize all possibilities of dependency flows between the different course activities. The agents also use this flow graph to configure the interface of the learning environment for the student, according to the activities performed by them and the results obtained in these activities. The dependency graph can be edited during the course, but the teacher should previously prepare the pedagogical model, and the possible paths that can be followed by the students and set up the prerequisites using the Tutor block.

The Bedel agents are also configured through this block, however, they do not include any user from the LMS. All the work of Bedel agents is done directly in the system's database. Agents with the role of Bedel are responsible for the adaptive behavior of the virtual environment by setting up the appropriate information in the Moodle database tables. To make the resources and activities available to students, two resources were used in this version of Moodle. The first one is the Moodle resource called Groups, and the second one is Restricted Access, which enables a resource or activity shown to the students who obey the configured restriction. The defined restriction is to be member of a specific group. Each resource and activity are directly related to a group.

The Bedel agent calculates the profile of the student who has been evaluated and, with this profile, it knows the level to which this student belongs. According to this information, the agent defines how the next content must be shown to the student. Bedel checks if there is already another student who has the same profile for this same content and, if not, creates the group with the name Adaptation, followed by the letter that represents the basic, intermediate or advanced level and the id of the resource or activity that will be related to that group. After that, it inserts the student into the group. Once the student is in the group s/he starts to view the content restricted to that group. The Bedel calculates the profile every time it needs to provide new content to the students, that is, whenever there is a student with a new evaluation. The agent checks if the group needed for setting up the student view of the environment exist. In this case, the agent adds the student to the appropriate group, if it does not exist, it creates a new group and adds the student to it.

The 2.9.1 version of Moodle stores all the information about the environment in 328 tables of the database. Some additional tables have been added to support the system: *Tutor _student _evaluated*: stores the data which the agents need to know the students' performance history; *Tutor_bedel_course*: stores the information of the classes in which the Tutor block was activated; *Tutor_tutor_student*: stores the information of the students who belong to one or more adaptive classes; *Tutor_rec_act _profile*: stores the profile information (Basic, Medium, Advanced, General) of each of the resources and activities reported by the teacher; *Tutor_dependency*: stores the information about the configuration of prerequisites and dependencies. The Manager, Bedel and Tutor agents use the information stored in these tables to execute their plans and make the Moodle LMS an adaptive environment.

The operation of the system was tested with a class with university level students, using the contents of a basic calculus course as a field study. This test was performed to verify the proper operation of the system in a real scenario. The preliminary results prove that the system works as expected and that students received adapted content. The test had eight volunteer participants who completed all the topics of the course. For each topic the students were evaluated, and the material was provided to them considering their performance in the previous content. The students passed from basic to intermediate or advanced and vice versa, depending on the grades they obtained in each evaluation. The Bedel agent organized the material for each student independently and the Tutor agent sent the messages according to the student profile in the moment. For this work an adaptive learning environment model developed previously [6] was taken as a basis. Improvements on the original model were made to achieve adaptivity in each learning environment independently, if several students are enrolled in different courses and each course has several student classes.

Below are some images of the course and of the conducted tests, keeping the anonymity of the participants at all times. The course was designed in Portuguese, although much of the content is already translated into English and the plan is to have it translated into Spanish soon. The course is divided into topic 1, topic 2, topic 3, topic 4 and topic 5. The first two have content that will be adaptive. The last 3 have support contents. The course is shown to students from topic 2, with the theme of Functions (Funções) considered the initial and the topics that are below are opened to students as they progress, conducting activities and being evaluated. The themes of topic 1 are revision and are given to students who have a low grade in topic 2 themes, following the configuration of the adaptive system. For example, if the student had a low grade in "limits", the system will show real numbers and powers and roots for him. In this way, the student sees issues that he might need to revise in more detail (Figs. 5 and 6).

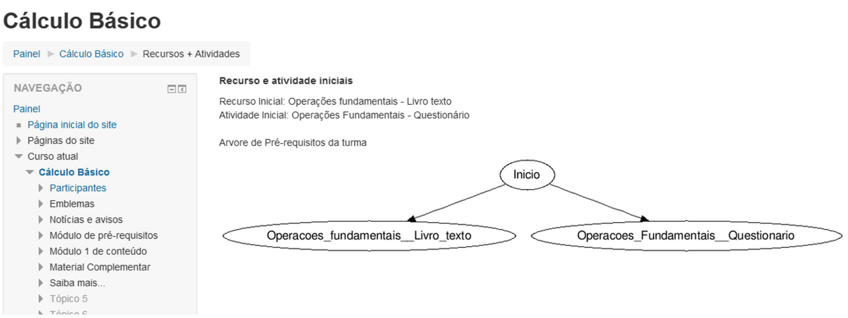

Fig. 5. Graph of pre-requisites configured by the tutor, for the topic "Primitive and integral functions"

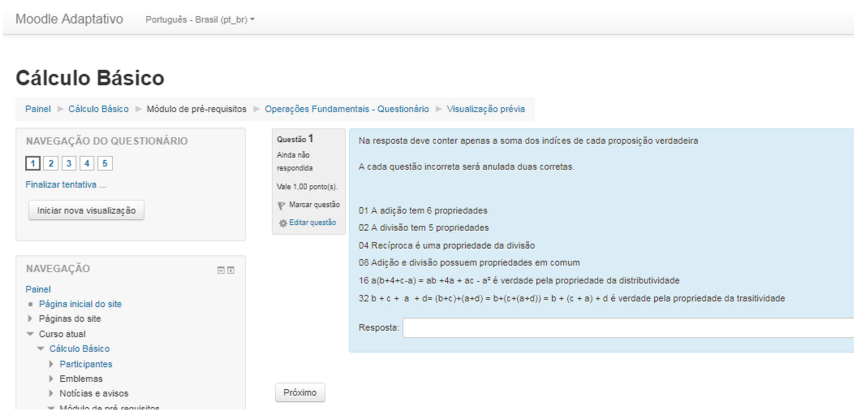

Fig. 6. Sample questionnaire

5 Final Remarks

To conclude, the most relevant contribution of this work is the insertion of intelligent and adaptive tools in common LMS, so that teachers can attend students with different levels of knowledge and skills and personalize their teaching. Giving more advanced tasks to students who perform above the average, creates efficient learning while maintaining a basic level for the general learning of course content.

The organization-based MAS was tested in the Moodle virtual environment, installed exclusively for model testing. The creation and adaptation of resources and activities of different levels of learning was carried out in a basic calculation course. Through the model proposed in this active and educational project, the students had an open space, with which they could interact through their own profile and which facilitated continuous training, self-evaluation, interaction between students, learning through guided practices, implementation of knowledge constructivist models, and management of test and practices. Experimental results confirmed that the presented model enables teachers to provide the content and learning activities of the course in an environment that adapts to students' performance.

This work intended to check the viability of using virtual organizations of agents within adaptive learning environments. This was done through the implementation of the system and the experience of users in its operation. In addition, this research is expected to contribute to the development of adaptive environments that help improve the way students learn, with the possibility of adding adaptability in various subjects that can be offered in distance or face-to-face courses. Also, this work hopes to contribute to the increase of the instructional design options that are currently used in course development.

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References

1. Helsinger, A., Thome, M., Wright, T.: Cougaar: a scalable, distributed multi-agent architecture. In: IEEE International Conference Systems, Man and Cybernetics, vol. 2, pp. 1910–1917 (2004)
2. Casado-Vara, R., Corchado, J.M.: Blockchain for democratic voting: how blockchain could cast off voter fraud. Orient. J. Comp. Sci. Technol. **11**(1) (2018)
3. Corchado, J.M., Aiken, J., Corchado, E.S., Lefevre, N., Smyth, T.: Quantifying the ocean's CO2 budget with a CoHeL-IBR system. In: Funk, P., González Calero, P.A. (eds.) ECCBR 2004. LNCS (LNAI), vol. 3155, pp. 533–546. Springer, Heidelberg (2004). https://doi.org/10.1007/978-3-540-28631-8_39
4. Corchado, J.M., Aiken, J.: Hybrid artificial intelligence methods in oceanographic forecast models. IEEE Trans. Syst. Man Cybern. Part C-Appl. Rev. **32**(4), 307–313 (2002). https://doi.org/10.1109/tsmcc.2002.806072

5. Corchado, J., Fyfe, C., Lees, B.: Unsupervised learning for financial forecasting. In: Proceedings of the IEEE/IAFE/INFORMS 1998 Conference on Computational Intelligence for Financial Engineering (CIFEr) (Cat. No. 98TH8367), pp. 259–263 (1998). https://doi.org/10.1109/CIFER.1998.690316
6. Corchado, J.M., Bajo, J., de Paz, Y., Tapia, D.: Intelligent environment for monitoring alzheimer patients, agent technology for health care. Decis. Support Syst. **34**(2), 382–396 (2008). ISSN 0167-9236
7. Costa, Â., Novais, P., Corchado, J.M., Neves, J.: Increased performance and better patient attendance in an hospital with the use of smart agendas. Log. J. IGPL **20**(4), 689–698 (2012). https://doi.org/10.1093/jigpal/jzr021
8. Weyns, D., Haesevoets, R., Helleboogh, A., Holvoet, T., Joosen, W.: The MACODO middleware for context-driven dynamic agent organizations. ACM Trans. Auton. Adapt. Syst. (2010)
9. Dignum, V., Dignum, F.: A logic for agent organization. In: Proceedings of the FAMAS@Agents 2007 (2007)
10. Argente, E., Giret, A., Valero, S., Julian, V., Botti, V.: Survey of MAS methods and platforms focusing on organizational concepts. In: Vitria, J., Radeva, P., Aguilo, I. (eds.) Recent Advances in Artificial Intelligence Research and Development, Frontiers in Artificial Intelligence and Applications, pp. 309–316 (2004)
11. Zacarias, E., de Almeida, L.R., Prettz, J.B., da Costa, J.P.C., de Freitas, E.P., Canedo, E.D., de Sousa, R.T.: Optimizing the access records of students in the Moodle virtual learning environment database. In: IFAC-PapersOnLine, vol. 49, no. 30, pp. 98–101 (2016). ISSN 2405-8963
12. Ferber, J., Gutknecht, O., Michel, F.: From agents to organizations: an organizational view of multi-agent systems. In: Giorgini, P., Müller, J.P., Odell, J. (eds.) AOSE 2003. LNCS, vol. 2935, pp. 214–230. Springer, Heidelberg (2004). https://doi.org/10.1007/978-3-540-24620-6_15
13. Fernández-Riverola, F., Díaz, F., Corchado, J.M.: Reducing the memory size of a fuzzy case-based reasoning system applying rough set techniques. IEEE Trans. Syst. Man Cybern. Part C Appl. Rev. **37**(1), 138–146 (2007). https://doi.org/10.1109/TSMCC.2006.876058
14. FIPA Agent Management Specification (2001). http://www.fipa.org/specs/fipa00023/
15. Fyfe, C., Corchado, J.: A comparison of Kernel methods for instantiating case based reasoning systems. Adv. Eng. Inform. **16**(3), 165–178 (2002). https://doi.org/10.1016/S1474-0346(02)00008-3
16. Fyfe, C., Corchado, J.M.: Automating the construction of CBR systems using kernel methods. Int. J. Intell. Syst. **16**(4), 571–586 (2001). https://doi.org/10.1002/int.1024
17. García, E., Rodríguez, S., Martín, B., Zato, C., Pérez, B.: MISIA: middleware infrastructure to simulate intelligent agents. Adv. Intell. Soft Comput. **91** (2011). https://doi.org/10.1007/978-3-642-19934-9_14
18. García, Ó., Alonso, R.S., Prieto, J., Corchado, J.M.: Energy efficiency in public buildings through context-aware social computing. Sensors **17**, 826 (2017)
19. Giraffa L.M.M., Viccari, R.M.: The use of agents techniques on intelligent tutoring systems. In: Computer Science, SCCC 1998 (1998)
20. Giuffra, C.E.P., Silveira, R.A., Nakayama, M.K.: Using agent based adaptive learning environments for knowledge sharing management. Int. J. Knowl. Learn. (Print) **10**, 278–295 (2015)
21. Glez-Bedia, M., Corchado, J.M., Corchado, E.S., Fyfe, C.: Analytical model for constructing deliberative agents. Int. J. Eng. Intell. Syst. Electr. Eng. Commun. **10**(3) (2002)

22. Glez-Peña, D., Díaz, F., Hernández, J.M., Corchado, J.M., Fdez-Riverola, F.: geneCBR: A translational tool for multiple-microarray analysis and integrative information retrieval for aiding diagnosis in cancer research. BMC Bioinform. **10** (2009). https://doi.org/10.1186/1471-2105-10-187
23. Hübner, J.F., Sichman, J.S., Boissier, O.: S-Moiseþ: a middleware for developing organised multi-agent systems. In: Boissier, O. (ed.) AAMAS 2005. LNCS (LNAI), vol. 3913, pp. 64–77. Springer, Heidelberg (2006). https://doi.org/10.1007/11775331_5
24. Foster, I., Kesselman, C., Tuecke, S.: The anatomy of the grid: enabling scalable virtual organizations. Int. J. High Perform. Comput. Appl. **15**(3), 200–222 (2001)
25. Rymanova, I., Baryshnikov, N., Grishaeva, A.: E-course based on the LMS Moodle for English language teaching: development and implementation of results. In: Procedia - Social and Behavioral Sciences, vol. 206, pp. 236–240 (2015). ISSN 1877-0428
26. Bajo, J., Corchado, J.M., Botti, V., Ossowski, S.: Practical applications of agents and MAS: methods, techniques and tools for open MAS. J. Phys. Agents **3**, 1–2 (2009)
27. Jason Developers: Jason a Java-based interpreter for an extended version of AgentSpeak (2017)
28. Jennings, N.R., Sycara, K., Wooldridge, M.: A roadmap of agent research and development. Auton. Agents Multi-Agent Syst. J. **1**(1), 7–38 (1998). (Ed. by, N.R. Jennings, K. Sycara, M. Georgeff)
29. Agüero, J., Rebollo, M., Carrascosa, C., Julián, V.: MDD-approach for developing pervasive systems based on service-oriented multi-agent systems. ADCAIJ: Adv. Distrib. Comput. Artif. Intell. J. **2**(3), 55 (2013). ISSN: 2255–2863
30. Rezgui, K., Mhiri, H., Ghédira, K.: Extending Moodle functionalities with ontology-based competency management. Procedia Comput. Sci. **35**, 570–579 (2014). ISSN 1877-0509. https://doi.org/10.1016/j.procs.2014.08.138
31. Kurt, V.: The relative effectiveness of human tutoring. Intell. Tutor. Syst. Other Tutor. Syst. Educ. Psychol. **46**(4), 197–221 (2011)
32. Laza, R., Pavn, R., Corchado, J.M.: A reasoning model for CBR_BDI agents using an adaptable fuzzy inference system. In: Conejo, R., Urretavizcaya, M., Pérez-de-la-Cruz, J.L. (eds.) TTIA 2003. LNCS, vol. 3040, pp. 96–106. Springer, Heidelberg (2004). https://doi.org/10.1007/978-3-540-24620-6_15
33. Becerra-Bonache, L., López, M.D.J.: Linguistic models at the crossroads of agents, learning and formal languages. ADCAIJ: Adv. Distrib. Comput. Artif. Intell. J. **3**(4), 67 (2014). ISSN 2255-2863
34. Li, T., Sun, S., Bolić, M., Corchado, J.M.: Algorithm design for parallel implementation of the SMC-PHD filter. Sig. Process. **119**, 115–127 (2016). https://doi.org/10.1016/j.sigpro.2015.07.013
35. Li, T., Sun, S., Corchado, J. M., Siyau, M.F.: Random finite set-based Bayesian filters using magnitude-adaptive target birth intensity. In FUSION 2014 - 17th International Conference on Information Fusion (2014)
36. Lima, A.C.E.S., De Castro, L.N., Corchado, J.M.: A polarity analysis framework for Twitter messages. Appl. Math. Comput. **270**, 756–767 (2015). https://doi.org/10.1016/j.amc.2015.08.059
37. Marcuzzo, M.M.V., Gubiani, J.S., Lopes, L.F D.: A satisfação dos alunos de educação a distância em uma Instituição de Ensino Superior. Centro de Processamento de Dados, UFSM (2015)
38. Gómez, L.M., Cáceres, M.N.: Applying data mining for sentiment analysis in music. In: De La Prieta, F., et al. (eds.) PAAMS 2017. AISC, vol. 619, pp. 198–205. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-61578-3_20
39. Mata, A., Corchado, J.M.: Forecasting the probability of finding oil slicks using a CBR system. Expert Syst. Appl. **36**(4), 8239–8246 (2009). https://doi.org/10.1016/j.eswa.2008.10.003

40. Méndez, J.R., Fdez-Riverola, F., Díaz, F., Iglesias, E.L., Corchado, J.M.: A comparative performance study of feature selection methods for the anti-spam filtering domain. In: Perner, P. (ed.) ICDM 2006. LNCS (LNAI), vol. 4065, pp. 106–120. Springer, Heidelberg (2006). https://doi.org/10.1007/11790853_9
41. Oxman, S., Wong, W.: White Paper: Adaptive Learning Systems. Integrated Education Solutions (2014)
42. Chamoso, P., De La Prieta, F.: Simulation environment for algorithms and agents evaluation. ADCAIJ: Adv. Distrib. Comput. Artif. Intell. J. **4**(3) (2015). ISSN 2255-2863
43. Chamoso, P., Rivas, A., Rodríguez, S., Bajo, J.: Relationship recommender system in a business and employment-oriented social network. Inf. Sci. **433–434**, 204–220 (2018). https://doi.org/10.1016/j.ins.2017.12.050
44. De Oliveira, P.M., Valdeni De Lima, J., Krug Wives, L., Marilza Pernas, A., Gasparini, I., Fernández, A., Díaz, A.: Adaptatividade geocultural em ambientes virtuais de aprendizagem. RIED **7**(1), 83–109 (2014)
45. Palomino, C.G., Nunes, C.S., Silveira, R.A., González, S.R., Nakayama, M.K.: Adaptive agent-based environment model to enable the teacher to create an adaptive class. In: Vittorini, P., et al. (eds.) MIS4TEL 2017. AISC, vol. 617, pp. 20–27. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-60819-8_3
46. Marín, P.A.R., Duque, N., Ovalle, D.: Multi-agent system for knowledge-based recommendation of learning objects. ADCAIJ: Adv. Distrib. Comput. Artif. Intell. J. **4**(1), 80–89 (2015). ISSN 2255-2863
47. Pavon, J., Gomez-Sanz, J., Fuentes., R.: The INGENIAS Methodology and Tools, pp. 236–276. Idea Group Publishing, Hershey (2005). Article IX
48. Pérez de la Cruz, J.L, Pavón, J., ANA-MAS: Agentes Software y Sistemas Multi-Agente: Conceptos, Arquitecturas y Aplicaciones. Pearson Prentice-Hall, Upper Saddle River (2005)
49. Redondo-Gonzalez, E., De Castro, L.N., Moreno-Sierra, J., Maestro De Las Casas, M.L., Vera-Gonzalez, V., Ferrari, D.G., Corchado, J.M.: Bladder carcinoma data with clinical risk factors and molecular markers: a cluster analysis. BioMed. Res. Int. (2015). https://doi.org/10.1155/2015/168682
50. Silveira, R., Da Silva Bitencourt, Gelaim, G.K., Marchi, J., De La Prieta, F.: Towards a model of open and reliable cognitive multiagent systems: dealing with trust and emotions. ADCAIJ: Adv. Distrib. Comput. Artif. Intell. J. **4**(3), 57 (2015). ISSN 2255-2863
51. Rodríguez, S., De La Prietade, F., Tapia, D.I., Corchado, J.M.: Agents and computer vision for processing stereoscopic images. In: Corchado, E., Graña Romay, M., Manhaes Savio, A. (eds.) HAIS 2010. LNCS (LNAI), vol. 6077, pp. 93–100. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-13803-4_12
52. Rodríguez, S., Gil, O., De La Prieta, F., Zato, C., Corchado, J. M., Vega, P., Francisco, M.: People detection and stereoscopic analysis using MAS. In: INES 2010 – Proceedings of 14th International Conference on Intelligent Engineering Systems (2010). https://doi.org/10.1109/INES.2010.5483855
53. Tapia, D.I., Corchado, J.M.: An ambient intelligence based multi-agent system for alzheimer health care. Int. J. Ambient Comput. Intell. **1**(1), 15–26 (2009). https://doi.org/10.4018/jaci.2009010102
54. U.S. Department of Education, Office of Educational Technology: Expanding Evidence Approaches for Learning in a Digital World, Washington, D.C. (2013)
55. Wooldridge, M., Jennings, N.R.: Intelligent agents: theory and practice. Knowl. Eng. Rev. **10**(2), 115–152 (1995)
56. Zambonelli, F., Jennings, N.R., Wooldridge, M.: Developing multiagent systems: the Gaia methodology. ACM Trans. Softw. Eng. Methodol. (TOSEM) **12**(3), 317–370 (2003)

Designing a Conceptual Framework to Enhance Teacher Professional Development in a 3D VLE

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Abstract. As the increasing interaction of people, countries and cultures unfolds today's teachers must raise standards and manage dealing issues based on cultural differences. The discourse concerning cultural interactivity should be major in Teacher Professional Development (TPD). It is widely accepted that Virtual Learning Environments (VLE) and especially 3D platforms as Second Life (SL) could enhance Social and Cross cultural skills as Information and Media Literacy. In this paper we emphasize the importance of TPD by presenting a well-designed conceptual framework and the 3D VLE affordances that were utilized and exploited in the context of an educational experiment in SL environment. This framework is using Cognitive Apprenticeship and Problem Based Learning as background theories and CSCL strategies as well a script built on ancient Greek myth of Jason and the Argonauts. This study reveals that engagement of teachers being exposed to SL training, is significantly increased.

Keywords: Teacher Professional Development · Second Life
Cognitive Apprenticeship · Problem Based Learning
Virtual Learning Environment

1 Introduction

In a rapid changing society education must follows same pace. Teachers must be efficient to keep up with the latest trends and needs of their students and therefore they must receive constant training. Furthermore, the essential skills that students must acquire include Life and Career Skills such as Social and Cross Cultural skills and Information, Media and Technology. Training in the key competences, namely of knowledge, skills and attitudes, is seen as fundamental for each individual in 21st century society. Thus, every teacher needs to be trained in cross cultural skills in order to help more sufficiently children to acquire these skills. As 2018 is the European Year of Cultural Heritage a current demand is to encourage more people to discover and explore their cultural heritage and others' in order to reinforce a sense of belonging to a common family. It is widely accepted that the 21st century skills are not only related to knowledge, but also extend to information and communication skills, thinking and problem-solving skills, interpersonal and management skills and media and information literacy skills (Pearlman 2015).

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Regarding the 21st century skills the latest trend in research is studying social and cross-cultural interaction, creating programs and curriculum for students to increase leadership and responsibility skills, positive perspective to difference and new environments, be capable of working with people of different cultural background (Pacific Policy Research Center 2010).

To this direction it is necessary to design new cross cultural programs. Every teacher should be able to help each student to develop social and cross cultural skills. This could be achieved by using VLE and 3D platforms and be part of TPD. Taking all the above into consideration this study came up with the design, implementation and evaluation of a Cross Cultural Training Program orchestrated along the lines of Cognitive Apprenticeship and Problem Based Learning theories combined with the processes of collaborative strategies in an online 3D Virtual Learning Environment so as to empower Continuing Professional Development for Teachers.

The aim of this research is to design a script that evokes collaboration and enhance social skills based on pedagogical so that the learners can exchange ideas in their professional communities.

In this paper we focus on the well-designed conceptual framework – and the 3D VLE affordances that can be used to facilitate learning tasks and students' learning outcomes in order to engage participants in a more efficient way. This study presents the tailoring of the well-designed conceptual framework and how the 3D VLE can be used as a learning tool to help professional educators. Initially the literature review is presented regarding the Teachers Professional Development and the 3D Virtual Learning Words. Then Methodology is explained as well as the background theories used and the CSCL strategies. Afterward the educational experiment is described and in the end Findings and Conclusions are cited.

2 Literature Review

2.1 Teachers' Professional Development and 3D Virtual Learning Worlds

According to the Teacher Policy Development Guide published by UNESCO in 2015, the primary aim of teacher training is to develop educational skills that are compatible with education policies and enable teachers to comply with these policies. A teacher must deliver learning under stressful conditions, reaching automaticity and multitasking around many students which is extremely demanding. Thus, a teacher must be constantly updated for the latest trends to deliver the finest performance of his capacities. The focal point of professional development should be helping teachers develop knowledge, skills and attitudes in order to to improve teaching. Furthermore TPD should take in consideration the intense work environment and teachers' needs (Burns 2011). The lack of an adequate support in entry level teachers creates an invalid start for professional educators. (Dede et al. 2016). The current state of research on the impact of 21st century skill acquisition of student achievement is steadily expanding, with current research seeking to highlight the effects of the acquisition of 21st century skills on student success and their teachers.

Virtual learning environment (VLE) is a Web-based platform used for educational purposes. VLEs allow participants to be organised into groups and have roles; present resources, activities and interactions within a specific order; provide feedback in various stages of assessment and encourage participation. Furthermore, they bring a deep insight into learners' different learning patterns and that's the way teachers' professional skills are reinforced (Leu et al. 2011).

The 3D Virtual Worlds platforms are an innovative ICT technology that can be used for the creation of immersive 3D graphical and interactive online environments which can be a reproduction of existing physical places, or an imaginary one. The VW can be proprietary or open-source. In comparison to other e-learning technologies, 3D VWs can provide learners a better experience of fully understanding a situation. The reason for that is because the participant is able to walk through the VW, find his own way, get lost, join groups, communicate and interact with other avatars (Maratou et al. 2015).

A collaborative learning environment is an environment in which the users involved acquire different roles and duties. The educational interactions in the environment transform the simple virtual space into a communication space. The information in the environment is being transmitted through multiple ways such as text or 3D graphics. Furthermore, students are not passive users but can interact with each other and with the VLE. In such environment such technologies may be developed that can serve fully realized educational scenarios. Also one can feel the sense of real life due to the fact that can be reconstructed realistically segments from the real world. (Mavridis et al. 2010)

Learning environments in the school of the future should be integrated without excluding traditional learning and teaching methods. New generation students are digital natives, use social media from early age and prefer to work on their own or in collaboration with others. Thus VLEs are perfect educational tool for them.

2.2 Virtual World – Second Life

An online virtual world is a specific type of web VW in which users can interact with each other. By that term we refer to an electronic environment that visually mimics complex physical spaces, where people can interact with each other and with virtual objects, and where people are represented by avatars. The features of virtual worlds include shared space, graphical user interface, immediacy, interactivity, persistence, and community (Lesko and Hollingsworth 2010).

Second Life, launched by Linden Lab in 2003, is the most popular of the Social Worlds, with the largest active user and educational community. SL provides a highly comprehensive 3D graphical environment, avatars that can be customized, built-in voice and standard text communication tools (i.e. chat, IM). Second Life has a big education aspect; educational institutes have online presence in SL and there are islands where anyone can learn languages with native speakers. (Mattila et al. 2013). This virtual world is a great tool for teachers to communicate, interact and realize the affordances of a 3D VW that can be useful in their work. To this end, this research aims to design, develop and implement the Cross Cultural Training Program in SL so as to familiarize teachers with Cross Cultural Skills.

3 Methodology

The aim of this paper is to present the design – as well-designed conceptual framework – and the 3D VLE affordances that can be used to facilitate learning tasks and students' learning outcomes in order to engage participants in a more active way.

The Research Question is as follows:

RQ1: What are the educational potential and affordances of 3D multi-user virtual worlds that can contribute to the effect of teachers' engagement and positively impact their learning performance?

In order to answer this research question we came up with the design, implementation and evaluation of a Cross Cultural Training Program titled "The Quest of the Golden Fleece". This program is orchestrated along the lines of Cognitive Apprenticeship and Problem Based Problem theories combined with the processes of collaborative strategies in an online 3D Virtual Learning Environment. In this paper we present a well-designed conceptual framework in the context of the instructional design.

3.1 Instructional Design

The training program was designed based on the theories of Cognitive Apprenticeship regarding to the 3D world and Problem Based Learning in relation to the script. The CSCL strategies used were Simulation and Think Pair Share. The Program has four phases (Fig. 1). The activities designed were divided in four online meetings. The program focuses on teachers originated from different countries and carrying a differentiated linguistic and cultural background. Activities were based on the ancient Greek myth of Jason and the Argonauts. This myth was chosen because it is closely related to traveling and is well known in internationally.

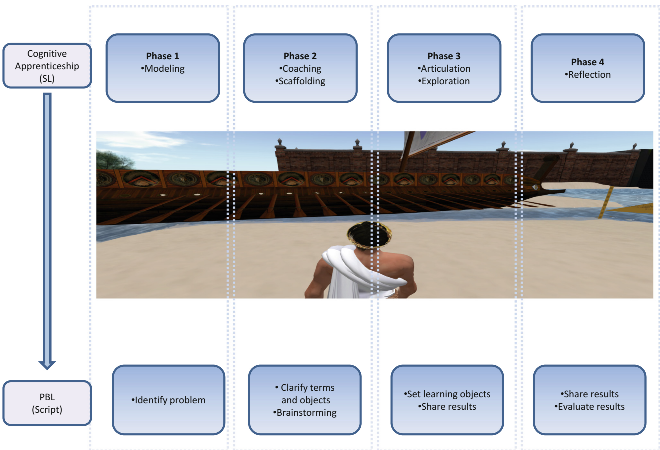

Fig. 1. Background theories in instructional design

3.1.1 Background Theory: Cognitive Apprenticeship (Second Life)

The theory we used for the built of web based platform Second Life was Cognitive Apprenticeship. The concept of a cognitive apprenticeship is defined as learning through guided experience on cognitive and metacognitive, rather than physical, skills and processes (Collins 1989). We applied the six steps (modeling, coaching, scaffolding, articulation, exploration, reflection) in the four phases of the experiment with our goal to serve better the participants. This theory was chosen due to the fact that fits exactly to our goal. Cognitive skills are gained not through theoretical ways but through witnessing in authentic learning experiences.

3.1.2 Background Theory: Problem Based Learning (Script)

PBL is considered one of the most fitting learning methods in VW, especially in SL. 3D worlds are an excellent tool for both synchronous and asynchronous learning. In this method the educator provides with some situations and guides learners to create their own scenarios. Usually participants are invited to interact with the world and become active members in completing tasks, usually in small groups. Scenarios are presented through avatars or from given information (Vosinakis et al. 2011). Our script was based on the ancient Greek myth of Jason and the Argonauts. The researcher and the participants play the roles and get involved in various processes in order to complete the tasks (Fig. 2). Since the main goal is to reinforce cultural skills, activities were based on elements that constitute culture: verbal communication, food, sports, myths and fairytales, music, literature, traditional dresses, national days, architecture. Each activity was designed in a way that forces participants to explore and get in touch with their own and others' cultural background.

Fig. 2. Visualization of roles and processes in script

3.1.3 CSCL Strategies: Simulation

We used two collaborative strategies to reach better our educational goals. Simulation is a strategy where participants engage in role-playing experiences and learning becomes experiential (Hernández-Leo et al. 2006). In this way we can transfer ideas and images from real world to a non physical place. Through this process the researcher was clarifying terms and objects, beginning the simulation process in a small group and then extended in a bigger group. Finally the conclusions were discussed.

3.1.4 CSCL Strategies: Think-Pair-Share

Think-Pair-Share is a collaboration learning strategy where students talk about the subject and discuss their ideas before sharing with a whole group. Participants are able in the beginning to think and then interact with the group. Thus the process of cooperative learning is completed. Think-Pair-Share's purpose is to help students understand the subject, improve their interpersonal skills and perfect critical thinking. In this way students are encouraged to participate in discussion, create arguments, give and receive critique in small and large groups (Sampsel 2013). Therefore, the use of this strategy to our experiment seemed ideal. Participants were given a task, doing some research, pairing with each other and then sharing their knowledge to other people. This strategy is one of the active cooperative learning strategies where in order to fulfill a task students have to recall previously acquired knowledge on the relevant educational subject (Hamdan 2017).

3.2 Educational Experiment

The educational experiment was conducted in virtual learning environment of Second Life. Participants were 12 teachers with different nationalities and differentiated cultural background. Experiment completed in 8 sessions with duration of each session 2 h in the VLE of SL in a period of 2 months (November–December 2017). This was a pilot implementation and the experiment will be conducted again for a second time. The main character is the researcher named Jason that coordinates and helps the procedure. The goal of the script is for Jason and the Argonauts to get the Golden Fleece which represents the harmonious living between people. For each activity/destination a completely new and different environment was designed to match the needs of the activity and enhance the feeling of traveling to a new country. The instructional design uses Cognitive Apprenticeship and PBL as background theories for the SL environment and the script. Simulation and TPS are used as CSCL strategies. Activities were given, and the processes were different for the participants and the researcher. The processes that occurred for each role and the script are analyzed in the following figure (Fig. 3).

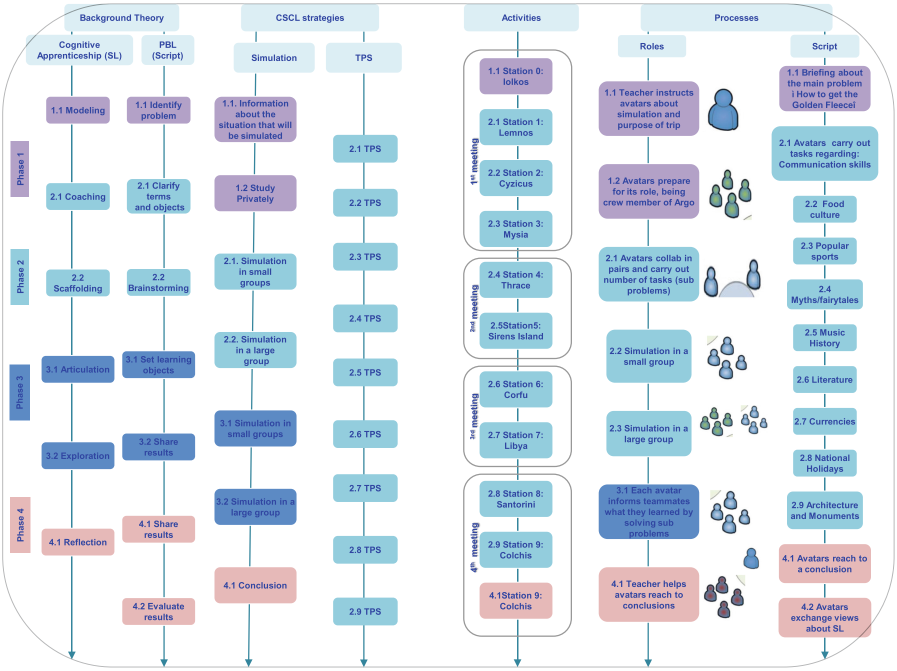

Fig. 3. Instructional design used in the educational experiment

1st session: Before the first session participants were given instructions and tutorial videos about SL. Researcher sets a specific time and land in SL that avatars meet. This session consists of three activities. According to framework we will mention briefly the activities that took place in SL platform.

Station 0: Iolcus/Intro. Participants read the signs that Jason provides. There is a briefing about the main problem "How to get the Golden Fleece". Educators get familiar with avatars and movements in SL environment. Avatars get on the ship Argo and sail for the first destination.

Station 1: Lemnos/Introduce. Yourself Participants learn how to greet in different languages. They are asked to make a collage of greeting expressions of their own country and share cards with others (Fig. 4).

Fig. 4. Greeting activity in SL

Station 2: Cyzicus/Traditional food Participants are being asked to make a presentation of food being served in special occasions. They gather recipes and prepare a wedding table (Fig. 5).

Fig. 5. Food activity in SL

Station 3: Mysia/Popular. Sports Researchers ask avatars to suggest some sports which are most popular in their country, then make a poster demonstrating some rules and gear that are being used. In the end they vote the 3 most suitable sports for Jason and his friends.

2nd session: Researcher sets the meeting point. Avatars have been notified by email for the next destination. This session lasts 2 h and consists of 2 activities.

Station 4: Thrace/Popular Myths. Teachers are assigned to find the most popular myth or fairytale from their country and share it with their pair (Fig. 6).

Station 5: Sirens Island/Showcase your Musical History. Participants must find a song for the Argonauts to listen to so they can be saved from the deadly Sirens. They choose a well known song from their country and share it with others. Also, they showcase a musician who influenced their people's music history. Finally they vote for the top 3.

Fig. 6. Myth activity in SL

3rd session: This session lasts 2 h and consists of 2 activities.

Station 6: Corfu/Famous Writers. Participants must help Alcinous create the biggest library in the world and suggest a famous writer from their country who should definitely be included in the library. In the end they vote for the top 3 writers that Alcinous must know (Fig. 7).

Fig. 7. Literature activity in SL

Station 7: Libya/Various Currencies and Traditional Dresses. Educators help Atalanta buy some chitons. They also practice in an online store with currency which is different from their owns. They also showcase traditional dresses.

4th session: This session lasts 3 h and consists of two activities regarding cultural elements and the conclusion.

Station 8: Santorini/National Holidays. The theme is National Holidays. What are the reasons to celebrate? Participants create a Word file or a Powerpoint presentation explaining why they celebrate (Fig. 8).

Fig. 8. National holiday activity in SL

Station 9: Colchis/Architecture. Participants are asked which is the most important monument in their country. Then gather information about architectural monuments and give their pair a 3D tour.

Station 10: Colchis/Conclusion. In the end participants create a Global Village which includes all the cultural elements they collected through their journey. King Aeetes delivers Golden Fleece to the Global village to protect all people and help them live in harmony representing their unique cultural heritage. They arrive to conclusion that all different cultural elements are equally valued and must be protected to enjoy cultural heritage and cultural diversity (Fig. 9).

Fig. 9. Conclusion activity in SL

4 Findings

The aim of this research was to investigate the educational potential and affordances of 3D multi-user virtual worlds and whether these can contribute to the effect of teachers' engagement and positively impact their learning outcomes. Specifically the main goal was to answer the basic research question which was whether the affordances of a 3D VLE can facilitate TPD. The effectiveness of the training program was evaluated. The assessment includes data regarding the satisfaction of the in two aspects: if they gain new knowledge in the experiment and if they can transfer the newly acquired knowledge in their work. A rubric was given to the participants before first meeting and after last meeting.

Questions on rubrics were related to structure (script and SL), interest, goal achievement, understanding. The results for the log files were given as an overall evaluation based on all online meetings combined.

The data from the online discussions in chat and in the forum were analyzed qualitatively, while there was also a quantitative analysis of the various indexes. In this analysis method we combine quantitative and qualitative criteria. We chose this method to deliver best results from both types (Bouta et al. 2012).

During the analysis of chat and forum log files, we were interested in some qualitative criteria. In particular, we measured the number of times learners: (a) "were able to navigate in the 3D environment" (Spatial knowledge); (b) "completed the activities we asked" (Experiential learning); (c) "seemed eager to go through all the activities (increased motivation and engagement); (d) "understood how to transfer the newly acquired knowledge in real life" (Transfer of knowledge and skills to real life situations); (e) "collaborated in differentiated teams" (Problem solving) (Table 1).

Table 1. Connection of criteria, indexes and appraisals

Criteria	Indexes	Appraisals
Spatial knowledge representation	Representation of knowledge	Examine if the environment allows participants to model a subject domain and the corresponding simulation environment
Experiential learning tasks that would be impractical or impossible to undertake in the real world	Structure (script, SL)	
Increased intrinsic motivation and engagement	Interest goal achievement	
Improved transfer of knowledge and skills to real situations through contextualisation of learning	Understanding	Making it a practical platform for participants to embed their ideas and test out their hypotheses
More effective collaborative learning	Problem solving	

A list of indexes is created which justifies the use in different forms of assessment. These indexes are used for quantitative assessment and to identify and evaluate the weight and quality of learners' knowledge structure, verify the change in their cognitive structure, indicate the extent to which the cognitive structure covers the learning objectives, clarify their participation in the subject matter and control the frequency and proximity (specific components, answers, nodes, etc.).

In the rubrics and configuration of the log files we took into consideration the constraints on concepts or links depending on the degree of difficulty of the subject. In the formative assessment phase, the qualitative analysis of the successive maps and student tests assessed the degree of understanding of the concepts as well as their conceptual change. On this basis, the rubrics and log files were used as a measure, utilizing the criteria mentioned above. Specific criteria for qualitative assessment were weighted, which were representative of the structure of the tools used and the content of the cognitive object. During the final evaluation phase, the quantitative analysis of the rubrics and log files was used and related to the final performance of the students.

Specifically several quantitative evaluation methods have been proposed, such as the structural method, according to which 1 point is given in each correct sentence, 5 points at the right hierarchy level, 10 points in each significant-correct connection, and 1 point in each correct example (Novak and Gowin 1984). A similar rating scale was followed for the evaluation of log files. For the reliability of the two forms of evaluation adopted in the survey, a list of criteria is presented which justifies the reliability of the use of different forms of assessment. These criteria are used for qualitative assessment, identify and evaluate the weight and quality of learners' knowledge structure, verify the change in their cognitive structure, indicate the extent to which the cognitive structure covers the learning objectives, clarify their participation in the subject matter, control the frequency and proximity.

Indexes appear schematically in the following table (Table 2).

Table 2. Indexes table

	Indexes	Rubrics	Log files	Importance %
1	**Formative evaluation**			
1.1	**Functionally**			30
1.1.1	Structure (script, SL)	High	High	10
1.1.2	Interest	High	High	10
1.1.3	Content	Low	High	10
1.2	**Cognitively**			40
1.2.1	Understanding	Low	High	10
1.2.2	Representation of knowledge	Low	High	10
1.2.3	Problem solving	Low	High	10
1.2.4	Goal achievement	Low	High	10
2	**Final evaluation**			30
2.1	Evaluation	Low	High	10
2.2	Time management	High	Low	5
2.3	Proximity (development of nodes - completing replies)	Low	High	5
2.4	Reliability	High	High	10
2.5	Validity	High	High	10

From our experiment results showed that participants enhanced their spatial knowledge representation, had greater opportunities for experiential learning, increased their motivation/engagement, improved contextualisation of learning and experienced a more effective collaborative learning.

A study of log files in the chat of the online sessions showed clearly participants achieved great success in CSCL mainly due to the high interaction they had through the 3D platform. Their engagement in terms of cognitive, behavioral, social, and emotional dimensions was above average as was showcased by the state of heightened attention and involvement.

5 Conclusion

Understanding and embracing cultural and social differences and using those differences to develop new ideas and new solutions to problems are extremely important our world, especially in education and in business environments. Teachers need to be trained to manage conflicts that arise from cultural differences.

It is now widely accepted that digital games and VLE support transformation of game-players' knowledge through participation in the gaming activity that involves the whole person in a dynamic individual-environment interaction (gamification). However, this domain requires further research for better understanding how these processes work, measurement of the mechanisms developing in VLEs, and design practices that promote learners' skills. Therefore, we recommend future research need to include empirical studies to prove the reliability of the results on 3D VLEs that took place in such worlds and their educational possibilities.

In a future paper we will publish the measurements regarding the engagement and learning outcomes of the Cross Cultural Training Program along with the findings of the Social and Cross Cultural Skills, Information Literacy and Media Literacy.

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References

Bean, R.: Cross-cultural Training and Workplace Performance (2008)

Bouta, H., Retalis, S., Paraskeva, F.: Utilizing a collaborative macro-script to enhance student engagement: a mixed method study in a 3D virtual environment. J. Comput. Educ. **58**(1), 501–517 (2012)

Burns, M.: Distance education for teacher training: modes, models and methods (2011)

Compendium: American Institutes for Research, Washington (2011)

Dalgarno, B., Lee, J.W.: What are the learning affordances of 3-D virtual environments? Br. J. Educ. Technol. **41**(1), 10–32 (2010)

Dede, C., Ketelhut, D., Whitehouse, P., Breit, L., McCloskey, E.: A Research Agenda for Directorate-General for Education, Youth, Sport and Culture (European Commission). Cultural Awareness and Expression Handbook (2016)

Foster, A.N.: The process of learning in a simulation strategy game: disciplinary knowledge construction. J. Educ. Comput. Res. **45**(1), 1–27 (2011)

Giannakou, I., Paraskeva, F., Alexiou, A., Bouta, H.: A case of emotional intelligence for teachers' professional development: emotions and connections are ubiquitous in second life. In: Uden, L., Liberona, D., Feldmann, B. (eds.) LTEC 2016. CCIS, vol. 620, pp. 39–50. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-42147-6_4

Gkemisi, S., Paraskeva, F., Alexiou, A., Bouta, H.: Designing a PBLJii script in a CSCL environment for bolstering collaboration and communication skills. In: Uden, L., Liberona, D., Welzer, T. (eds.) LTEC 2015. CCIS, vol. 533, pp. 77–92. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-22629-3_7

Hernández-Leo, D., Villasclaras-Fernández, E., Asensio-Pérez, J., Dimitriadis, Y.: COLLAGE: a collaborative learning design editor based on patterns. J. Educ. Technol. Soc. **9**(1), 58 (2006)

Leu, E., Ginsburg, M.: Inservice teacher professional development: EQUIP1 first principles

Maratou, V., Xenos, M., Vučković, D., Granić, A., Drecun, A.: Enhancing learning on information security using 3D virtual world learning environment (2015)

Mattila, P., Brauer, S., Arhippainen, L., Rantakokko, A.: Towards immersive user-friendly future learning spaces in education. In: Gardner, M., Webb, M., Callaghan, V., Kloos, C.D. (eds.) Proceedings of the 3rd European Immersive Education Summit, pp. 111–122 (2013)

Mavridis, A., Konstantinidis, A., Tsiatsos, T.: Collaboration in 3D collaborative virtual learning environments: open source vs. proprietary solutions (2010)

Novak, J.D., Gowin, D.B.: Learning How to Learn (1984)

Online Teacher Professional Development (2009)

Pacific Policy Research Center: 21st Century Skills for Students and Teachers. Kamehameha Schools, Research & Division, Honoloulou (2010)

Pearlman, B.: Designing New Learning Environments to Support 21st Century Skills (2015)

Hamdan, R.K.A.: The effect of (Think – Pair – Share) strategy on the achievement of third grade student in sciences in the educational district of Irbid. J. Educ. Pract. **8**(9), 88–95 (2017)

Sampsel, A.: Finding the Effects of Think-Pair-Share on Student Confidence and Participation (2013)

United Nations Educational, Scientific and Cultural Organization: Teacher Policy Development Guide (2015)

Vosinakis, S., Koutsabasis, P., Zaharias, P.: An exploratory study of problem-based learning in virtual worlds. In: 3rd International Conference in Games and Virtual Worlds for Serious Applications (VS-Games 2011) (2011)

Whitehouse, P., Breit, L., McCloskey, E., Ketelhut, D.J., Dede, C.: An overview of current findings from empirical research on online teacher professional development. In: Dede, C. (ed.) Online Professional Development for Teachers: Emerging Models and Methods, pp. 13–30. Harvard Education Press, Cambridge (2006)

Xu, Y., Park, H., Baek, Y.: A new approach toward digital storytelling: an activity focused on writing self-efficacy in a virtual learning environment. Educ. Technol. Soc. **14**(4), 181–191 (2011)

A Motivational Design of a Flipped Classroom on Collaborative Programming and STEAM

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Abstract. The purpose of this study was to design a blended learning environment, specifically a flipped classroom in order to provide capabilities for motivation to primary school students, to familiarize them with programming principles and encourage them to get involved with the STEAM (Science, Technology, Engineering, Arts, Mathematics) fields. The blended learning environment provides on-line distance learning programming activities integrated into Moodle through which asynchronous collaboration and problem solving skills are cultivated. It also provides face-to-face active learning through STEAM programming activities. The instructional design is based on the ARCS motivational model, for each of its key components (Attention - Relevance - Confidence - Satisfaction) different strategies and techniques were incorporated and combined with collaborative learning techniques, using various technological means. The study investigates mainly the impact of this design on the terms of: (a) motivation, (b) collaboration and (c) computational thinking of the students. The findings tentatively indicate that the instructional design of the blended environment is capable to empower motivation and enhance students' collaborative and computational thinking skills. However, a further research is required to confirm the proposed conceptual framework.

Keywords: Flipped classroom · ARCS model · Motivation
Collaborative Learning (CL) · STEAM · Moodle

1 Introduction

Since motivation plays an important and continuing role in learning and affects performance and achievements by enhancing cognitive processing or encouraging positive engagement, a key element for this challenging accomplishment is an effective instructional design. Designers should be aware of how the integration of motivational methods should be applied to various instructional conditions [15], taking into account both internal and external factors in their instruction [24]. However, the challenge seems to increase when the learning subject is considered complex and demanding by the students and the teachers correspondingly such as computer programming [4, 22] on a blended learning environment.

There are research gaps in blended learning due to the absence of a general consensus on its definition which should be theoretically coherent, philosophically

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well-founded and in a realistic way informative [17]. While there are many forms of blended learning, there is no acceptable classification of these [19]. In particular, research is limited regarding the implementation of motivational design strategies in blended courses. In addition, there is a lack of literature supporting the idea that learners gain different motivational experiences when the instructional design of blended courses is keeping up with the guidelines of the ARCS Motivation Model [5].

This study aims to contribute to the empirical evidence in the field of blended learning. It concerns an introductive approach to a wider spectrum of the research on learning factors of motivation, collaboration and computational thinking but focuses exactly on the design of a blended learning instruction by incorporating motivational strategies and techniques proposed by the ARCS model and collaborative techniques. Specifically, it highlights the introduction of the innovative rotation blended learning model [23] of a flipped classroom into primary education for teaching basic programming principles through STEAM concepts. The rest of the paper is structured as follows: Sect. 2 contains the theoretical background. Section 3 refers to the Method including the instructional design of the blended learning environment and the customization of the Moodle educational platform. Finally, Sect. 4 presents the discussion and future work.

2 Theoretical Background

Theoretical background documents this study by using references to the concepts of the ARCS model, Collaborative Learning and the innovating Flipped Classroom model as it is applied to Programming courses and STEM education.

2.1 The ARCS Motivational Model

The ARCS model [13] provides through its systematic procedure guidelines for designing motivational strategies based on the analysis of the motivational characteristics of learners [14].

Table 1. The two parts of the ARCS motivational model

Part a.1. Category	Part a.2. Subcategory/factor	Part b. Strategies [14]
Attention: the awaking of the curiosity and interest of the students	(A1) – Perceptual arousal	*Capture interest*
	(A2) – Inquiry arousal	*Stimulate inquiry*
	(A3) – Variability	*Maintain attention*

(*continued*)

Table 1. (*continued*)

Part a.1. Category	Part a.2. Subcategory/factor	Part b. Strategies [14]
Relevance: the connection between the learning environment and topics considered important to the students	(R1) – Goal orientation	*Relate to goals*
	(R2) – Motive matching	*Match interests*
	(R3) – Familiarity	*Tie to experiences*
Confidence: the attribution of students' success to their abilities and effort. It incorporates the concepts of self-regulation [26], self-efficacy [2] and recommends the creation of an internal locus of control	(C1) – Learning requirements	*Success expectations*
	(C2) – Success opportunities	*Learning activities*
	(C3) – Personal control	*Success attributions*
Satisfaction: all positive feelings that students receive by the completion of an achievement	(S1) – Self reinforcement	*Intrinsic satisfaction*
	(S2) – Extrinsic rewards	*Rewarding outcomes*
	(S3) – Equity	*Fair treatment*

It consists of three parts: (a) a set of four categories (Attention – Relevance – Confidence – Satisfaction) for human motivational concepts (b) strategies and techniques for enhancing motivation during learning process (c) a motivational design model [11]. Each category includes three basic subcategories/factors, each factor is accomplished by strategies and each strategy is completed by a set of techniques. The first part of the model is described briefly in Table 1 accompanied with a list of motivational strategies that Keller has proposed [13] and have been cited in several articles as successful in web-based and e-learning settings [11]. Subsequently, in this paper we will mostly refer to the ARCS techniques.

2.2 Collaborative Learning

According to Vygotsky [25], discussion and collaboration between individuals are the key elements of the learning experience. Collaborative Learning (CL) approaches student interactions and is considered an important stimulus of the learning process. When students participate in task-oriented learning groups then collaborative learning guides them to the cultivation of their social and team working skills offering at the same time valuable preparation for their careers [3]. A set of collaborative techniques [3] is at every designer's disposal, making the right selection according to the learning goals and settings. Therefore, the design of the suggested learning environment includes the familiar techniques of Brainstorming and Think-Pair-Share [16] due to the fact that they are based on a simplified procedure and can be accomplished even by primary school students with little experience in collaborative learning environments.

2.3 Programming, STEM Education and Flipped Classroom

Nowadays, STEM approaches encourage students to get acquainted with scientific inquiry, escaping from the common use of ICT [9] while they are directly linked to active learning [8]. Programming is considered a powerful tool for teaching key concepts applied in Mathematics, Physics and Logic [18] therefore it is a means of STEM education. Various programming tools give students the opportunity to create games, moving from game design to STEM education applications. A game-based approach has shown increased enjoyment in computer learning and concurrently the development of computational thinking concepts [21], since designing and developing a computer game is a complex task that requires not only programming, but also the ability to think at multiple levels of abstraction. Furthermore, the addition of the arts into the term STEAM has the effect of triggering students' imagination to develop creative thinking, innovation and design skills.

The flipped classroom model is an innovative effective teaching model, facilitated by technology which is gaining popularity in STEM education. In this new model students learn initial course concepts outside of the classroom often in an on-line environment in contrast to the traditional classroom paradigm, reserving in that way the total class time for more active learning [1, 20] providing capabilities for the development of critical thinking skills [10]. The advantages of a flipped classroom in the learning environment concern all involved [7]. On the one hand, the teacher doesn't spend precious time on providing new knowledge and thus she is able to cover more instructional matter. On the other hand, students perform better as the levels of comprehension of the cognitive subject increase. In fact, they enjoy learning by watching their instruction in condensed lesson videos [12] into the on-line settings of Moodle and benefit by doing less work than in a traditional classroom.

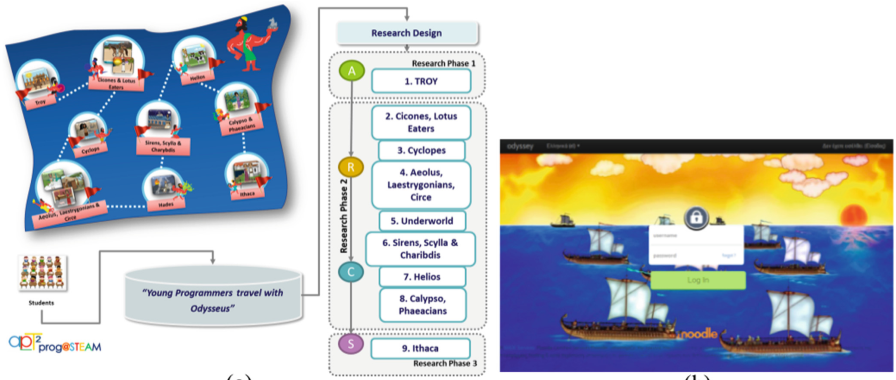
3 Method

This study aims to present the high impact of the instructional design of a flipped classroom on the basis of the ARCS model strategies/techniques combined with collaborative techniques, implemented by a wide range of technology on the learning factors of motivation, collaboration and computational thinking. Thus, this section presents an instructional well-designed framework. This framework also refers to the customization of the Moodle platform, highlighting the embedded plugins as an integral part of the design.

3.1 Instructional Design

The course was built on a case-study scenario of a programming Odyssey, in which "**Young programmers travel with Odysseus**" passing through nine course units. Every course unit was adapted and named by the real name of one or more stations of

Homer's Odyssey (Fig. 1a). The framework of a wider research is based on this scenario, although this paper focuses on the analysis of the instructional motivational design of the course unit.



(a) (b)

Fig. 1. a. An adaptation of Homer's Odyssey to the course b. Login page of the Moodle educational platform

In order to support the flipped classroom model, the suggested instructional design consists of a four-step instruction that is equally performed in both types of environment (face-to-face, on-line) progressing into three phases (Fig. 2).

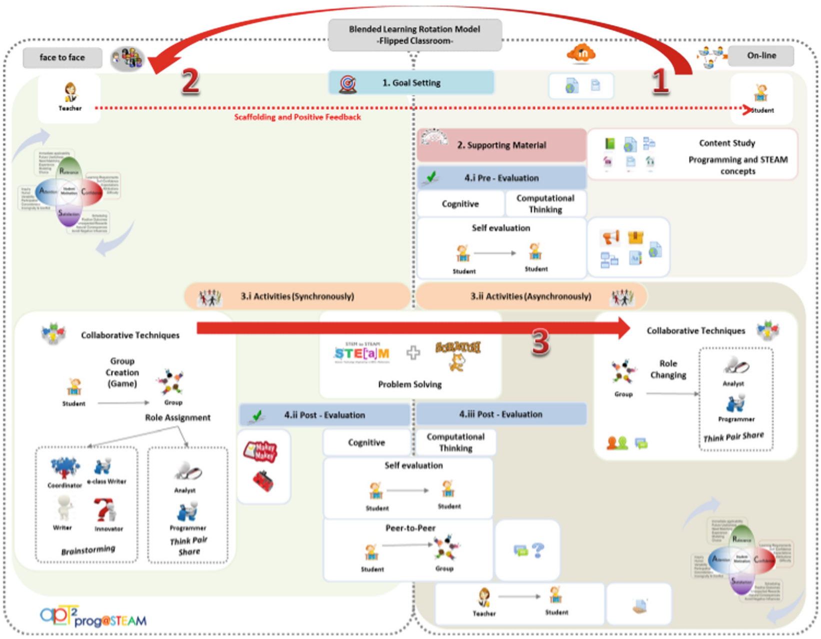


Fig. 2. Course unit instructional design

The first two phases follow the process of the flipped classroom model. The third is additional and has been incorporated in order to offer the opportunity to young students to collaborate remotely and asynchronously after they have already gained the live face-to-face experience. Table 2 illustrates the above figure, presenting a brief description of the learning process.

Table 2. Course unit instructional design analysis

Phase	Settings	Step	Description
Phase 1 (prepare new knowledge)	On-line	Step 1. Setting goals	Announcement of the learning objectives
		Step 2. Supporting material	Self-paced study on new programming and STEAM concepts
		Step 4.i. Pre-evaluation	Self-evaluation by completing on-line quizzes
Phase 2 (Flip the classroom for active learning)	Face-to-face	Step 1. Setting goals	Announcement of the learning objectives by the teacher
		Step 3.i. Activities	• Synchronous collaborative problem-solving activity on programming and STEAM • Groups creation and roles assignment
		Step 4.ii Post-evaluation	Peer-to-Peer evaluation by using Makey-Makey/Picoboard
Phase 3 (Shift the process back in order to proceed in asynchronous collaboration)	On-line	Step 3.ii. Activities	• Asynchronous collaborative problem-solving activity on programming and STEAM • Role alternation • Discussion and Deliverable posting
		Step 4.iii. Post-evaluation	• Self-evaluation by optimizing the given solutions • Peer-to-peer evaluation by using forum ratings and voting • Teacher's evaluation by filling marking guides or rubrics

A detailed description for each step of the instructional design is given below:

Step 1. Setting Goals: Learning objectives are set for the following three key elements: (a) programming concepts, as they arise from the functionalities of the SCRATCH programming tool, for example algorithmic structures, data input-output, debugging, etc. (b) STEAM concepts, as they spring off the elementary school curriculum for 4th, 5th and 6th grades (mathematics, physics and environmental study, ICT, music and visual arts) and (c) problem-solving techniques which indicate computational thinking skills as the following: logical reasoning, algorithm, decomposition, patterns' recognition, generalization, abstraction and evaluation. Furthermore, all learning requirements such as rules, assessment criteria, time duration and rewards are clearly presented to the students (e.g. assessments, grades, badges and certificates). Moodle is primarily compatible with the SCORM standard as well as with the integration of free/trial web-based tools such as VOKI, H5P and STORYBIRD into its resources through TinyMCE HTML editor.
Step 2. Supporting Material: The supporting material aims to document the theoretical framework of the course. It mainly concerns interactive multimedia (video, presentations, animations, comics, games etc.) with examples of the concepts to be taught. Thus, a variety of external web-based tools (e.g. SCRATCH, TOONDOO, THINGLINK, EDPUZZLE, ARTICULATE ENGAGE 360 and H5P) are integrated into labels, pages, books, lessons, urls of the Moodle educational platform providing a familiar and attractive learning context.
Step 3. Activities: Different collaborative problem-solving activities take place in both settings (face-to-face: Step 3.i Activities, on-line: Step 3.ii Activities). In particular, on-line settings demand the PADLET external tool, for brainstorming and discussion, a group choice plugin installation and forums' integration for TPS technique, too. More specifically, two types of forum were exploited in order to provide capabilities for real participation. The first was used for establishing separate discussion between pair group members and the second for posting all deliverable links or .sb2 files by all pair groups. Additionally, SCRATCH is dominant, supporting the learning of programming basics through STEAM concepts (e.g. learning the programming structure of repetition through a "water-cycle" simulation activity). In face-to-face settings, groups' creation occurs by taking advantage of educational and entertaining games, cultivating collaborative interaction between peers.
Step 4. Evaluation: In the context of self-evaluation, students test their new knowledge through quizzes, glossaries, feedbacks, games, etc. integrated in Moodle activities equally in terms of learning content and computational thinking (Step 4.i. Pre-Evaluation). In the context of peer-to-peer evaluation, while students share their projects, their peers are able to vote using Moodle choices or forum ratings. The teacher also assigns marks using guides or rubrics (Step 4.iii. Post-Evaluation). Evaluation gains strength through STEAM education in face-to-face settings. The boards of Makey-Makey and Picoboard give life to students' projects, increasing levels of interactivity to the fullest by connecting every day conducting materials (fruits, coins, staplers, water, etc.). Through active learning, experimentation and

observation on real-world phenomena simulations, inquiring and discussing, students are able to perceive STEAM concepts while examining whether their projects are executed correctly thus putting more emphasis on programming concepts (Step 4.ii. Post-Evaluation). Therefore, the "micro-world" environment of the SCRATCH programming tool helps the establishment of an "authentic learning environment". The following table (Table 3) presents a list of ARCS techniques, incorporated appropriately into every step of the course design and combined with the selected collaborative technique.

Table 3. Course design, ARCS factors and techniques

Step	ARCS factor	ARCS techniques	Brainstorming	TPS
1. Setting goals	**(A1) – Perceptual arousal**	• Introduce the emotional element • Use audiovisual media (graphics, videos, animations) • Use humor		
	(A3) – Variability	Alternate teaching methods, material and presentation tools		
	(R1) – Goal orientation	Describe the value of the knowledge provided in the present and future in various ways		
	(R2) – Motive matching	Demonstrate positive models (modeling)		
	(R3) – Familiarity	Use a specific language, examples and concepts that are directly related to students' experiences and values		
	(C1) – Learning requirements	• Divide the general purpose into clear objectives in each educational unit or activity • Present clearly the structure and components of the educational process		
2. Supporting material	**(A1) – Perceptual arousal**	• Introduce the emotional element • Use audiovisual media (graphics, videos, animations) • Use humor		
	(A3) – Variability	• Alternate teaching methods, material and presentation tools		
	(R1) – Goal orientation	• Relate learning process with students' interests and needs		
	(R3) – Familiarity	• Use a specific language, examples and concepts that are directly related to students' experiences and values • Place knowledge in a familiar context • Provide a personal choice of tools and methods for completing activities and tasks		
	(C1) – Learning requirements	• Highlight previous knowledge and skills that help students achieve their goals		
	(C3) – Personal control	• Provide the ability to the students to control their study rate by using auxiliary tools (menu, previous - next buttons, breadcrumbs, achievement bars)		
3. Activities	(A1) – Perceptual arousal	• Introduce the emotional element • Use humor		
	(A2) – Inquiry arousal	• Set a query and a problem solving activity	**1. Query announcement**	**1. Think**
	(C1) – Learning requirements	• Highlight previous knowledge and skills that help the student achieve his or her goal	**2. Group and roles assignment**	

(*continued*)

Table 3. (*continued*)

Step	ARCS factor	ARCS techniques	Brainstorming	TPS
		• Present clearly the structure and components of the educational process • Define clearly the process (type, duration, content) and the evaluation criteria • Provide scaffolding		
	(R2) – Motive matching	• Provide opportunities for collaborative interaction and personal responsibility enhancement	**2. Group and roles assignment**	**2. Pair**
	(A3) – Variability	• Shift interaction between peers	**3. Brainstorming into the group**	
	(C2) – Success opportunities	• Define peer-to-peer interaction for consolidation of confidence feelings	**4. Discussion into the group**	
	(R1) – Goal orientation	• Relate learning process with students' interests and needs		
	(R3) – Familiarity	• Place knowledge in a familiar context • Configure an "authentic learning environment"		
	(S1) - Self reinforcement	• Use educational games for relax and practice of new knowledge • Provide positive feedback for achievements' recognition		
4. Evaluation	(A1) – Perceptual arousal	Introduce the emotional element		
	(A3) – Variability	• Shift interaction between peers Use educational games for relax and practice of new knowledge		
	(R1) – Goal orientation	Describe the value of the knowledge provided in the future with feedback activities		
	(R3) – Familiarity	Configure an "authentic learning environment"		
	(C1) – Learning requirements	• Define peer-to-peer interaction for consolidation of confidence feelings Provide scaffolding		
	(C3) – Personal control	• Guide students to effective goals • Provide continuous (positive) feedback Provide Analytical grade in each task so that they know the margins of improvement		
	(S1) – Self reinforcement	• Provide positive feedback for achievements' recognition • Provide unpredictable remuneration instead of regular and intended for non-boring tasks Stimulate students to share knowledge with peers who have gaps	**5. Presentation and discussion into the classroom**	**3. Share**
	(S2) – Extrinsic rewards	• Provide high marks and positive feedback for boosting good performance • Provide External fees (praises, awards, certificates of attendance) • Use self-assessment methods • Use of visual/ acoustic stimuli associated with praise		
	(S3) – Equity	• Evaluate with predetermined assessment criteria for all (assessment rubrics) • Provide equal fee to students who have similar performance and degree of effort		

As evident in the previous table, each step's motivational gravity lays almost on different ARCS factors which are indicated by a bold font.

3.2 On-Line Environment – Moodle Customization

As a matter of fact, Moodle is a flexible educational platform which provides capabilities for a variety content creation, students' active attitude towards learning content and development of collaboration and critical thinking skills. As mentioned above, the instructional design utilizes many different resources and activities, offered by Moodle. However, there are some extra settings which incorporate ARCS techniques into on-line environment mainly through plugin installation. For example, Evolve-D is a very attractive Moodle theme, which simplifies the entrance to the platform (Fig. 1b) and the access to the learning content of the course. Also, the "Meet the students" block provides communication capabilities among all participants by presenting their avatars as it happens in on-line games. A customized user-friendly dashboard which displays the gamified case-study scenario as an Odyssey route interactive image provides the structure of the course clearly in a different but at the same time attractive way. Furthermore, "Grid course format" is a modular and visual learning form for each Moodle course structure, providing a grid of icons, one for each topic. When a student clicks on an icon, the content of the topic is displayed in a "lightbox". At the same time, the most powerful tool is the Progress Bar Block. It is a time management tool for students, showing the progress in course activities/resources. It includes color coding for an easy classification of completed or non-completed activities, which can be sorted by time criteria. According to ARCS model, the cultivation of intrinsic motivation is necessary for the student with the self-regulation enhancement in a personalized learning environment. Group Choice, is a very effective tool that allows students to enroll automatically in a course group and randomly be divided into groups so that everyone can work together, supporting on-line collaboration. Finally, Moodle provides the utility of the badges, awarding students for their accomplishments as well as assessment methods such as rubrics and marking guides, establishing a fair evaluation for all.

The following table (Table 4) presents a list of Moodle plugins and extra settings corresponding to ARCS factors and techniques for every step of the instructional design.

As such, the presented framework attempted to support the flipped classroom model, utilizing mostly a variety of technological means provided by Moodle and other external resources. The purpose of this attempt was the creation of an effective motivational blended learning environment in which students empower their motivation and collaboration. Based on our study, the incorporation of motivational strategies combined with collaborative techniques on the basis of ARCS instructional design, highlighted high levels of motivation both into on-line and face-to-face settings. Making use of improvised questionnaires judged on a five-point Likert scale (1 = strongly disagree and 5 = strongly agree) under IMMS (Instructional Material Motivation Survey) and CIS (Course Interest Survey) guidelines, there was **a predominance of the on-line environment on students' motivation** (on-line settings means: Attention: 4,458, Relevance: 4,380, Confidence: 4,037, Satisfaction: 4,833, **Motivation: 4,3958/**

Table 4. Moodle plugins and extra settings

STEP	ARCS factor	ARCS techniques	Moodle tool
	(A1) – Perceptual arousal	• Introduce the emotional element • Use audiovisual media (graphics, videos, animations)	Moodle theme evolve-D (plugin) Meet the students block (plugin)
1. Setting goals	(C1) – Learning requirements	Present clearly the structure and components of the educational process	User dashboard (customized setting)
2. Supporting material	(C3) – Personal control	Provide the ability to the students to control their study rate by using auxiliary tools (menu, previous - next buttons, breadcrumbs, achievement bars)	Course format grid (plugin) Progress bar block (plugin)
3. Activities	(R2) – Motive matching	Provide opportunities for collaborative interaction and personal responsibility enhancement	Group choice (plugin)
	(A3) – Variability	Shift interaction between peers	
	(C2) – Success opportunities	Define peer-to-peer interaction for consolidation of confidence feelings	
4. Evaluation	(S2) – Extrinsic rewards	Provide External fees (praises, awards, certificates of attendance)	Badges (customized setting)
	(S3) – Equity	Evaluate with predetermined assessment criteria for all (assessment rubrics)	Rubrics/marking guides (customized setting)

face-to-face settings means: Attention: 4,365, Relevance: 4,324, Confidence: 3,990, Satisfaction: 4,380, **Motivation: 4,270**). In terms of collaboration (Leadership & Initiative, Participation, Flexibility, Responsibility & Productivity, Responsiveness & Constructive Feedback and Self-Regulation) the motivational instructional design of the blended learning environment also showed a significant impact (**mean: 4,078**), confirming the well-designed framework.

4 Conclusions and Future Work

During the instructional motivational design of the blended learning environment there are many parameters that should be taken into account. The assumption on which ARCS is based, that the individual must give value to their work and believe they will achieve their ultimate goal, is the key of motivation. As such, the design should pay attention to the students' beliefs, needs, attitudes and previous knowledge toward learning subject and in general to the learning process. Specifically, students' belief about programming difficulty is an inhibiting factor. This fact guides the instructor to construct relevant learning material of scalable difficulty to students' needs, encouraging them to set their own personal goals and believe them.

From this perspective, technology is a significant ally of the motivational instructional design. Designers have a wide range of technological means at their disposal, many of which provide unlimited possibilities to students' positive learning experience. Both, Moodle tools and the various external ones, offer variability in on-line settings which concerns the increased levels of interactivity between student and learning material, peers, and teacher and student. Besides, communication and collaboration are achieved through technology in that kind of environments and are enhanced by using monitoring mechanisms [6] and tools for discussion, reflection and feedback such as forums, which are used for all these purposes, in a simplified version. However, from a programming teaching perspective the following issues are very sensitive: (a) an integration of a SCRATCH plugin filter into Moodle platform updated to current needs and (b) a distributed way of pair programming through Moodle platform.

From another perspective, the Flipped Classroom was applied effectively by favoring students the comprehension of the programming and STEAM concepts and that is due to the fact that the instructional design exploited the pedagogical philosophy of Moodle. Moodle is definitely a user-friendly, a learner-centered and a flexible system that provides opportunities to students to become independent self-regulated learners. As such, more time was gained for face-to-face active learning by exploiting all the functionalities of Makey-Makey & Picoboard boards for STEM education, enhancing in this way students' computational thinking skills (**pre-test mean: 2,8444, post-test mean: 3,4345**).

To sum up, the orchestration of the well-designed instructional framework on the basis of the ARCS motivational model, the collaborative techniques, the flipped classroom model and STEAM, succeed in enhancing all the above mentioned skills (motivation, collaboration, computational thinking). Our next step is to present a rigorous analysis of research methodology and framework as well as the final statistical analysis in a future paper.

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References

1. Adams, R., Evangelou, D., English, L., Figueiredo, A.D., Mousoulides, N., Pawley, A., Schifellite, C., Stevens, R., Sviniki, M., Trenor, J.M., Wilson, D.M.: Multiple perspectives on engaging future engineers. J. Eng. Educ. **100**(1), 44–88 (2011)
2. Bandura, A.: Self-efficacy. In: Ramachaudran, V.S. (ed.) Encyclopedia of Human Behavior, vol. 4, pp. 71–81. Academic Press, New York (1994). (Reprinted in Friedman, H. (ed.): Encyclopedia of Mental Health. Academic Press, San Diego (1998)
3. Barkley, E.F., Cross, K.P., Major, C.H.: Collaborative Learning Techniques: A Handbook for College Faculty. Wiley, Hoboken (2014)
4. Chatzinikolakis, G., Papadakis, S.: Motivating K-12 students learning fundamental computer science concepts with app inventor. In: 2014 International Conference on Interactive Mobile Communication Technologies and Learning (IMCL), pp. 152–159. IEEE (2014)
5. Colakoglu, O.M., Akdemir, O.: Motivational measure of the instruction compared: instruction based on the ARCS motivation theory vs traditional instruction in blended courses. Turk. Online J. Distance Educ. **11**(2), 73–89 (2012)

6. Collazos, C.A., Guerrero, L.A., Pino, J.A., Ochoa, S.F.: Improving the use of strategies in computer-supported collaborative processes. In: Favela, J., Decouchant, D. (eds.) CRIWG 2003. LNCS, vol. 2806, pp. 247–260. Springer, Heidelberg (2003). https://doi.org/10.1007/978-3-540-39850-9_22
7. Fulton, K.: Upside down and inside out: flip your classroom to improve student learning. Learn. Lead. Technol. **39**(8), 12–17 (2012)
8. Gasiewski, J.A., Eagan, M.K., Garcia, G.A., Hurtado, S., Chang, M.J.: From gatekeeping to engagement: a multicontextual, mixed method study of student academic engagement in introductory STEM courses. Res. High. Educ. **53**(2), 229–261 (2012)
9. Govaerts, S., Cao, Y., Vozniuk, A., Holzer, A., Zutin, D.G., Ruiz, E.S.C., Tsourlidaki, E.: Towards an online lab portal for inquiry-based stem learning at school. In: Wang, J.F., Lau, R. (eds.) ICWL 2013, vol. 8167, pp. 244–253. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-41175-5_25
10. Herreid, C.F., Schiller, N.A.: Case studies and the flipped classroom. J. Coll. Sci. Teach. **42**(5), 62–66 (2013)
11. Hodges, C.B.: Designing to motivate: motivational techniques to incorporate in e-learning experiences. J. Interact. Online Learn. **2**(3), 1–7 (2004)
12. Johnson, G.B.: Student perceptions of the flipped classroom. Doctoral dissertation, University of British Columbia (2013)
13. Keller, J.M.: Development and use of the ARCS model of instructional design. J. Instr. Dev. **10**(3), 2–10 (1987)
14. Keller, J.M.: How to Integrate Learner Motivation Planning into Lesson Planning: The ARCS Model Approach, pp. 1–13. VII Semanario, Santiago (2000)
15. Keller, J.M., Litchfield, B.C.: Motivation and performance. In: Reiser, R.A., Dempsey, J.V. (eds.) Trends and Issues in Instructioanal Design and Technology. MerillPrenctice Hall, Upper Saddle River (2002)
16. Lyman, F.: Think-pair-share: an expanding teaching technique. Maa-Cie Coop. News **1**(1), 1–2 (1987)
17. Oliver, M., Trigwell, K.: Can 'blended learning' be redeemed? E-learn. Digital Media **2**(1), 17–26 (2005)
18. Papert, S.: Mindstorms: Children, Computers, and Powerful Ideas. Basic Books Inc., New York (1980)
19. Picciano, A.G., Dziuban, C.D., Graham, C.R.: Blended Learning: Research Perspectives. Routledge, Abingdon (2013)
20. Ramírez, D., Hinojosa, C., Rodríguez, F.: Advantages and disadvantages of flipped classroom: STEM students perceptions. In: 7th International Conference of Education, Research and Innovation ICERI, Seville, Spain, pp. 17–19 (2014)
21. Repenning, A., Webb, D., Ioannidou, A.: Scalable game design and the development of a checklist for getting computational thinking into public schools. In: Proceedings of the 41st ACM Technical Symposium on Computer Science Education, pp. 265–269. ACM (2010)
22. Robins, A., Rountree, J., Rountree, N.: Learning and teaching programming: a review and discussion. Comput. Sci. Educ. **13**(2), 137–172 (2003)
23. Staker, H., Horn, M.B.: Classifying K-12 Blended Learning. Innosight Institute, San Mateo (2012)
24. Stracke, E.: A road to understanding: a qualitative study into why learners drop out of a blended language learning (BLL) environment. ReCALL **19**(01), 57–78 (2007)
25. Vygotsky, L.S.: Mind in Society: The Development of Higher Psychological Processes. Harvard University Press, Cambridge (1978)
26. Zimmerman, B. J.: Attaining self-regulation: a social cognitive perspective. See Boekart-set al. 2000, pp. 13–39 (2000)

An Experience Using Educational Data Mining and Machine Learning Towards a Full Engagement Educational Framework

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Abstract. The Massive Open Online Courses (MOOC) movement is part of the learning ecosystem nowadays. Several educational institutions are offering a myriad of courses from different topics. However, it is evident that the courses are facing a high drop-out rate, while some students, classified as lurkers, are used to enroll to the courses and read specific content or in the worst case they are enrolled by they never log-in to the course. This work presents an experience using an innovative framework with the aim to create full engagement for the learners on massive open online learning environments. The framework is called Full Engagement Educational Framework (FEEF). This experience contributes to the framework with an innovative module prototype that makes use of the Educational Data Mining (EDM) and Machine Learning (ML) techniques to feed a virtual assistant that provides appropriate feedback and follow-up to students in order to increase engagement and reduce drop-out. This work evolves the FEEF functionalities, the future work envisages the improvement of the module and optimization with large amount of students and different courses at a time.

Keywords: Interaction analysis · EDM · Machine learning · MOOCs Engagement · Adaptive learning

1 Introduction

At present the online learning scenarios that students are facing is quite extensive and encouraging. The MOOC movement is offering a myriad of courses from different topics, prepared in different languages and taught by top-class teachers from the most important institutions. The different aspects related to MOOCs have been analyzed in literature. In this sense, authors in [1–3] present a detailed evolution and potential of the MOOC movement, including the definition of a taxonomy of the different types and uses of MOOCs for educational purposes. On the other hand, the latent issue related to the high drop-out rates in MOOCs is depicted in [4–6]. Moreover, authors in [7–10] explore on the accessibility aspects that should be included in MOOCs in order to be used by all the students, including students with disabilities.

In order to explain the general idea of this work, and the reasons and problems that the proposal intends to tackle, the following use cases are presented as follows. It is possible to identify three phases related to the learner life-cycle in a MOOC:

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pre-MOOC, MOOC and post-MOOC. The first use case for your consideration is related to a self-pace enrollment course. In this kind of courses the learner is able to start the course at the beginning of any new week. This particular case presents the potential drawback that the learners could be enrolled in different weeks, and have different progress within the course path. As an example, each new week several learners are starting the course, so there are in different states of the learning path, and because it is a self-pace scenario, the learner could stop the activity for one or two weeks, so there is no certainty that the learner will be at a specific learning unit. In this sense, it is difficult and inefficient for the instructor to send global reminders unless the learners of a specific week are grouped. It could be interesting if the MOOC learning environment is able to detect the actual status of the learner, and then elicit an effective communication at scale. In terms of communication, there are several options related to key messages destined to the learners, as an example: the outline of the activities of the week, video highlights, personal messages to follow-up the opinion from the learner, news about the topic of the course among others. Taking into account the first use case, it is possible to identify that in the pre-MOOC phase, the waiting time for the learner to start the course is minimal. In this sense, it is important to mention and consider as part of the pre-MOOC phase the high amount of learners that enroll on a course and actually never log-in to start the learning experience. The second phase of the participation cycle is the learning experience within the MOOC, this phase involves the specific duration of the course and the different activities planned by the teaching staff. The post-MOOC phase begins after the end of the course, in the case of a series of MOOC course, the organizers are interested in the perseverance from the learner, which will be crystallized if the learner continues to the next course and finally finish all the scheduled courses in a particular series of courses.

The second use case is defined with a group of MOOC courses with a previously defined starting and ending date. In this sense, the courses have fixed dates and all the learners will try to complete the course at the same pace. For this use case it is possible to identify that in the pre-MOOC phase, the learner could be enrolled to the course several weeks before the beginning of the learning experience. During this waiting time several scenarios can happen, including a loss of interest from the learner in the course topics or the emergence of new time-consuming tasks that will hinder the participation of the learner in the course, leading to a potential drop-out. The MOOC and post-MOOC phases are similar to the first case, with the goal to motivate the learners to complete each of the courses that are part of a series of courses with the aim to create a long-lasting relationship.

This work presents an experience to complement the Full Engagement Educational Framework (FEEF) [11–13] with an innovative module prototype that makes use of the Educational Data Mining (EDM) and Machine Learning (ML) techniques. The aim of the proposed module prototype is to overcome the problem that the teacher cannot handle personalized messages for each of the learners. Moreover the aim is that the module prototype will act in the future as a virtual teaching assistant, making use of the defined rules from the teacher, and even more, will be able to start learning through an artificial neural network making use of Deep Learning (DL) techniques. The main task of the proposed prototype is to provide appropriate feedback and follow-up to students in order to increase engagement and reduce drop-out.

The work is organized as follows: Sect. 2 presents a literature review related to Data Mining (EDM) and Machine Learning (ML). Then Sect. 3 describes the proposed component within the Full Engagement Educational Framework (FEEF), complemented with a first validation in Sect. 4. Finally, in Sect. 5 conclusions are presented with a lookout for future work.

2 Related Work

Nowadays, several educational institutions are exploring into different ways to make use of the huge volumes of data that is generated by Virtual Learning Management systems, and aspect that is particularly true in the context of MOOC courses, with an evident approach of massiveness and scale. In order to achieve this objective to improve the performance of the students, provide better personalized experiences, reduce drop-out and increase engagement, research groups are making use of the Educational Data Mining (EDM) field of study. The EDM is an interdisciplinary approach that makes use of statistics, data processing, patterns recognition, information retrieval techniques and recommender systems methods to improve the teaching-learning experiences [14]. EDM is a sub-domain of Data Mining with the aim of extraction of meaningful and interesting patterns from the current and historical data. Different works in literature present experiences using the Educational Data Mining (EDM) with the purpose to acquire knowledge that can be used to offer suggestions to enhance the decision making process from teachers. As an example using strategies as: detection of usage patterns, classify participant learning styles, prediction, grouping, to recommend the best courses combination, to group students with similar performance, among others [15]. Moreover, the concept of Machine Learning (ML) in a component is related to an artifact that makes use of algorithms that parse the data, then learn from the available data to apply what the artifact has learned to make informed decisions. In this sense it is important to highlight that several applications in customer service utilize machine learning algorithms with the aim to achieve self-service functionality and providing means to increase the final user productivity. In the case of customer service applications, the algorithms are fed from the incoming customer queries from the email messages and ticketing system, an approach that could be extrapolated to the context of online education.

The context of this paper is related to previous work prepared within the Full Engagement Educational Framework FEEF [11–13], a proposal with the aim to create a holistic learning experience that will last before, during and especially after a MOOC course is finished. This framework is composed of different strategies to identify specific target audiences in order to create engaging experiences through valuable and interesting content. In this work, the Data Mining and Machine Learning component is presented, with the aim to facilitating the task of personalized communication with a great number of learners, each one in different phases of the learning path.

3 EDM and Machine Learning Component Proposal

The aim of the proposed component is to increase engagement, contributing to the FEEF framework [13]. In terms of learner engagement, Kuh et al. [16] defined the term as a two-fold condition. The first one is represented by the amount of time and effort learners put into their learning activities and self-study. The second component of learner engagement is represented on how the institution deploys its resources and organizes the learning activities in order to induce learners to participate in the proposed activities that lead to the experiences and desired outcomes such as persistence, satisfaction, learning, and finally, course completion and certification. Both components represent study fields based on the data analysis, but more importantly based on the context and progress of each learner. In the same line, there are studies in literature [17, 18] that explore on different approaches to motivate and engage learners to be persistent and complete a course with a strong component of service-based architectures and cloud technologies used for learning activities. There are also studies that explore on the use of gamification in learning scenarios to increase motivation [19, 20]. Nevertheless, it is not possible to find an online framework proposing specific actions to be performed to involve learners in all the phases of a MOOC (pre-MOOC, MOOC and post-MOOC) while at the same time perform personalized communication with the learners, based on context-aware information and the particular stage within the MOOC.

The identified Full Engagement Educational Framework (FEEF) [13] is composed of the following components:

- An online community with open forums to discuss MOOCs topics and specific topics not tied to the MOOCs contents
- Production of edutainment content to create engaging experiences
- A blog to publish such *high value content* to targeted audiences
- Distribution of content to enrolled learners
- Distribution of at least 20% of the MOOC content as open tutorials
- Social media channels for content distribution to increase the reach to targeted audience beyond enrolled learners
- Specific segmentation of the different types of enrolled learners with the aim of providing targeted communication to take them to the next level of engagement and course participation

The aim of the new Full Engagement Educational Framework (FEEF) component [13] is to create a holistic learning experience that will last before, during and especially after a MOOC course is finished. This framework is composed of different strategies to identify specific target audiences in order to create engaging experiences through valuable and interesting content. Moreover, the main idea is to move learners from each of the following groups: Potential Learner, New Learner, Low-Activity Learner and Active Learner with a strong use of personalized communication with the help of Educational Data Mining and Machine Learning. The different strategies are planned to increase learners' activity and create a long-lasting relationship. One of the main strategies is to elicit specific segmentation of the different types of enrolled learners with the aim of providing targeted communication to take them to the next level of engagement and course participation.

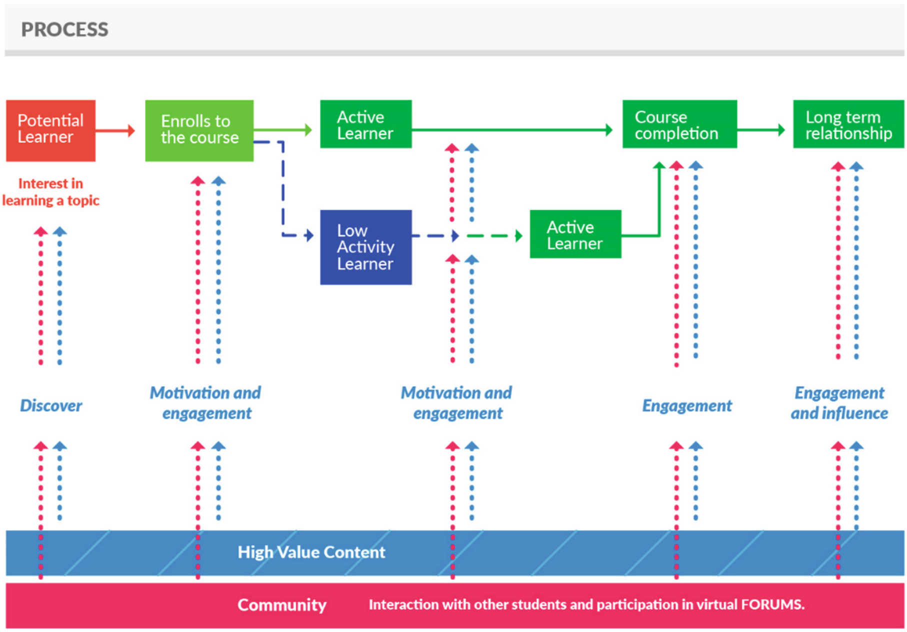

Fig. 1. Identified process to move learners using the FEEF [13]

In order to identify each of the phases of the learner life-cycle (pre-MOOC, MOOC, post-MOOC) two use cases were presented in the introduction. The first use case is related to a self-pace enrollment course and the second use case is related to a MOOC course with a previously defined starting and ending date, a fixed cohort. In both use cases, there is a Potential Learner group, these learners are exposed to the open content available through online communities with a common topic. The goal of the different strategies is to motivate a Potential Learner to actually enroll and start the course. Then, the learner will be classified based on the amount of activity performed within the course, the learner will be moved to the "Active Learner" or the "Low Activity Learner" groups (see Fig. 1). With the help of personalized notifications inside and outside the virtual learning environments, the learner is encouraged to enjoy the content provided in each learning unit. At the same time, an automatic and personalized follow-up is envisaged with the use of machine learning techniques. Finally, when the learners complete and approve a course the efforts are focused to the enrollment in the next course in the path, creating a long-lasting relationship. Figure 1 presents the process followed using the framework to move learners from the main categories: (Potential Learner, Low Activity Learner and Active Learner).

Specifically the data of each student is analyzed with detail, and based on the performance and behavior of the students, the Machine Learning component makes the decisions of the next notification. As an example, if a student that is included in the group "Low Activity Learner" provides a positive response to the different inputs (reminder, high value content video, short micro lesson, etc.), the module with adapt to the next response and each student will be treated in a personalized way and all the results will be recorded for re-learning purposes.

4 Component Validation and First Results

The experiences presented in this work were prepared by Galileo University within the edX platform with a MicroMasters specialization titled "Professional Android Developer". In the case of the "Professional Android Developer", this specialization has five courses and the first cohort had more than 30,000 enrolled participants.

This specialization has the following five courses:

- Java Fundamentals for Android Development
- Android App Development for Beginners
- Professional Android App Development
- Monetize your Android Applications
- Android Developer Capstone Project: Building a Successful Android App.

For this innovative framework, specific engaging actions were identified for each of the three phases of the learner life-cycle: pre-MOOC, MOOC and post-MOOC. The proposed engaging experiences are intended to take the participants from a very low interest in pursuing the course at a specific time, to an increased level of engagement that will enable the learner to gain real interest in the topic and invest more time to learn in the near future.

Related to the pre-MOOC and MOOC phases, the teaching staff part of the proposed educational framework prepared engaging and informative content to periodically send e-mail messages to keep the learners interested and informed even if they enrolled in the course three months before the start of the course and the high value content is sent through all the MOOC course. With the incorporation of the Educational Data Mining and Machine Learning component, this tasks were automated with a decrease of the work from the teaching staff, giving them more time to other tasks within the course and providing follow-up to the activity of the prototype.

For this full engagement educational framework a real community is built around each MOOC specialization. The aim is to create a community that persists after the learner finished the course through the post-MOOC phase. While nurturing a sense of belonging, sharing knowledge and increase skills, the community also serves as a place where participants can ask for help with real job questions and problems. The discussion forums are at the heart of the community, thus all questions and answers are done through the community. The communities provide blogs, high quality content and videos related to the topics of the courses.

For the particular case of the "Professional Android Developer" MicroMasters, the FEEF has proven to create long-lasting engaging experiences with an average of 12,000 weekly readers in the blog (http://androiddeveloper.galileo.edu). Specifically, using the PTAT (People Taking About This) metric, which represents the number of unique people that created a story about a page or on a page via different actions as the following: Like to page, Like to post, content sharing; Mentions, tags, event registration; Comments on the wall, retweets, answer to a poll. For the particular case of both blogs, the monthly average PTAT is 10,000. Reaching an average of 50,000 viewers per week, and with peaks of over 200,000 viewers per week. Figure 2 presents the top channels of distribution and daily session average of 500 visits for a particular space of time between March and June 2017.

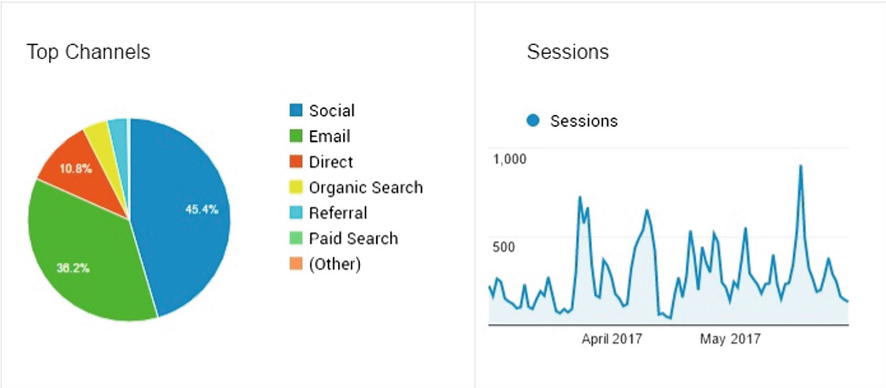

Fig. 2. Top channels of distribution and daily session average of 500 visits for MicroMasters on Android Development.

The Full Engagement Educational Frameworks has proven to create lasting engaging experiences and move learners from being inactive to low activity to higher activity within the MOOC.

Additionally, it is important to mention that the discussion forums that are used during the MOOC course provide enhanced and easy tools to foster collaboration, and increase visibility of community leaders and major contributors, providing means for community recognition. An important fact is that the community is fully open, and will remain open after the end of the course so the learners are able to browse through it without login, and also is possible to participate in it without being member of a MOOC in order to create a live and growing community to enhance the post-MOOC phase. Actually for the common configuration of MOOCs, the discussion forums represent an internal learning activity, but the idea is to open the access to general topic discussion forums to all participants so that the content and contribution will not be lost at the end of the course, even the enrolled learners are not able to review the discussion forums again past the expiration date of the courses, in this sense it is important to provide an open space to involve potential and future learners and public in general to make use of the interesting discussions of topics of general interest. At the same time, internal forums to discuss particular aspects of the course and methodology will be taken into account.

In summary the expected results from the FEEF and the prototype module are the following:

- Learning analytics related to the engagement perception and proper context-aware information to learners
- Identification of at least three main levels: potential learner, low to moderate participation, high participation
- Identification of the following stages: potential user stage, enrollment phase, pre-MOOC, becoming active user, MOOC, post-MOOC
- Generation of a sense of belonging materialized with the enrollment in the next courses of a proposed series of courses from the same institution
- Increased awareness and enrollment
- Generation of positive open influence on the Web in order to attract potential learners continually
- Maintain a long-term relationship with the learner, independently of her current engagement and participation level.

5 Conclusions and Future Work

At present the online learning scenarios that students are facing is quite extensive and encouraging. The MOOC movement is offering a myriad of courses from different topics, prepared in different languages and taught by top-class teachers from the most important institutions. However there are issues related to high drop-out rates that should be improved while increasing the engagement of the learners with different techniques.

This work presents an experience using an innovative framework with the aim to create full engagement for the learners on massive open online learning environments. The framework is called Full Engagement Educational Framework (FEEF). This experience contributes to the framework with an innovative module prototype that makes use of the Educational Data Mining (EDM) and Machine Learning (ML) techniques to feed a virtual assistant that provides appropriate feedback and follow-up to students in order to increase engagement and reduce drop-out.

In order to identify each of the phases of the learner life-cycle (pre-MOOC, MOOC, post-MOOC) two use cases were presented. The first use case is related to a self-pace enrollment course and the second use case is related to a MOOC course with a previously defined starting and ending date, a fixed cohort. In both use cases, there is a Potential Learner group, these learners are exposed to the open content available through online communities with a common topic. The goal of the different strategies is to motivate a Potential Learner to actually enroll and start the course. Then, the learner will be classified based on the amount of activity performed within the course, the learner will be moved to the "Active Learner" or the "Low Activity Learner" groups. The innovative module prototype provide personalized notifications inside and outside the virtual learning environments, with the messages the learner is encouraged to enjoy the content provided in each learning unit.

This work evolves the FEEF functionalities, the future work envisages the improvement of the module and optimization with large amount of students and different courses at a time.

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References

1. Sanchez-Gordon, S., Luján-Mora, S.: MOOCs gone wild. In: Proceedings of the 8th International Technology, Education and Development Conference (INTED 2014), pp. 1449–1458 (2014)
2. Pilli, O., Admiraal, W.F.: A taxonomy for massive open online courses. Contemp. Educ. Technol. **7**(3), 223–240 (2016)
3. Collazos, C.A., González, C.S., García, R.: Computer supported collaborative MOOCs: CSCM. In: Proceedings of the 2014 Workshop on Interaction Design in Educational Environments, p. 28. ACM (2014)
4. Onah, D.F., Sinclair, J., Boyatt, R.: Dropout rates of massive open online courses: behavioural patterns. In: EDULEARN 2014 Proceedings, pp. 5825–5834 (2014)
5. Liyanagunawardena, T.R., Parslow, P., Williams, S.: Dropout: MOOC participants' perspective (2014)
6. Halawa, S., Greene, D., Mitchell, J.: Dropout prediction in MOOCs using learner activity features. In: Experiences and Best Practices in and Around MOOCs, vol. 7 (2014)
7. Varela, C., Miñán, A., Hilera, J., Restrepo, F.A., Amado, H., Córdova, M.A., Villaverde, A.: Estándares y legislación sobre accesibilidad web. In: Actas del IV Congreso Internacional ATICA, pp. 46–56 (2012)
8. Amado-Salvatierra, H.R., Hilera, J.R., Tortosa, S.O., Rizzardini, R.H., Piedra, N.: Towards a semantic definition of a framework to implement accessible e-learning projects. J. Univ. Comput. Sci. **22**(7), 921–942 (2016)
9. Martín, J.L., Amado-Salvatierra, H.R., Hilera, J.R.: MOOCs for all: evaluating the accessibility of top MOOC platforms. Int. J. Eng. Educ. **32**(5), 2274–2283 (2016)
10. Hilera, J.R., et al.: Combining multiple web accessibility evaluation reports using semantic web technologies. In: Paspallis, N., et al. (eds.) Advances in Information Systems Development. LNISO, vol. 26, pp. 65–78. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-74817-7_5
11. Hernández, R., Amado-Salvatierra, H.R.: Towards full engagement for open online education. A practical experience for a MicroMaster. In: Delgado Kloos, C., Jermann, P., Pérez-Sanagustín, M., Seaton, D.T., White, S. (eds.) EMOOCs 2017. LNCS, vol. 10254, pp. 68–76. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-59044-8_8
12. Hernández, R., Amado-Salvatierra, H.R.: An adaptive learning approach using a full engagement educational framework. In: Xhafa, F., Caballé, S., Barolli, L. (eds.) 3PGCIC 2017. LNDECT, vol. 13, pp. 622–631. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-69835-9_58
13. Rizzardini, R.H., Amado-Salvatierra, H.R.: Towards full engagement for open online education. A practical experience from MicroMasters at edX. In: Caballé, S., Conesa, J. (eds.) Software Data Engineering for Network eLearning Environments. LNDECT, vol. 11, pp. 161–177. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-68318-8_8
14. Romero, C., Ventura, S.: Educational data mining: a review of the state of the art. IEEE Trans. Syst. Man Cybern. Part C (Appl. Rev.) **40**(6), 601–618 (2010)
15. Dutt, A., Ismail, M.A., Herawan, T.: A systematic review on educational data mining. IEEE Access **5**, 15991–16005 (2017)

16. Kuh, G.D., Kinzie, J. Buckley, J.A., Bridges, B.K., Hayek, J.C.: Piecing together the learner success puzzle: research, propositions, and recommendations. In: ASHE Higher Education Report, vol. 32, no. 5. Jossey-Bass, San Francisco (2007)
17. Quaye, S.J., Harper, S.R.: Learner Engagement in Higher Education: Theoretical Perspectives and Practical Approaches for Diverse Populations. Routledge, Abingdon (2014)
18. Clark, R.C., Mayer, R.E.: E-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning. Wiley, Hoboken (2016)
19. Muntean, C.I.: Raising engagement in e-learning through gamification. In: Proceedings of 6th International Conference on Virtual Learning ICVL, pp. 323–329 (2011)
20. Morales, M., Amado-Salvatierra, H.R., Hernández, R., Pirker, J., Gütl, C.: A practical experience on the use of gamification in MOOC courses as a strategy to increase motivation. In: Uden, L., Liberona, D., Feldmann, B. (eds.) LTEC 2016. CCIS, vol. 620, pp. 139–149. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-42147-6_12

ICT Skills in University Teachers, the Knowledge, Use and Pedagogical Appropriation of These Technologies

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Abstract. The main objective of this research work was to identify the ICT skills that teachers have in knowledge use and pedagogical appropriation of these technologies in the educational practice, for a university in the city, Duitama (Boyacá-Colombia), based on a diagnosis made to the teachers of one of their undergraduate programs. The instrument used was a questionnaire designed based on three documents alluding to ICT competencies for teachers, the participants of the study had provision and recognition of the need to have sufficient skills that allow them to appropriate ICT in a didactic way. It is concluded that it is important to provide teachers with spaces that enable them to improve their skills in the digital era, with strategies that train teachers, including ICT in the teaching processes, facilitating students to improve their learning, helping them acquire specific skills that contribute to making them digitally competent, taking into account that they are elements to be taken into account by the university professors, interested in providing a quality education according to the latest development.

Keywords: ICT skills · Teacher training · Training · Educational practice

1 Introduction

Even in the current era of digital endemics, it can be verified that in some contexts the appropriation of ICT can be complicated and create a digital divide by establishing a factor of inequality to the community involved. This leads to reflect on how ICT should be leveraged to be implemented in favour of that community and not against it (Del Vasto 2015). The level of competences of teachers in higher education has been a cause of studied because of its importance for the performance of their work, and especially for its impact on student learning (Valenzuela et al. 2013).

L. Uden et al. (Eds.): LTEC 2018, CCIS 870, pp. 249–259, 2018.
https://doi.org/10.1007/978-3-319-95522-3_21

The importance of the teaching role to the impact of ICT requires constant updating, they must rethink their work and learn to use new means and resources to implement them in the classroom (Arista 2014).

To guide the integration of ICT in teaching practice, some authors such as Mishra and Koehler (2006) propose the concept of TPACK, corresponding to the acronym of the expression "Technological PedAgogical Content Knowledge". Being a model that identifies the types of knowledge that a teacher needs to master the integration of ICT in an effective way in the teaching that imparts.

Some teachers seeking to transform their teaching practices incorporate different ICT within the classroom, but these attempts often fail, because they do not count as indicated by the TPACK model with the pedagogical and technological knowledge needed to integrate ICT pedagogically into the training process (Schmidt et al. 2009 cited by Boude and Sarmiento 2016).

After 30 years of research in the field of integration of Information Technology and Communication (ICT) in education, we understand that ICTs are tools to provide content and implement best educational practices (Rodriguez et al. 2012; Crook 2012; Draxler 2008; Jones 2004; Law and Chow 2008; Losada Iglesias et al. 2012; Wastiau et al. 2013, cited by Melgarejo and Rodríguez 2017).

Depending on how ICT is used, these can generate changes in pedagogical models, as well as new learning concepts and methodologies in teachers and their unification with the educational system, which conceives policies and strategies for training teachers to improve their teaching work and contribute to the improvement of the quality of education (Montero 2010).

According to the research of Melgarejo (2016) who describes seven frameworks, identified as being of an international character. Organizations such as UNESCO and countries such as South Africa, Australia, the United States and the Netherlands, among others, have designed frameworks to establish a reference point for the skills necessary for their effective inclusion, use and appropriation in educational environments (Melgarejo and Rodríguez 2017). Melgarejo (2016), states that each framework clearly conceives different stages of evolution over time, additionally these stages of evolution change their denomination in each framework. However, they can be interrelated as shown in Table 1:

From the list it is important to highlight the Framework designed by UNESCO since it demonstrate how several frameworks take it as a reference for its construction and development, such as that proposed by Colombia, that is ICT Competencies for Professional Development of a Teacher, also the one proposed by ISTE National Standards (USA) of Information and Communication Technologies (ICT).

In this sense, this research has taken up mainly three documents, which are mentioned below:

In January 2008, UNESCO published ICT competency standards for teachers, which seek to serve as a guide to teacher training institutions (training programs). This document sets out the competencies for the development of educational innovation supported by ICT, which are research, technological, pedagogical, communicative and management.

Table 1. Evolution states of the frameworks

Framework	Evolution states			
	Inclusion	Use	Appropriation	
1. UNESCO ICT competency standards for teachers	*Approaches to teaching*			
	Technology literacy	Knowledge deepening	Knowlegde creation	
2. ICT-enhanced teacher standards for Africa	*Stages*			
	Emerging	Applying	Infusing	Transforming
3. ISTE: National Educational Technology Standards for Teachers (NETS-T)	*Rubrics*			
	Beginner	Medium	Expert	Transformer
4. Australia: ICT competency framework for teachers	*Phases*			
	Phases 1	Phases 2	Phases 3	
5. ICT- tools for a balanced use of ICT in the Netherlands	Expertise/Vision			
	Teacher-driven learning	Autonomous learning	Self-organized learning	
7. Competencias TIC para el Desarrollo Profesional Docente	*Levels*			
	Exploration	Integration	Innovation	

Source: Melgarejo (2014).

Finally, the document "ISTE National Standards (USA) of Information and Communication Technologies (ICT) for teachers (2008)" apply the standards, design, implement and evaluate learning experiences to engage students and improve their learning, enrich professional practice and serve as a positive example for students, colleagues and the community.

The previous documents were taken into account for the elaboration of a cross-sectional survey, where the objective was to identify the ICT competences that teachers should possess in the knowledge, use and pedagogical appropriation of these technologies in educational practice, for teachers of undergraduate programs in regional universities of Colombia. A sample was obtained from a faculty of a recognized University in a small populated city, in this case the city selected was Duitama.

This article is structured through five sections. Section 1 introduction; Sect. 2: methodological approach, where the most significant aspects are collected; Sect. 3: compilation of the results of the survey according to the ICT competencies and as a result a proposal to develop ICT competencies for the selected Faculty; Sect. 3: results of the survey applied to the teachers of the Program; Sect. 4: discussion and finally, the Sect. 5: conclusions.

2 Method

The research is a cross-sectional study that followed a methodological approach of quantitative type and a non-experimental design in order to address the research objectives. The data were contrasted through descriptive and correlational studies, the sample is non-probabilistic and followed the accessibility criteria and sample availability. For the collection of information, an instrument was used designed in the Seminar on Teacher Training in ICT within the framework of the academic activities of the Master's Degree in Applied ICT to the Education Sciences in the second semester of 2016. The bibliographical revision was carried out for the construction of the instrument through three main texts that present ICT competencies for teachers:

ICT competencies for teacher professional development of MEN (2013), ISTE National Standards (USA) of Information and Communication Technologies (ICT) for teachers (2008), ICT Competencies Standards for teachers (UNESCO 2008).

The statistics of the use of the virtual platform within the University were reviewed and an Undergraduate Program was chosen that had an average use to which the questionnaire was applied. After the review, the instrument was structured taking the most relevant items from each document, the questionnaire was sent to the twenty (20) teachers of the program, of which 13 were completed. From the total, 8 are men (62%) and 5 women (38%), their range of teaching experience ranges from 1 to 33 years, 69% have master's degree, 16% have specialization degree and 15% doctorate.

The instrument used is composed of 20 questions, through which you can identify the greater or lesser degree of ICT competencies that teachers have in the knowledge, use and pedagogical appropriation of these technologies in educational practice.

The first nine items focus on obtaining accurate information on knowledge, use and attitudes towards the different ICT, compared to the competition, research, technology, pedagogy, communication and management. The next five items seek to highlight the knowledge between the curriculum and the role of the teacher in the program, as a leader in the training of their colleagues and their own professional development through ICT. The last six items allow the analysing of the usefulness that they give in their academic training and in their personal life as research strategies and for answers, the scale based on Likert was applied: Always, Sometimes, Never.

3 Results

Table 2 shows the results of the questionnaire applied to identify the competences in ICT that teachers should possess in the knowledge, use and pedagogical appropriation of these technologies in educational practice. 13 teachers from the Faculty were surveyed. The research revealed figures on the proficiency of teachers in ICT, identifying the areas that require further training for the appropriation of these technologies in the classroom.

Table 2. ICT competencies of teachers.

Document	Item	Questions:	Always	Sometimes	Never
ICT competencies for teacher professional development (MEN 2013)	Investigative competence	1. Do you filter and analyse the information available on the Internet?	77%	15%	8%
	Investigative competence	2. Do you contrast and analyse information from multiple digital sources with your students?	38%	46%	15%
	Investigative competence	3. Do you use the information available on the Internet with a critical and reflective attitude?	69%	23%	8%
	Technological competence	4. Do you design and publish digital content or virtual learning objects through the appropriate use of technology tools?	38%	31%	31%
	Technological competence	5. Do you use technological tools to help your students build meaningful learning and develop critical thinking?	38%	46%	15%
	Pedagogical competence	6. Do you implement ICT-mediated didactic strategies to strengthen your students' learning to solve real-life problems?	38%	46%	15%
	Communicative competence	7. Do you evaluate the relevance of sharing information through public and mass channels, respecting the rules of intellectual property and licensing?	62%	38%	0%
	Communicative competence	8. Do you contribute your knowledge and those of your students to human repositories on the internet, with texts of different nature?	0%	77%	23%
	Management competence	9. Do you raise ICT-related educational policies to make students aware of the good use of information?	23%	54%	23%
ICT competencies standards for teachers UNESCO (2008)	Curriculum	10. Do you pose problems to measure the degree of understanding of students integrating the use of the ICT?	38%	31%	31%
	Pedagogy	11. Do you develop and monitor collaborative projects where students apply their ICT skills?	38%	31%	31%
	ICT	12. Do you use ICT to create and supervise class projects done individually or by group of students?	38%	31%	31%

(*continued*)

Table 2. (*continued*)

Document	Item	Questions:	Always	Sometimes	Never
	Organization and administration	13. Do you play a leadership role in the training of your colleagues, as well as in the development and implementation of the vision of your educational institution, enriched by ICT?	23%	62%	15%
	Teacher professional development	14. Do you participate in any projects with other teachers and experts through the use of networks to access information, in order to support your own professional training?	8%	69%	23%
ISTE national standards (USA) of ICT for teachers (2008) (NETS•T)	Facilitate and inspire students' learning and creativity	15. Do you pose situations involving students in investigating real-life problems and situations, and evaluating solutions using digital tools and resources?	31%	62%	8%
	Design and develop learning experiences and evaluations of the digital age	16. Do you adapt ICT-based materials to individually address student learning styles?	38%	46%	15%
	Model the work and learning characteristic of the digital age	17. Do you explain the use of digital tools in order to support and disseminate research and learning strategies in students?	38%	54%	8%
	Promote and exemplify digital citizenship and responsibility	18. Do you propose activities for students to use communication technology resources to interact with students or experts from other communities and other countries?	23%	54%	23%
	Technological competence	19. Do you create learning activities using applications, content, computer tools and audio-visual media?	38%	54%	8%
		20. Do you use the virtual classroom of the University for the development of your classes?	8%	69%	23%

The research shows that teachers do not use the virtual classroom of the university to support their classes, insufficient use of the repositories on the internet to publish their work and participation is minimal in some projects with other teachers and experts through the use of networks to access to information, in order to support their own professional training.

Considering the results of the proficiency level of teachers in ICT, the following proposal is presented that promotes training actions, both initial and continuous, in order to promote research and innovation skills, application of ICT-based strategies and knowledge to develop didactic proposals according to the disciplinary area or the interdisciplinary component of the academic programs, Table 3 presents the proposal for the training of teachers.

Table 3. Proposal for the development of ICT competencies.

Competencies	Proposal	Activities
Technological competencies	Train teachers in the development of learning activities using applications, content, computer tools and audio-visual media	Propose a course where the teacher learns to develop pedagogical contents from the use of the image, audio and video
		Contemplate within the courses of educational update a diploma or course on computer tools and content development (blog/web)
	Train teachers in the use of the virtual classroom of the University to support the development of their classes	Schedule trainings for teachers of the Faculty in services and the use of virtual classrooms
		Develop workshops that allow the knowing of the virtual classroom and the different resources and activities that the platform has
Communicative competencies	Train teachers on the use of repositories of humanity on the Internet, and the importance of publications	Develop a course on the development of scientific texts and the importance of publishing in indexed journals
		The sectional library can offer training in search in specialized databases
		Develop workshops focused on collaborative works, where literature on topics of interest is shared through forums
Teacher professional development	Train teachers in the use of networks, in order to support their own professional training and participation with other teachers in the development of projects	Training on information networks, in support of research
		Design a course with the purpose of disseminating the importance of networks and maintaining updated and interesting topics, e.g. the Trello platform

4 Discussion

The Institutions of Higher Education (Instituciones de Educación Superior – IES) are the entities that count, according to the legal norms, with the official recognition as providers of the public service of higher education in the Colombian territory (MEN 2010). Within the didactic component of the disciplines is the incorporation of pedagogical and didactic criterion with the use of the Information and Communication Technologies (ICT) to its educational processes in its sociocultural context (MEN 2016).

At the national level, a number of research and political actions are currently being promoted to improve the quality of the teacher as an important pillar in national education, thus, studies such as those reviewed by the Fundación Compartir in collaboration with the Universidad del Rosario, Universidad de los Andes and organizations such as the Randa Corporation, point to the teacher as a starting point for educational change. In that sense, it seeks to improve the preparation of teachers of undergraduate and graduate programs (Padilla 2015).

In the University, activities should be proposed for students to use communication technology resources to interact with students or experts from other communities and other countries, as well as to implement ICT-mediated teaching strategies to strengthen students' learning that allows them to solve real life problems. In the research, less than 38% and 23% develop or have a notion of these activities.

As discussed in other research, Cózar-Gutiérrez et al. (2016) states that:

> The technological culture, which has been in all educational processes in a short space of time, conditions the way of teaching and learning, as well as the interpersonal relationships among the members of the educational community. The possibilities offered by ICT today through didactic tools, digital resources and virtual learning environments, allow the creation or selection of specific, more motivating and personalized activities, according to the different ways of learning. Being aware of this fact will, undoubtedly, contribute to improving the quality of teaching within the framework of higher education, providing students with new training possibilities and personal enrichment (p. 114).

Incorporating ICT in university campuses and adding a challenge to teachers is not enough to manage these new technologies and their applications in the area of knowledge of each one, they also require discovering the use and attitude of students towards themselves in order to achieve a correct learning (Cózar-Gutiérrez et al. 2016).

Research such as that of Boude and Sarmiento (2016), show that currently higher education teachers go through a particular moment where the technological skills that students have are superior to those of teachers, as well as, the expectations they have about how their training process should be carried out, the resources that should be used and even the role that their teacher should play in this process (Biggs and Catherine 2011; Laurillard 2013, cited by Boude et al. 2016).

5 Conclusions

Content dominance, pedagogy and technology alone do not respond to effective teaching integrating ICT. It is necessary to have training and experience in the spaces where these components intervene and condition each other. In addition to mastering the content and the teaching/learning strategies, one must also know which technological tools to use and how they can be applied, taking into account that their use can modify the contents and the dynamics of teaching and learning (Posada 2013).

The impact of Information and Communication Technologies (ICT), has an unprecedented due to the contemporary condition of the information society, thus the educational context and more specific pedagogical processes in Institutions of Higher Education (Instituciones de Educación Superior – IES), have been transformed in order to adopt this ubiquitous condition in their curricula and training processes (Padilla 2015).

This work reflects the importance of the technologies in the learning process and evidences the following scenario by faculty teachers, followed by some assessments:

- Lack of training in the use of ICT and in various pedagogical applications that can be included in the classroom, where scenarios that allow various levels of training are facilitated, according to the teacher's knowledge, as there are teachers with basic level of computer science.
- As the university has several sections, teachers argue that the training should be done in the respective sections and not in the headquarters, in order to have a greater reception.
- Not all teachers use the virtual classroom, as they do not know the benefits of sharing information on this platform.
- The trainings must be scheduled in the weeks of Institutional planning, not in person, so that the teachers do not lose classes.
- Improve the capacity of the University channel for the best quality of virtual courses.

Finally, it is significant to know the degree of knowledge and usefulness that university professors have about ICT in their daily lives, even more so when these technologies are immersed daily on social networks, recreational and leisure spaces. The society of the future requires knowledgeable and trained individuals for a good use of ICT, at all personal, academic, work, and social levels.

References

Arista, J.: Tecnologías de la información y la comunicación (TIC) aplicadas a la docencia. Univ. Autón. Estado Hidalgo **1**(2), 8–15 (2014)

Biggs, J., Catherine, T.: Teaching for Quality Learning at University: What the Student Does, p. 357. McGraw-Hill Education, New York (2011)

Boude Figueredo, O.R., Sarmiento, J.: El reto de formar a profesores universitarios para integrar el aprendizaje móvil. Educ. Médica Superior **31**(1), 61–77 (2016)

Crook, C.: The 'digital native' in context: tensions associated with importing Web 2.0 practices into the school setting. Oxf. Rev. Educ. **38**(1), 63–80 (2012)

Cózar-Gutiérrez, R., Moya-Martínez, D., María, V., Hernández-Bravo, J.A., Hernández-Bravo, J. R.: Conocimiento y Uso de las Tecnologías de la Información y las Comunicaciones (TIC) según el Estilo de Aprendizaje de los Futuros Maestros. Form. Universit. **9**(6), 105–118 (2016)

Competencias TIC para el desarrollo profesional docente: Documento elaborado por la Oficina de Innovación Educativa con Uso de Nuevas Tecnologías. Ministerio de Educación Nacional. Primera Edición - Obra Independiente (2013). www.mineducacion.gov.co. ISBN 978-958-750-762-1

Draxler, A.: New Partnerships for EFA: Building on Experience. UNESCO-IIEP (2008)

Estándares Nacionales (EEUU) de Tecnologías de Información y Comunicación (TIC) para docentes (2008)

UNESCO: Estándares de Competencias en TIC para docentes (2008)

Del Vasto, P.H.: Influencia de las tecnologías de información y comunicación (TIC) en el proceso enseñanza-aprendizaje: una mejora de las competencias digitales. Cient. Gen. José María Córdova **13**(16), 121–132 (2015)

Jones, A.: A Review of the Research Literature on Barriers to the Uptake of ICT by Teachers. BECTA recuperado en, London (2004). http://publications.becta.org.uk/display.cfm

Laurillard, D.: Rethinking University Teaching: A Conversational Framework for the Effective Use of Learning Technologies, p. 260. Routledge, Abingdon (2013)

Law, N., Chow, A.: Teacher characteristics, contextual factors, and how these affect the pedagogical use of ICT. In: Law, N., Pelgrum, W.J., Plomp, T. (eds.) Pedagogy and ICT Use in Schools Around the World: Findings from the IEA Sites 2006 Study. CERC, vol. 23, pp. 181–219. Springer, Hong Kong (2008). https://doi.org/10.1007/978-1-4020-8928-2_6

Losada Iglesias, D., Carrera Juarros, I., de Aberasturi Apraiz, E.J.: Factors facilitating successful educational innovation with ICT in schools **17**(1), 113–134 (2012)

Melgarejo, V.: Indicators for monitoring and evaluation of ICT for education: a systematic review. In: 16th Congress of the World Organization of Systems and Cybernetics, WOSC 2014, pp. 117–127. University of Ibagué, Ibagué (2014)

Melgarejo, V.: Esquema de evaluación y monitoreo del estado de inclusión, uso y apropiación de las tic para la educación en las instituciones educativas públicas del municipio de Tunja. (Tesis de Maestría). Universidad Pedagógica y Tecnológica de Colombia, Tunja, Colombia (2016)

Melgarejo, V., Rodríguez, A.: Modelo integral de monitoreo y evaluación para inclusión, uso y apropiación de TIC en educación. Rev. Salud Histor. Sanid. On-Line **10**(3), 60–79 (2015)

Ministerio de Educación Nacional: Instituciones de Educación Superior (2010). https://www.mineducacion.gov.co/portal/Educacion-superior/Sistema-de-Educacion-Superior/231240:Instituciones-de-Educacion-Superior. Accessed 01 Nov 2017

Ministerio de Educación Nacional: Lineamientos de calidad para las Licenciaturas en educación (versión preliminar) (2014). http://www.mineducacion.gov.co/1759/articles-357233_recurso_1.pdf. Accessed 04 Nov 2017

Ministerio de Educación Nacional: Resolución 2041 “Por la cual se establecen las características específicas de calidad de los programas de Licenciatura para la obtención, renovación o modificación del registro calificado” (2016). http://www.mineducacion.gov.co/1759/articles-356982_recurso_1.pdf. Accessed 06 Nov 2017

Mishra, P., Koehler, M.: Technological pedagogical content knowledge: a framework for teacher knowledge. Teach. Coll. Rec. **108**(6), 1017–1054 (2006)

Montero, O.: Estrategia para la introducción de las Tecnologías de la Información y las Comunicaciones. Rev. Latinoam. Tecnol. Educ. **9**(1) (2010)

Padilla, J.: Formación Pedagógica e Investigativa en Tecnologías del Aprendizaje y el Conocimiento para Licenciaturas en Proceso de Acreditación. Universidad Militar Nueva Granada, Cajicá (2015). (Proyecto de Investigación Científica)

Posada, F.: El modelo TPACK (Mensaje en un blog) (2013). https://canaltic.com/blog/?p=1677. Accessed 21 Feb 2018

Rodríguez, P., Nussbaum, M., Dombrovskaia, L.: ICT for education programme: a conceptual framework for the sustainable adoption of technology-enhanced learning environments in schools. Technol. Pedag. Educ. **21**(3), 291–315 (2012)

Schmidt, D., Baran, E., Thompson, A., Mishra, P., Koehler, M., Shin, T.: Technological pedagogical content knowledge (TPACK) the development and validation of an assessment instrument for preservice teachers. J. Res. Technol. Educ. **42**(2), 123–149 (2009)

Valenzuela, B., Guillén, M., Campa, R., Jaime, M., López, M.D.: Evaluación de las competencias docentes del profesorado de la Universidad de Sonora, México. Eur. Sci. J. **9** (2), 55–64 (2013)

Wastiau, P., Blamire, R., Kearney, C., Quittre, V., Van de Gaer, E., Monseur, C.: The use of ICT in education: a survey of schools in Europe. Eur. J. Educ. **48**(1), 11–27 (2013)

SWEBOK – Based Process for the Teaching and Learning of Requirements Engineering

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Abstract. The teaching of software engineering and specifically the requirements engineering, presents some particularities that require the use of strategies to encourage students to hold on to the principles of this important discipline in software development. Therefore, an investigation is presented in which methodological and pedagogical guides are created and applied in order to improve quality in the teaching and learning process of software engineering. These guides were designed based on three fundamental inputs which includes, first, an understanding of a diagnosis of the current situation in the degree program in Systems and Computer Engineering of the Universidad Pedagógica y Tecnológica de Colombia (UPTC), thereafter, identified the teaching strategies suitable for this discipline and finally aligned it with the topics established in the Software Engineering Body of Knowledge (SWEBOK) guide. As a result, a series of templates for the creation of the class guides was obtained as well as a set of guides used in the validation process, and fundamentally, its contribution to the academic process in the Requirements Engineering was identified.

Keywords: Teaching and learning · Requirements Engineering
Pedagogical guides · SWEBOK

1 Introduction

Software engineering is becoming more and more changeable, adaptable and updatable, according to the evolution of technology. It has become necessary to generate and apply new concepts, techniques and theories on how to plan, analyse, design, build and test softwares [1], as well as the teaching of this discipline and being at the same level with these updates. The SWEBOK guide [2] proposes a series of themes and guidelines which can be applied to Educational concepts and one of the proposed area is Requirements Engineering, which presents fundamental theoretical and practical aspects in software development. This document describes the process of creating and applying a series of guides in the teaching of Requirements Engineering in a Systems and Computer Engineering Program at the Universidad Pedagógica y Tecnológica de Colombia (UPTC) [3].

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In the beginning, a study was conducted on the situation in the area of Requirements Engineering before the implementation of the guides, addressing the state of the contents, pedagogical strategies used and learning achieved, based on different information extraction methods and as a reference to the contents and strategies proposed by the SWEBOK Guide. Later, the analysis of different pedagogical strategies useful to the teaching process of the Requirements Engineering area are presented, which allowed to propose a Learning - Teaching model that integrates the contents proposed by the SWEBOK guide and the pedagogical strategies in accordance with the discipline. Finally, the process of applying the guidelines developed for this purpose and the validation of the model to verify the feasibility of it in the Academic Program of Systems and Computer Engineering is described.

From the above, a series of templates were generated that use pedagogical strategies to be applied in the construction of guides that allow students to expand their knowledge and to broaden their interest and learning in the area of Software Engineering, specifically Requirements Engineering. These templates were used for the generation of pedagogical workshops that applied the themes and strategies posed in this work and that aim to achieve an improvement of the Learning-Teaching process in the area of Software Requirements in the academic context.

2 Background and Preliminary Aspects

This section presents some important preliminary aspects about Requirements Engineering in the Systems and Computer Engineering Program and in the SWEBOK guide.

2.1 Contextualization of the Requirements Engineering in Systems and Computer Engineering Program of the UPTC

One of the purposes of this research work is to contribute to the optimization of the teaching-learning process of Software Engineering based on the SWEBOK guide, which is based on the identification of the current state of the Requirements Engineering area of the Systems and Computer Engineering Program of the UPTC, as well as the distribution and location of the them within the academic context. Taking into account the above, two techniques are mainly applied to the collection of information such as documentary exploration and interview, which at the end was applied to students as well as teachers of the program and from the information collected, this was obtained:

In the academic program case study, there is the Academic Educational Plan, which is the document that regulates various academic and legal aspects, among these are the programmatic content of the subjects, area distribution, credits and modalities of work, among others. The Academic Educational Plan proposes within its structure the distribution of contents in four areas: General, Interdisciplinary, Discipline and Expansion. Specifically for the disciplinary and expansion area, the areas addressed are presented in Fig. 1.

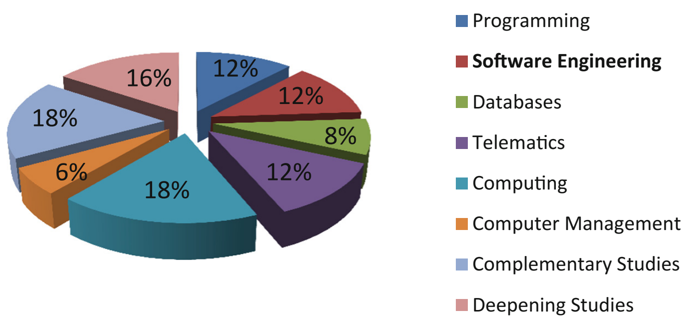


Fig. 1. Distribution and expansion disciplinary area [4]

As shown in Fig. 1, 12% of the subjects belong to the Software Engineering area, and within this, the first subject is Requirements Engineering, found in the fifth semester and whose topics are distributed in 5 units as shown in Fig. 2.

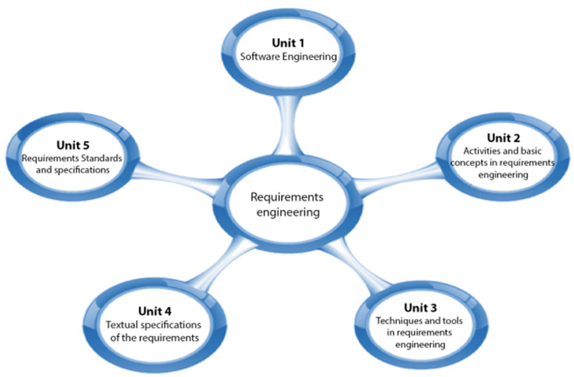


Fig. 2. Requirements engineering subject content distribution [4]

However, in the development of the subject between the period 2012–2014, and according to the results of the surveys applied in 2014, it was identified that the most used strategies are those corresponding to theoretical modalities: Exhibitions (Presentations), debates, project-based learning, panel discussion, which has led to the fact that knowledge is not assimilated in the best way, and even if students pass the subject, there are gaps that lead to deficiencies in professional performance.

2.2 SWEBOK

SoftWare Engineering Body of Knowledge (SWEBOK) is understood as a concrete compendium about the areas related to Software Engineering, in order to educate new generations about the approaches and uses of this guide [5]. It is for this reason that it has been applied to such diverse areas, highlighting aspects of the academic part of Software Engineering, to touch aspects related to the industrial process of software development.

Essentially, SWEBOK is a guide proposed and approved by the IEEE Computer Society, ISO, CEI and others, with the purpose of gathering criteria that establish the accepted knowledge in software engineering, in such a way that from it, suitable practices are established to carry out a good process of development of solutions or software products, establishing ten fundamental areas that are presented in Fig. 3.

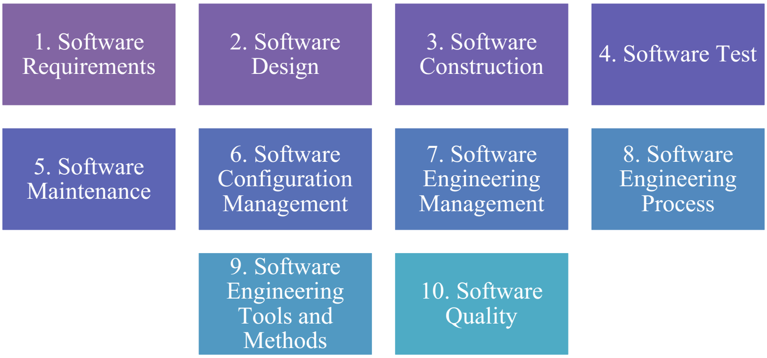


Fig. 3. Knowledge areas of software engineering according to SWEBOK

Regarding the area of Requirements Engineering, SWEBOK proposes some general contents that include: fundamentals of software requirements, Requirements Process, requirements elicitation, requirements analysis, requirements specification, requirements validation and practical considerations.

3 Pedagogical Guidelines Developed in the Research

From the study of pedagogical strategies useful in the teaching process in software engineering and diverse experiences, some guidelines are proposed to promote the optimization of the process in the area of Requirements Engineering. Below is a overview of some pedagogical strategies and then the process of construction of the pedagogical guides are described later.

3.1 Types of Pedagogical Strategies

There are several proposals regarding the compilation of pedagogical strategies, one of these is Bloom's taxonomy [6–8] which includes six components (Knowledge, Understanding, Application, Analysis, Synthesis, Evaluation), and from three of these are the grouping of certain strategies (See Fig. 4) [4].

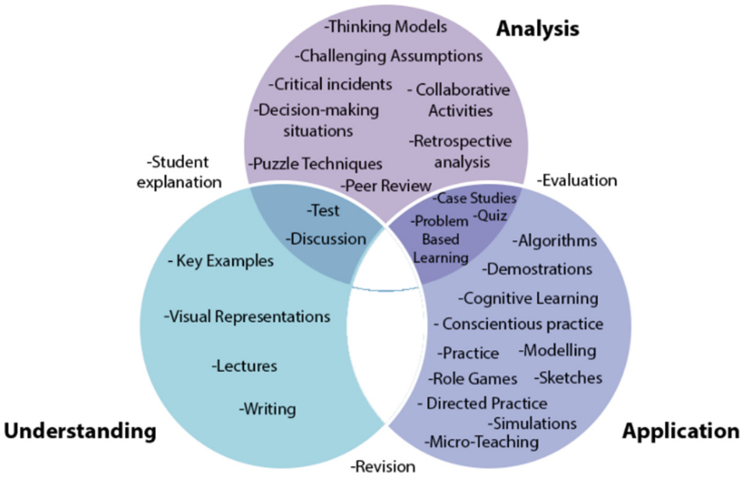


Fig. 4. Strategies by level of taxonomy

3.2 Construction of Pedagogical Guides

A group of specific strategies is selected that can be applied in such a way that they allow to cover the levels of understanding, application and analysis, which foster the assimilation, appropriation and integral evaluation of learning in the students. Additionally, the strategies are grouped taking into account that some may be implicit in others therefore the following basis are taking into account:

- Writing
- Presentations
- Visual representations
- Key examples (Inductive learning)
- Test
- Discussion
- Puzzle technique
- Roleplay
- Projects
- Algorithms

Based on these strategies, the teaching templates are structured, based on the guidelines of the SWEBOK Guide, and which considers certain aspects for each selected strategy, which is aimed at helping the teacher to give the necessary focus to optimize the learning and development of skills, abilities and motivation in students at a maximum level. As for the proposed templates, they are composed of seven parts. See Table 1.

In the development of the research, from the templates for the teaching guides, the main themes of the subject addressed are structured, also taking into account the strategies identified and the themes suggested in SWEBOK.

Table 1. Sections of the templates for teaching guides

Section	Descriptions
Títle	The title of the subject that you want to work must be presented
Objectives	The objectives that want to be achieved with the application of the strategy should be clearly stated
Activities	This instructs the end user of the templates on how to manage the selected strategy and which parameters should be taken into account when creating the teaching-learning guide. In addition, it carries the theoretical framework for the development of the thematic
Evaluation	It should be suggested how the selected strategy can be evaluated, taking into account that every evaluation must have feedback with the student
Bibliography	In this field, a bibliography is presented on what the student should use or the end user of the templates has used to prepare the workshop
Products	This aspect is optional within the templates and is only presented in case that the strategy can handle more than one deliverable product (Example: Writing Strategy). At this point the final user of the templates will choose the one that seems most appropriate for the student to develop their learning
References	To finish the template document, it is necessary to add to it the bibliography and infographic that was used for the creation of the templates and that these documents can be consulted in case of wanting to add something to the template

4 Application of the Developed Guides and Validation of the Model

In order to confirm the feasibility of the application of the guides in the Academic Program, the evaluation of learning objectives included in each guide was defined by subject, for this the qualitative and quantitative data were taken through the instruments: scale of rank (3 to 15) and objective tests that allowed the defining of the level of learning obtained by each student from a total of 16 enrolled in the course of Requirements Engineering (Semester I of 2016) selected for the application of the instrument. The implementation of the guides was carried out in a collaborative way, considering the following pillars [9]: shared interaction, individual responsibility and positive integration. Where individual responsibility indicates that each member must assume a role and excute a task responsibly and thus contribute to the development of a product, for this reason, despite the fact that the guides were applied in teamworks, the evaluation was made on individual basis.

4.1 Guides Application Schedule

The application of the teaching and learning guides was carried out in the first academic semester of the year 2015, in the course of seven weeks (see Table 2), and one of the proposed guides for the subject, Requirements Engineering, was applied in each of the week.

Table 2. Timetable for the implementation of the teaching and learning guides.

Week	Topic
3	Requirements process
4	Fundamentals of Requirements Engineering
6	Requirements elicitation
7	Requirements analysis
9	Requirements specification
12	Requirements validation
13	Practical considerations

4.2 Evaluation Scales

For this work, the grading scale of trials currently used in the evaluation process of UPTC for self-evaluation of the academic programs was used [10], summarized in the Table 3.

Table 3. UPTC trial grading scale.

Score	Grade performance
4.7–5.0	Full
4.0–4.6	High grade
3.0–3.9	Acceptable
2.0–2.9	Unsatisfactory
1.0–1.9	Deficient
0.0–0.9	Fail

4.3 Application Process of the Guides

The process covers the phases of initiation, process and exit. It is worth mentioning that for all the guidelines the beginning phase was oriented to the conformation of group works, as well as the presentation and explanation of the methodology, in Table 4. The description of the process is briefly presented, which is determined in each guide and finally the output, products developed by the students.

4.4 Information Analysis

Taking into account the statistical information of the qualifications obtained in the Requirements Engineering course in the period 2005–2013, from the Information System of Academic Registration (Sistema de Información de Registro Académico – SIRA) of the Institution, in Fig. 5. It is observed that the behavior of the performance by the students, which on average at this time is 3.62, framed in an “Acceptable” performance, before the application of the guides developed.

Table 4. Application process of the guide [11]

Guide	Process	Output
Guide 1: fundamentals of software requirements	• Reading of the guide by the students • Strategy selection (conceptual maps, synoptic charts, mental maps) and approach of the same strategy • Socialization of the visual strategy by each of the working groups	– Conceptual maps – Mental maps – Summary tables
Guide 2: requirements process	• Reading of the guide by students • Reading of the "Funny-Math" system specification, which is the case study designed for the implementation of the guides • Requirements analysis process for the proposed system • Algorithm construction • Selection of the software process model • Construction of flow diagrams based on the selected model • Feedback of the requirements process defined by each of the working groups	– Algorithm and flowchart, taking as reference the selected model
Guide 3: requirements elicitation	• Selection of elicitation techniques (points of view, use cases, scenarios, interviews) • Definition of "FunnyMath" system requirements by means of technique. • Preparation of the support • Support and identification of differences and similarities of the requirements defined by each working group by means of each technique	– Document with differences and similarities obtained by means of each technique – Use case diagrams
Guide 4: requirements analyses	• Classification (according to functionality, volatility and degree of complexity) of the requirements obtained in the previous activity • Construction of context and behavior models • Location and architectural design • Negotiation of requirements	– Document with the products obtained during the process
Guide 5: requirements specification	• Format design with minimaml aspects (title, version, authors, sources, general description of the requirement to be specified, actors, preconditions, normal sequence or basic flow, exceptions or alternate flows, post conditions, restrictions,	– Format with "Funny-Math" system requirements specification

(*continued*)

Table 4. (*continued*)

Guide	Process	Output
	special requirements, interfaces, extension points)	
Guide 6: requirements validation	• Assignment of roles within each work group • Meeting between student role (client) and workshop guide • Meeting between student role (mediator) and student role (specifier) • Meeting between student role (mediator) and student role (client) • Feedback of all the roles to validate	– Version history of requirements – Final prototypes – Acceptance tests
Guíde 7: practical considerations	• Reading and understanding of the new requirement • Implementation of change control • Construction and implementation of traceability mechanism • Measurement of requirements taking into account the IEEE14143.1 (functional size measurement concepts) standard	– Report of evidences of the measurement of the requirements taking considering the IEEE-14143.1 standard – Implementation of change control – Requirements traceability mechanism

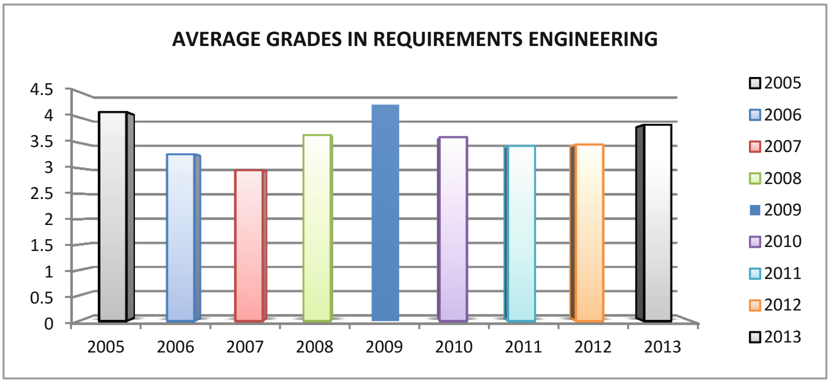
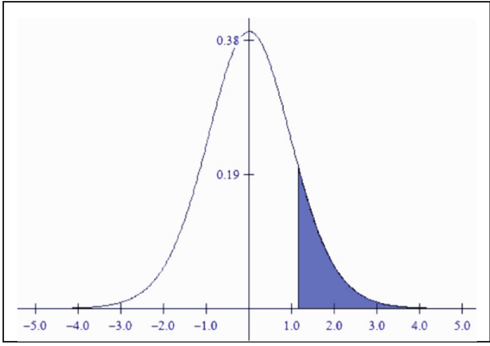


Fig. 5. Requirements engineering average grades 2005–2013 [4]

With the information obtained through the application of the guides, the data were prepared and tabulated quantitatively and with the application of the Kolmogorov-Smirnov model [12, 13], T - Student [14, 15], supported with 2013 SPPS tool. A set of data was processed to identify the validity and applicability of the guidelines and the proposed pedagogical model. Below is the analysis of the results of the implementation of the first teaching and learning guide, and in this same way the analysis is made for the others.

Application Analysis of the Guide 1. Basics of Software Requirements
It is observed that the T-Student calculated was 1.03 and that of the critical table (according to the T-Student method) at 15° of freedom and level of significance of 0.05 was 1.761. Therefore the T calculated is less critical, which means that through the strategy of "Visual Representations" for the theme of "Requirements Basics" results are obtained in the ratings equal to 4.0, because when performing the analysis by means of the real statistic, the value of the mean plus an error margin of 0.05 results in a value of 4.09, approximating to a value of 4.1. Which means that from the visual representations strategy, grades greater than 4.0 would be obtained (Fig. 6) [11], improving the average of the grades of the years 2005–2013, as mentioned above.



Mean	**($\bar{X}$)**	4,04
Hypothesis	**H**	4.0
Standar Deviation	**$\hat{S}$**	0,14
Sample Size	**N**	16
Degrees of Freedom	**gl (n-1)**	15
Significance level (%)	**A**	0,05
T-Student table	**(1 queue)**	1,761
Probability	**p**	0,318
Calculated T-Student	**t**	1,03

Fig. 6. Graphical representation of the T-Student test for guide 1–requirements basis [11]

With the quantitative information obtained in application of all the guides, it was analysed, based on the validated and implemented strategy, scores obtained would be higher than those obtained with the strategies applied in the initial diagnosis of the project. As well as being considered what were the most representative attitudinal characteristics that influenced positively and negatively in the development of the activities by the students during the execution of the investigation.

After the data collection and analysis, it is observed in Table 5 that in six of the subjects, of the total number of students, the percentage that achieved total grades within the "High grade" level (4.0 to 4.6) was higher than the percentage of students who obtained grades within the "Acceptable" level (3.0 to 3.9), which was only higher in the Requirements Process area with 54%.

In Fig. 7, one observes the performance of the competencies: Interpretive and propositive argumentative, where it is observed that the first and the second is where the average highest grade is presented, this happens in six of the seven themes, which shows that the Teaching and learning guides facilitated the understanding, analysis and articulation of concepts and processes by students. While for the propositive competition the average was lower, which means that the strategy developed in the guide allows students in a lower grade to propose the creation of new hypotheses and the possibility of new solution alternatives.

Table 5. List of qualifications and strategies in the requirements engineering course [11].

Theme	Strategy	% Students	Level
Fundamental requirements	Visual representation	64.28	High grade
		35.71	Acceptable
Requirement process	Algorithms	46%	High grade
		54%	Acceptable
Elicitation	Puzzle technique	100%	High grade
Analysis	Project	100%	High grade
Specification	Writing	92%	High grade
		8%	Acceptable
Validation	Role play	54%	High grade
		46%	Acceptable
Practical considerations	Project	100%	High grade

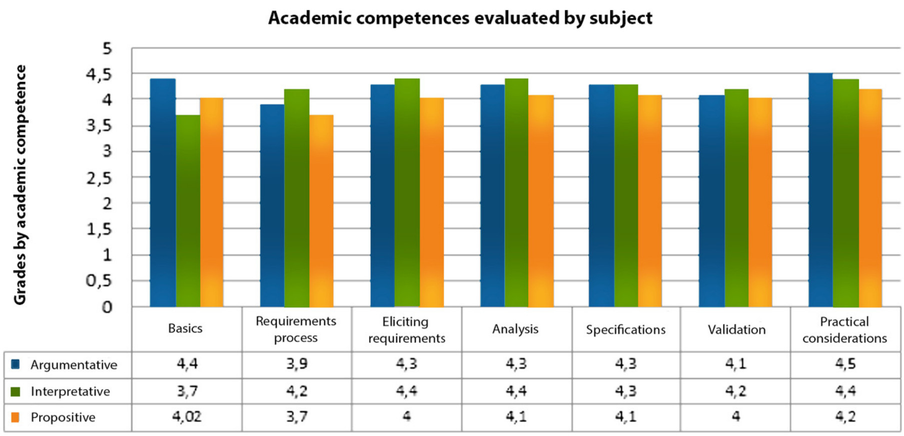


Fig. 7. Performance by competences [11]

On the other hand, the performance of the students was compared before the implementation of the guides with the performance obtained after, from which the following information is observed:

The final qualification of Requirements Engineering subject achieved before the implementation of the validated strategies (according to the SIRA 2005–2013 system report) was 3.62. However, the average grade obtained by the students enrolled at the time of application of the guide was 4.2, improving from an "Acceptable" compliance level to a "High grade" compliance level. Also, the Thematic Requirements Analysis and Practical Considerations were within an "Unsatisfactory" level indicating that the strategies used up to that moment did not have a positive implication with the learning in students, now with the implementation and validation of the project strategy, the learning levels increased by 27% and 31%, respectively progressing in two levels, remaining in "High grade"; On the other hand, there was less evidence of an increase in the thematic basics of requirements with 3.8% and specification of requirements with 4.8%, which were within an “Acceptable” level, increasing only one level, also remaining within “High grade”.

5 Conclusions

The Requirements Engineering area in the academic program, before the application of the guidelines, used to a greater extent the strategies that apply to the level of “Understanding”, indicating that if these strategies are used for topics that require levels of “Analysis” or “Application”, one loses competences and skills that are only obtained through the use of strategies that apply to these levels. With the application of the guides, it is possible to understand the theoretical aspects as well as bringing the student closer to practical and real contexts that allow assimilation of the contents of the subject.

The teaching templates facilitate the organization, planning and structuring of contents, also allowing the proper management of the pedagogical strategies that are to be implemented. The teaching-learning guides allow the contents, activities, objectives, evaluation, bibliography to be captured and products that can be used for the application of knowledge, potentializing according to the selected strategy including the abilities, skills and aptitudes that the student must have.

The structure of the guides allowed them to be implemented experimentally and face-to-face to students enrolled in the Software Requirements subjects, bearing in mind that the guide has established a methodological strategy and an activity to be carried out by the students, which facilitated the process of the implementation, since the activity consisted in following the proposed indications.

Through the T-student distribution model, a correlational analysis was carried out for each one of the guides, which concluded that the implementation of the same leads to the students achieving grades above the high grade level.

Based on the results obtained, the School of Systems and Computer Engineering, taken as a case study, can take this research as a reference to adjust the topics corresponding to the subject of Requirements Engineering according to the guidelines established by SWEBOK.

References

1. García-Peñalvo, F.J., Como-Palacios, R.: Innovative teaching methods in engineering. Int. J. Eng. Educ. (IJEE) **31**(3), 689–693 (2015)
2. IEEE Computer Society: SWEBOK V3 (2017). https://www.computer.org/web/SWEBOK/v3
3. Universidad Pedagógica y Tecnológica de Colombia. Información Escuela Ingeniería de Sistemas y Computación (2016). http://www.uptc.edu.co/facultades/f_ingenieria/pregrado/sistemas/inf_general/
4. Martínez, N., Sandoval, J.: Propuesta pedagógica y metodológica basada en SWEBOK para la enseñanza de la ingeniería de requisitos y gestiòn de software. Trabajo de grado Ingeniería de Sistemas y Computación, Facultad de Ingeniería, Universidad Pedagógica y Tecnológica de Colombia (2013)

5. Bourque, P.: SWEBOK refresh and continuous update: a call for feedback and participation (2009). http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=4812712
6. Abran, A., Moore, J.: Guide to the software engineering body of knowledge, p. 196. IEEE Computer Society, Los Alamitos (2004). ©2004. ISBN 0-7695-2330-7
7. University of Northern Iowa - College of Education. Bloom's Taxonomy "Revised" Key Words, Model Questions, and Instructional Strategies: IUPUI Center for Teaching and Learning (2012). http://www.uni.edu/coe/sites/default/files/wysiwyg/BloomRevisedTaxonomy.pdf
8. National Employee Development Center: Instructional Design Process. Suggested instructional strategies for use with each level of Bloom's Taxonomy (n.d). ftp://ftp-fc.sc.egov.usda.gov/NEDC/isd/taxonomy.pdf
9. Kagan, S.: Cooperative Learning. Kagan Publishing, San Clemente (1992)
10. Vicerrectoría Académica: Taller de gradación de cumplimiento y emission de juicios, Procedimiento de autoevaluación de programas (2011)
11. Castillo, L.: Evaluación de estrategias pedagógicas y diseño de infraestructura física de laboratorios para la enseñanza y aprendizaje de ingeniería de software. Trabajo de grado, Maestría en Tecnología Informática, Facultad de Ingeniería, Universidad Pedagógica y Tecnológica de Colombia (2015)
12. Rincón, L.: Curso elemental de probabilidad y estadística, Universidad Nacional Autónoma de México (U.N.A.M) (2007)
13. Granero, R.: El método de las características aleatorias, Notas de clase, Consejo Superior de Investigaciones Científicas, Instituto de Ciencias Matemáticas, Campus de Canto blanco, Madrid (2011)
14. Dougglas, H.: Análisis de desarrollo por competencias, desde la enseñanza asistida por computador, primera edición, Fundación Universitaria San Martin (2011)
15. Sánchez, R.: T – student: Usos y abusos. Rev. Mex. Cardiol. **26**(1), 59–61 (2015)

Mobile Learning and Moocs

The Impact of Mobile Device Use

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Abstract. The use of mobile devices is ubiquitous across all elements of daily life. The devices have become so embedded in all activities that users assume security concerns are limited to some specific apps or locations. Most devices and apps have credentialed logins that give an aura of privacy and security. When cautioned or asked whether to proceed to a somewhat suspect website, users proceed without exercising proper levels of caution. Convenience and time concerns out-weigh caution and privacy concerns for many users. This paper presents a teaching case, based on actual events, that provides students with a concrete example of how mobile devices can be used to commit business fraud. It demonstrates how seemingly-simple transactions that are conducted without careful security rules can cause great harm. The case includes teaching materials to support its use in the classroom.

Keywords: Fraudulent bank transactions · Bring your own device Business use of mobile devices · Ethics · Controlling mobile device use

1 Introduction

There are expected to be more than 5 billion mobile devices (smartphones and tablets) in use worldwide by 2050, according to eweek.com (www.eweek.com/mobile). They are valued for convenience, computing power, and connectivity, and provide the functionality of traditional computers. At least 10% of mobile device users have completely replaced their traditional computer with a mobile device (www.pewinternet.org/fact-sheet/mobile); more than half of all Google searches come from mobile devices (https://searchengineland.com). Mobile devices are used to gain access to digital resources, review recorded notes, collect data, and engage in transactions, among other uses [6].

Many organizations now allow employees to bring their own devices (BYOD) for use in organization work. This saves the organization money in the short run. Further, users tend to adopt organization systems more fully when using their own devices. However, it exposes the organization to security threats that would otherwise not be present, and employees often do not understand the threats mobile devices pose. Information on the organization's servers, colleagues' computers, and databases may all be impacted by problems brought in through a single employee's device. Even IT security professionals often fail to fully understand the implications mobile devices,

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especially BYOD, have on the organization [14]. In addition, even when an organization has security policies for mobile device use, less than one-third of users know about or implement those policies fully [10].

This instructional case provides accounting students with an example of how easily ordinary activities using mobile devices can expose an organization to substantial loss without the user realizing the loss has occurred. The next section provides additional literature and background, followed by the case and teaching materials.

2 Prior Literature

The current generation of students will be the first generation of workers to have widespread opportunities to BYOD to their jobs. Training these students about mobile device security is important because many BYOD users fail to see the links between computer security when in an office and computer security when using their own device. The accounting profession is especially concerned about BYOD risks because so much work accountants now perform is done remotely, with employees commonly using their own devices. The American Institute of Certified Public Accountants' (AICPA's) top 10 global risks for 2017 include cybersecurity, identity management and information security [3]. Control and use of mobile devices have been AICPA concerns since at least 2011 [2].

Mobile devices pose a unique internal control challenge because they integrate personal and business use. Employee use of their own devices intermingles organization activities and personal activities on a constant basis. Research has shown that one of the reasons users accept technology use more easily when using their own device is this integration of personal usage with organization (or educational) use. This is referred to as dismantling the border between personal and organization-driven use [6].

As BYOD policies continue to proliferate, organizations may not anticipate the variety of transactions for which mobile devices may be used, and therefore they may not limit or control those transactions properly. Unless steps are taken to control mobile device use, employees have a private and relatively straightforward capability to corruptly access organization data and engage in unauthorized transactions [16].

Lack of knowledge may be one of the root causes of security problems with mobile devices. Today's students are tomorrow's employees. There is a substantial body of research about student use of BYOD in education. Many studies e.g. [11] find that students' use of security on their own devices is sub-standard. Students know (mostly) what they should do but they don't consistently take the correct precautions. Mobile device security should be taught to all business students to ensure all organizations are protected against threats from the widespread use of the devices.

One reason education on this topic is essential is that research has found that people engage in transactions via mobile device when they conclude it is safe to do so (rather than when they know it is safe to do so). There are three main elements that drive this conclusion: if they have a sense of web privacy (they think their information is kept private), there is social influence to do so (they see other people do it apparently without difficulty) and they perceive a strong web reputation (they perceive little risk of anything going wrong) [17]. Note that these factors are all perception-based; the facts surrounding a transaction may run counter to these perceptions.

This paper provides a case which will help educate accounting students about the risks and ramifications of using mobile devices without proper precautions. One recent study found that more than 95% of college students own a mobile device [5]. Cases offer enriched learning experiences that are difficult to provide through lectures alone e.g. [13] and can convey complex decision settings better than many educational methods. Research has found that accounting students benefit from case studies; students who learn through cases show gains in self-confidence, self-learning skills and lifelong learning skills, among others [8].

Some aspects of the case (below) are designed to address some specific short-comings regarding student knowledge of mobile device security that have been noted in prior research. First, mobile devices are especially vulnerable to hacking, or the unauthorized use of the mobile device's capabilities. While devices are capable of encryption, a survey showed that 65% of students in [9] either did not know whether they used, or knew that they did not use, encryption and virus protection software.

Second, most mobile devices can serve as instant "hot spots" that allow access to network resources. Thieves can set up fake Wi-Fi "gateways" to which the latest generation of mobile phones will automatically connect. Once a connection is established, all the information passing through the gateway can either be read directly or decrypted using software that will run on a laptop. Research has shown that business students do not avoid harmful behaviors such as clicking on web links from unknown sources, downloading apps when they aren't sure they should trust the website, and using their phone for (unencrypted) financial transactions [9]. Studying the implications of these actions for businesses may reinforce the dangers of these risky online behaviors.

This case also contains a real-world ethics dimension that results from the size of the organization. While large organizations have resources to properly control technology use and separate duties effectively, small organizations are more likely to adopt the point of view that they should trust their employees to 'do the right thing'. This case is set in a small religious organization where there are resource constraints that highlight this issue.

Accountants regularly confront cost-benefit trade-offs when designing internal controls. Which controls are necessary for a small organization with a high level of employee trust? Are trust and internal controls incompatible in a small organization? Students will consider whether the organization's ethics and its history of trusting employees, should substitute for internal controls.

Cases are a major source of ethics education in all levels of accounting courses. Research has validated this approach, showing that ethics cases assist in students' ethical development e.g. [18]. Research has also shown that the nature of ethics training is important [12]. Students benefit most from specific training in the settings where they will make decisions. Students will surely have to make decisions about their own smartphone use when they become practicing accountants.

Beyond ethics, cases provide the ability to incorporate important real-world elements in decision contexts. For example, [19] is set in a small to medium-sized company. Their case introduces students to the challenges of implementing a new

ERP. Students consider business unit and organization-wide issues that are impacted by an ERP. In another example, [1] provides a series of cases to help students learn to use the FASB Codification.

3 Summary of the Case

Two churches located in a small town, East Church and West Church, struggled financially for years due to gradual declines in both contributions and membership. Being part of the same Protestant religion, they decided to merge and form a new legal entity, New Church. This case describes the churches, the merger and the control issues that contributed to lack of oversight of New Church. That lack of oversight permitted employees to BYOD to conduct banking business and ultimately led to a major theft of cash from New Church.

East Church and West Church had operated differently from a financial standpoint prior to the merger, which turned out to be a source of confusion once New Church began to operate. Both the leader of New Church and its part-time bookkeeper had been at East Church before the merger. They were accustomed to working together, and made decisions quickly and efficiently. In part because of their familiarity with each other, the level of documentation of the bookkeeper's financial work for the leader was very informal. This was a contributing factor in a. The main question of this case, which is based on real events, is this: did the bookkeeper make off with eighteen thousand dollars of church funds, did the leader take the money, or was the money stolen by Internet thieves who got lucky when the bookkeeper and the leader got sloppy?

4 Case Background

Two churches located in a small town, East Church and West Church, struggled financially for years due to gradual declines in both contributions and membership. Being part of the same Protestant religion, they decided to merge and form a new legal entity, New Church. A majority of the members of both churches voted to merge to try to realize efficiencies across the two parishes. The churches were of similar size and followed similar theologies. Each church had one leader to oversee the usual variety of church activities, and the members of both churches presumed that New Church would operate similarly to how their former church had operated.

The churches had different financial reasons for supporting the merger. East Church had largely been surviving by slowly draining its reserve fund. The fund, at one time in excess of $4 million, had dropped below $2 million. The fund was used to replenish cash in months when East Church contributions failed to cover operation costs. East Church members wanted to stop draining the fund and saw the merger as an excellent opportunity. East members felt that West Church's daycare program could be a source of cash to support New Church's operations. West Church had a very small reserve fund and had survived due to a consistent cash infusion from the daycare center it operated in the church building. Recently, West Church had begun to experience a decline in daycare customers. Members could see that the daycare profits would not sustain the church if current contribution trends continued. West Church members felt that the merger was necessary. West members saw the reserve fund held by East Church as a great advantage of the merger because the cash could be used to keep New Church open during hard times.

4.1 Financial Management Style

The two churches had different reasons for merging, but the members of both churches shared similar beliefs and similar faith that the merger would help their church survive for generations. When the merger happened, New Church opened without anyone having substantial knowledge about how each church's financial operations were conducted before the merger.

New Church hired Mary Anderson, a long-time church member of East Church, to be the accountant for New Church. Her background as a CPA and her knowledge of the church enabled Mary to work efficiently to take care of church business while also maintaining a full-time teaching position at a local community college. New Church leader quickly became accustomed to asking Mary to complete tasks on the fly, and he considered her timely attention to church matters very important.

4.2 New Church Operations

Mary became responsible for paying the bills for New Church, including costs and payroll for its day care operation and the church. Depending on the month, Mary sometimes needed to transfer money from the Church's reserve account into its checking account if cash revenue was low. Because Mary was not a full-time employee, she did much of her work for New Church from her home or her school office. She stopped by the Day Care Center each Friday to collect attendance information, which she used to bill customers.

She knew the Church was short of funds and considered BYOD a convenient way to help the Church save money while giving herself great convenience: she would not have to go to the Church to pay bills or make cash transfers. The church leader had emailed her links to various apps the leader knew Mary would need. Mary used the links to download the apps to her smartphone but did not bother with looking into the apps' functionality because the leader said they'd be necessary for her to do her work. Mary used an older version of smartphone for Church business because it allowed her to use a setting that bypassed user authentication. Mary found this to be an excellent time-saving device. The phone was new enough to permit her to use unencrypted apps over any Wi-Fi service.

4.3 The Cash Transfer Request

On one particularly hectic day, Mary checked her email on her smartphone in between meetings at the college. She noted there was an urgent email from the church leader indicating that $100,000 needed to be transferred immediately from the reserve account to the main church bank account. Mary knew that if he emailed her about something (rather than waiting to see her later in the week), the task he was requesting must be important.

Mary promptly logged on to the church's bank account from her smartphone and made the transfer based on the instructions in the email. The email specified the account number to move money into, where to take it from, and the amount; none of the information was encrypted. Mary assumed this information was for her one-time use and deleted everything once the transaction was completed.

The email also provided the bank routing number, the bank account number, and the online password for the account receiving the transferred cash. This was necessary because Mary had not yet been added as an official user of any New Church bank accounts. Mary did not question the transaction because she was busy and because the request was similar to many she had fulfilled for the leader previously, even though it was more than three times the average transfer amount she had made in the past and she had never been previously provided with transaction details in emails.

Mary quickly sent an email to the Leader letting him know the transfer was complete. Mary rushed into her next meeting without waiting for a reply to her email.

4.4 Cash Is Missing

Mary continuously checked her email throughout her next few meetings, using the building's public open Wi-Fi, in order to make sure she did not miss any important communications. A couple of hours later, she noted a response from the church leader asking her what she was talking about in her email. He said he did not know anything about a request to transfer money.

Mary felt a moment of panic but brushed it off as she had to attend another meeting. She assumed their emails had crossed somehow and that he would eventually acknowledge the cash transfer, that the bank account into which the transfer was made was fine, and there was no need for worry. After all, the banking information he had provided had worked perfectly. It never occurred to Mary that there was anything wrong with the cash transfer.

When Mary returned to her office, she called the leader. She reiterated that she had received an email asking her to transfer money to New Church's checking account from the East Church foundation account. He pointed out that he had always called her with such requests in the past so they could discuss the payment or transfer details; he had never before sent such a request via email. He felt this was an important distinction – that there was a big difference between discussing something on the phone and taking action based on an email request.

Mary replied that things had been so busy at New Church that she just assumed he knew the amount he wanted to transfer. Further, she had easily been able to fulfill his request because he'd given her all of the bank account security information. If he had not wanted her to fulfill the request without speaking to him, why had he given her the banking information along with the request? His answer surprised Mary: he had not provided her with any banking information because he had not sent her an email.

The conversation left both Mary and the church leader stunned at the other's reaction to the situation.

At the end of the day, Mary mentioned the situation to a colleague at the college where she taught. The colleague advised her to quickly call the bank and see if they could stop the payment. Mary did so, but it was too late. This was the first time it occurred to Mary that the cash transfer she had made might have been fraudulent.

Next, she called the church leader to discuss the email request she had received. He told her he had not sent any emails to her before the message she sent him late in the day. Mary went into her smartphone to read him the email. They both agreed that it appeared to be from the same email account he always used to communicate with Mary about church business.

Next, Mary contacted the bank from which the transfer was made and found the outgoing cash transfer out had gone through and their records showed Mary as the authorizing party. The bank found that the transferee bank was located offshore (outside the U.S.). The church leader called New Church's bank to determine if cash had been transferred in; it had not.

4.5 Panic Sets In

Mary decided to contact one of the members of New Church's board of directors to explain the situation. Mary felt as though she was the victim of a scam. It did occur to her that the fraudster could be the church leader, but she explained that it seemed more likely that she had been victimized by someone who had hacked the email system of New Church. Mary believed she could not possibly be at fault for having been the victim of this fraud. She was worried that the Church may have lost $100,000 and wanted reassurance from the board member that they would be sympathetic to her situation.

The board has contacted you for assistance.

5 Questions to Pose for the Case

The questions below have been tested with students in a graduate course on fraud and forensic accounting. See Sect. 6 solutions and related discussion of student results for each question.

1. Identify a list of suspects who might be responsible for the fraud and explain why each person might think they could get away with stealing the $100,000.
2. If you were on the Board, how would you investigate the case? Propose 10 questions that could help Board members of New Church investigate the case.
3. Find violations of best practices in mobile device security.
4. Identify and explain the security measures that should have been put in place to avoid this fraud from occurring.
5. Identify improvements that could be made to the internal controls over payments from New Church to prevent this type of fraud.

6 Solutions to Case Questions

6.1 Identifying Suspects

Students should be able to identify possible suspects in this theft and use elements of the case to provide plausible scenarios such as those described below. The case is written so students are unable to determine whether Mary, the Church Leader, or an unknown tech hacker committed this theft.

a. Mary – may be hiding straight theft by attributing it to a request she says her boss made. The variety of methods she used to communicate, their hurried nature, and the failure to employ return message verification controls may have implied to Mary that the transfers would be untraceable. She may have never received a request from her boss (he denies sending one). Therefore, checking his emails and texts would not reveal evidence as to Mary's guilt or innocence.
b. Church leader – due to his familiarity with Mary's habits and work schedule, he could have purposely made the request at a time of day when Mary was customarily very busy with her teaching job. He may have taken advantage of her emphasis on giving the Church great customer service, and her history of fulfilling his requests in a timely manner. In the absence of a high tech investigation, he could delete the requests he made and her replies. This would make it much more difficult to prove he was the responsible party.
c. An outside hacker – anyone accessing the open WiFi Mary used could may observed her activities. It is possible that the person hacked her on the day of the theft. It is equally plausible that they observed her activities through a Trojan Horse or other malware and planned the event in advance. Because their activities would be untraceable and the money was moved outside the U.S., they would have no concern over getting caught.
d. Someone else associated with New Church – anyone familiar with the general ways the Church Leader and Mary conducted financial transactions would only need to obtain Mary's email address to commit this theft. Mary shared her email widely at the Church, which means the number of people in this category could be quite large.

Students tend to identify Mary and the Church Leader as the most likely suspects, and also identify the possibility that Mary was the victim of identity fraud. Few students consider the possibility that the last category, anyone who knows what Mary does for the church and has her email address would be able to attempt this theft.

6.2 Investigation

Students will identify a wide variety of questions the Board should ask. It is important for students to realize that forensic investigators think beyond their initial suspects when investigating fraud. This question is worded to encourage students to think broadly about what an organization's leaders would investigate when faced with a large theft. The list of questions below are typical questions students have identified.

1. Why do we ever transfer $100,000 at a time between accounts?
2. Who usually authorizes such a large transfer?
3. Is there a way for our own bank to get the money back from the bank we transferred into?
4. Why are we using smartphones to conduct church business?
5. Can we get Mary's smartphone and take it to someone to get information from the phone?
6. How do we know the Church Leader didn't have this money sent to his own offshore account?
7. How long has Mary been doing this kind of work for us on her smartphone?
8. Who knows what Mary was supposed to be doing for us?
9. If this theft was committed by an outside hacker, does that mean the same person can hack our computers?
10. Should we cancel all electronic banking?
11. Has anyone looked at the bank accounts to see if other money is missing?
12. Can we see the bank reconciliations and check registers for our own accounts?
13. Should we look at Mary's bank accounts too?
14. Which employees other than Mary can access electronic banking for our accounts?
15. Should we contact the police? Our auditors?

Many students do not initially see questions 1 and 2 as being related in any way. Further, students tend to have relatively few questions that related to suspects in categories c and d in question 1. Class discussion should include meta-questions such as the Board's role in investigations of this kind, whether a Board member might be included as a suspect in category d (from question 1), whether the Board would work with the Police or conduct its own separate investigation, whether investigations should initially focus on suspects or other areas, and similar topics.

6.3 Violations of Best Practices in Mobile Device Security

This case violates nearly all best practices in mobile device security. These best practices are based on prior research [4, 7, 15], and are listed below. Students might find the list through an online search if the course has not covered this content

a. Use a passcode, or add data protection on the device itself.
b. Configure the device to wipe its contents automatically when an incorrect password is repeatedly entered or remotely if the device is out of one's possession.
c. Turn off features that are not needed. Use encryption (if available) to protect personal data.
d. Look at the reviews of the developer/company who published the application for security-related issues.
e. Review and understand the permissions you are giving when you download applications.
f. Use password protection for the application.
g. Obtain malware protection for the device.
h. Be aware of applications that enable Geo-location and disable that function.
i. Apply updates to software as they become available.

j. Do not connect to unknown public wireless networks.
k. Avoid clicking on or otherwise downloading software or links from unknown sources to avoid malware.

Discussion of this list with students reveals that they are able to find aspects of this case that relate to these best practices.

6.4 Security Measures to Prevent This Fraud

In addition to adopting the best practices listed in question 3, students should link security measures to this case by suggesting operations changes the Church needs to make. Examples of questions students may propose are listed below.

1. Security training and protocols for security updates should be the responsibility of one person as appointed by the Board of Directors. This person should not be someone who conducts any business transactions for the church.
2. The board of directors should require documentation to ensure that firewalls, data security, and device security are updated each year for all devices (not just smartphones).
3. No Church employees should conduct business over unsecured email.
4. Encryption should be mandated for all sensitive electronic communications.
5. Implement strict policies for BYOD for church business, including prohibitions against open access Wi-fi, use of devices that do not require user authentication, maintaining account information on the devices, among others.
6. Require professional inspection of all devices that interact with the Church's systems to look for malware, viruses, spoofing and other issues.
7. Implement policies regarding consequences of violating policies such as those related to large financial transactions.
8. Prohibit password sharing and require password changes on a regular basis.
9. Require transaction authentication measures for all electronic banking.

Students tend to suggest unrealistically strict limitations on electronic device use than is warranted at an organization such as the one in this case. They need to be reminded that there are many levels of organizations using the same tech and prohibiting use of that tech would not serve the organization well. For example, a student might recommend the church move away from BYOD. That would most likely mean the church would have to bear the cost of acquisition and maintenance of devices for all employees (even part-time people like Mary).

6.5 Improvements to Controls over the Payment System

Students may recommend many different controls related to documentation, authorization and authentication. These areas are the most likely to help prevent this type of fraud. Students should be aware that controls such as reviewing or reconciling bank statements can detect whether theft has occurred, but they cannot prevent theft. Common suggestions from students are shown below.

1. Limit the size of a cash transfer that can be made without Board approval.
2. Limit the size of cash transaction that can be conducted by Mary (or any one employee); require a second person to authorize all transactions over the dollar limit.
3. Require two signatures on every cash withdrawal or check.
4. Prohibit account transfers without two approvers who each enter a password.
5. Require maintenance of a minimum cash balance to reduce the need for emergency transactions.
6. Require all payment activity to occur within regular business hours.
7. Prohibit the use of smartphone for electronic banking; require electronic banking transactions to be conducted on church premises using church computers.

The separate answers to questions 4 and 5 help students understand that preventing this fraud is a matter of both technology and overall systems improvement.

7 Use of This Case

This case maybe used in any course that introduces students to technology risks, controls, security or fraud. It has been used successfully in a fraud and forensic accounting course. In that course, students use many similar cases to learn topics in specific areas of accounting or business. This is the only case that directly addresses current technology security issues. The transaction that led to the theft in this case is very common, and the methods used to complete the transaction is used everyday without incident. Organizations must take action to ensure that is always true.

References

1. Alford, R., DiMattia, T., Hill, N., Stevens, K.: A series of revenue recognition research cases using the codification. Issues Account. Educ. **6**(3), 609–650 (2011)
2. AICPA: Top Technology Initiatives. American Institute of Certified Public Accountants (2011). http://www.aicpa.org/InterestAreas/InformationTechnology/Resources/TopTechnologyInitiatives/Pages/2010TopTenInitiatives-Complete.aspx. Accessed 4 Jan 2012
3. Amato, N.: The top global risks for 2017. CGMA Magazine, 19 December 2016. www.cgma.org/Magazine
4. Baker, P.: Ten smartphone security tips. CIO Update, 9 February 2011. http://www.cioupdate.com/trends/article.php/3924241
5. Chen, B., Seilhamer, R., Bennett, L., Bauer, S.: Students' mobile learning practices in higher education: a multi-year study. EduCause Review (2015). http://er.educause.edu/articles/2015/6/students-mobile-learning-practices-in-higher-education-a-multiyear-study
6. Cheng, G., Guan, Y., Chau, J.: An empirical study towards understanding user acceptance of bring your own device (BYOD) in higher education. Australas. J. Educ. Technol. **32**(4), 1–17 (2016)
7. Erlanger, L.: Smartphone security best practices. McAfee Blog Central, 4 November 2010. http://blogs.mcafee.com/enterprise/security-connected

8. Healy, M., McCutcheon, M.: Engagement with active learning: reflections on the experience. Ir. Account. Rev. **15**(1), 31–49 (2008)
9. Jones, B., Heinrichs, L.: Do business students practice smartphone security? J. Comput. Inf. Syst. **53**(2), 22–30 (2012)
10. Jones, B., Chin, A., Aiken, P.: Risky business: students and smartphones. Techtrends: Link. Res. Pract. Improv. Learn. **58**(6), 73–83 (2014)
11. Kim, E.: Recommendations for information security awareness training for college students. Inf. Manag. Comput. Secur. **22**(1), 115–126 (2014)
12. Miller, W., Becker, D., Pernsteiner, A.: The accounting ethics course reconsidered. Glob. Perspect. Account. Educ. **11**, 77–98 (2014)
13. O'Leary, C., Stewart, J.: The interaction of learning styles and teaching methodologies in accounting ethical instruction. J. Bus. Ethics **113**(2), 225–241 (2013)
14. Patten, K., Harris, M.: The need to address mobile device security in the higher education curriculum. J. Inf. Syst. Educ. **24**(1), 41–52 (2013)
15. Rose, B.: Security: How to keep your handset safe. PC World, 10 January 2010. http://www.pcworld.com/businesscenter/article/216420
16. Roux, B., Falgoust, M.: Information ethics in the context of smart devices. Ethics Inf. Technol. **15**(3), 183–194 (2013)
17. Sánchez-Alzate, J., Sánchez-Torres, J.: Analysis of social factors and their relationship with perceived risk for e-commerce purchases. Dyna **84**(200), 335–341 (2017)
18. Thomas, S.: Ethics and accounting education. Issues Account. Educ. **27**(2), 399–450 (2012)
19. Xu, H., Rondeau, P., Mahenthiran, S.: Teaching case the challenge of implementing an ERP system in a small and medium enterprise - a teaching case of ERP project management. J. Inf. Syst. Educ. **22**(4), 291–296 (2011)

Adaptation of an Educational Exergame to Mobile Platforms: A Development Process

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Abstract. This work presents an adaptation of an educational Exergame aimed for cognitive stimulation to mobile platforms, specifically Tablets. The educational Exergame "The Incredible Adventures of Apollo and Rosetta in the Space (As Incríveis Aventuras de Apollo e Rosetta no Espaço)" was developed and applied in an intervention with children in the range from 6 to 10 years old in the school context, presented in previous work. This paper proposes a combination of end user-centric techniques for adapting an Exergame aimed for Executive Functions stimulation into mobile platforms. The methodology uses three distinct techniques in the process of the game adaptation: (1) evolutionary model of software development aimed for games; (2) non-participant observation on game applications with voluntary subjects; and (3) semi-structured interview with the subjects. This methodology allows the project's development team to constantly evaluate the game through prototypes and user tests with voluntary subjects, guaranteeing a continuous process of improvement and polishment of the game. As the results indicate, this end-user centric development enables an effective portability process of the game between different platforms.

Keywords: Exergame · Mobile game · Game adaptation · Executive functions Inhibitory control

1 Introduction

This paper demonstrates the process of an adaptation between platforms of a game developed for computers with motion sensor devices into mobile platforms, named *"The Incredible Adventures of Apollo and Rosetta in the Space (As Incríveis Aventuras de Apollo e Rosetta no Espaço)"* (Apollo & Rosetta) [11]. This active-game (Exergame) consists of seven ludic activities (minigames) where children are able to use their own body to interact and perform what is proposed in each minigame. The Exergame was developed focusing on the stimulation of the Executive Functions (EF), specifically Inhibitory Control (IC), in elementary school children [11].

Currently, there are many studies in the neuropsychology field related to the EF [4], which are a set of cognitive skills and behavior regulation needed to handle everyday

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tasks. In this context, interventions aimed at exercising EF show that it is possible to exercise, stimulate and improve individual's abilities through cognitive stimulation programs [4, 5, 13].

Also, in the intervention area, there are computerized programs designed for cognitive stimulation which utilize digital games to exercise EF, according to studies by Klingberg et al. [8], as well as using games for the rehabilitation of these functions [12]. In this direction, [11] proposes an Exergame for cognitive stimulation, Apollo & Rosetta, developed aiming the stimulation of the EF, specifically IC, for children from 6 to 10 years old. Built to address various aspects of the IC, the game consists of 7 different minigames, each of which requires the player to behave in a specific way, according to the cognitive stimulation event. These events aim to stimulate the IC through visuospatial, visual and sound activities.

The cognitive stimulation activities present in the game Apollo & Rosetta were planned and designed by a multidisciplinary team, which included a specialist in the neuropsychology field [11]. Subsequently, the research team decided to port these seven activities to mobile platforms, specifically Android tablets, to improve mobility and the process of game evaluation by the development team.

This paper proposes a combination of end user-centric techniques for adapting an Exergame aimed for EF stimulation into mobile platforms. The methodology uses three distinct techniques in this process of adaptation: (1) evolutionary model of game development; (2) game application with non-participant observation; and (3) semi-structured interview with the players.

This work is organized as follows: the next section will describe the EF and cognitive stimulation programs, followed by a subsection to contextualize the game Apollo & Rosetta. Section 3 describes the methodology and the process of adaptation. Next, Sect. 4 exposes the application results and, finally, Sect. 5 presents the final considerations.

2 Executive Functions

It is now known that it is possible to help children to develop and improve their EF through tasks that exercises reasoning, planning, and IC. Recently, studies have shown that higher levels of EF during childhood are directly related to higher levels of self-control, creativity, and flexibility between tasks. Not only are these skills seen as essential in many aspects of an individual's life, they range from health issues, cognitive development, to their effects on the professional aspects of the subject's life [2, 4, 6]

In this context, exercising the EF to improve these abilities on individuals can be a strong impetus towards success related to reading, writing and mathematics [3, 10, 14, 15], hence raising the need for investment in programs aimed for EF stimulation. Currently, there are researches on the cognitive processes that the human brain operates to accomplish daily tasks. Diamond [4] states that the core of these cognitive aspects, the Executive Functions (EF), consists in family of three, interrelated core skills: (1) Working Memory, responsible for relating and managing information, thus critical for reasoning and problem-solving; (2) Inhibitory Control, responsible for containing and inhibiting inappropriate impulses or behaviors; and (3) Cognitive Flexibility, which is the ability to switch attentional focus between different tasks, change perspective and to adapt to the environment.

In the EF context, the Inhibitory Control (IC) is a skill that acts on the behavioral aspects of the individual, which is used to control and restrict inappropriate actions or thoughts, allowing the subject to choose between different responses and reactions to certain situations or objectives. Thus, this cognitive aspect allows the inhibition of a tendency or reaction in order to think correctly before committing an action, granting the choice of different responses beyond the usual ones [4].

The set of mental processes exercised by the EF stimulation helps in the concentration, attention and action planning of individuals. In addition, the capacity not to perform impulsive and instinctive actions as well, which are factors that can be developed through these stimuli [4]. When these tasks are performed with subjects such as children, these stimuli can improve their actions in front of different everyday situations, including those related to the context/environment of the school. However, according to [5] it is unclear whether computerized training or games are able to improve IC or not.

2.1 Exergame Aimed for Cognitive Stimulation

The development of the Apollo & Rosetta project for cognitive stimulation has been underway since its inception in 2014, in the Learning Objects Laboratory of the Feevale University (*LOA – Laboratório de Objetos de Aprendizagem - Universidade Feevale*). A multidisciplinary team was set up between game designers, screenwriters, programmers, sound designers, voice actors, neuropsychology experts, students and researchers in psychology, computer science, pedagogy, applied computing in education and digital games.

The game was developed with a ludic and aesthetic narrative, based on science fiction targeting the children audience, from 6 to 10 years old. In this context, the characters in the game are two children who love outer space and, while they go camping in their backyard to watch the stars, they wake up at a space exploration training school, where they start their training with the school Master to become space explorers. From this moment, a program of stimulation is initiated, which depends on seven activities with different gameplay containing necessary resources for the spatial preparation of its characters. The activities are shown in Fig. 1.

These activities will allow the player to deal with inhibitory control events, in which each activity has a continuous increase of executive difficulties, contextualized by narrative and specific configurations. The activities in the Exergame are detailed as follows:

Activity 1 - Explorer (Fig. 1A): The objective of this activity is to collect multiple items that appear on the screen, guiding the character with the body and reaching to the items with both hands. A list of marked items indicates what must be collected, and the player must avoid the unmarked items from the list (which changes from level to level) as well as the obstacles on the way. This activity requires the inhibition of the action of collecting all the items automatically, focusing on the list and the items on-screen.

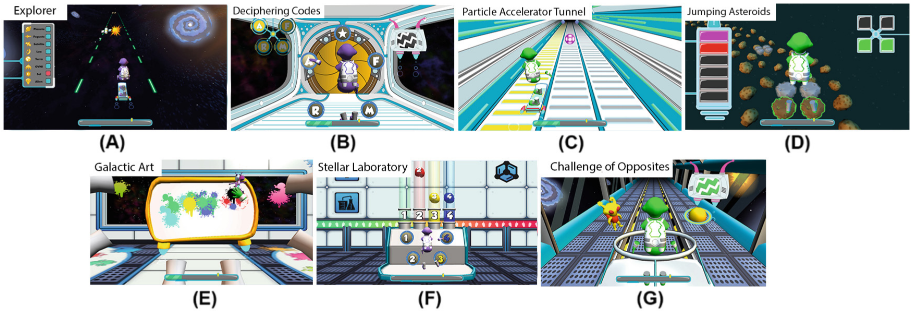

Fig. 1. The seven minigames available in the Exergame "Apollo & Rosetta" [11]. (Color figure online)

Activity 2 - Deciphering Codes (Fig. 1B): In this activity the player has to focus on a panel that has 4 letters, which corresponds to 4 on-screen buttons. The panel indicates which buttons the player has to interact with both hands and feet, and from time to time a voice in-game says a single word. If the indicated letter from the panel matches the first letter of the voiced word, the player has to reach with the hand a special button on-screen, otherwise the indicated button must be pressed. Therefore, the player's tendency to always press what is indicated is inhibited, stimulating attention and verbal comprehension.
Activity 3 - Particle Accelerator Tunnel (Fig. 1C): The purpose of this activity is to guide the character with body movements through a tunnel, dodging obstacles that appear along the way. Eventually, the camera in the game is reversed for a few seconds (from behind the character to front view), causing the controls to be reversed, so that the player's left is the character's right, and vice versa. Thus, the player must maintain focus to keep up with the character's required movement in order to avoid the obstacles.
Activity 4 - Jumping Asteroids (Fig. 1D): In this minigame, the player must be alert for a panel with four monitors, which correspond to four asteroids under the character's feet. This panel will indicate a pair of colors, which the player must jump and step on the asteroids corresponding to these colors. However, the player must also be aware of a list of "hot" colors on-screen that shouldn't be stepped on when matched to the pair of colors indicated on the panel, thus requiring the opposite move to the indication, inhibiting the usual response of always stepping on indicated colors.
Activity 5 - Galactic Art (Fig. 1E): The purpose of this activity is for the player to hit with his hand on colored balls that appear flying on the screen, coloring a frame on the scene, while avoiding black and white colored balls. From time to time, a space fly flies through the screen to distract the player and mess with the picture, and should be scared away as the player keeps his hand over the fly for a few seconds. This game requires that the player inhibits the tendency to hit all the balls in order to get a higher score, as well as losing some balls to scare away the space fly, working with factors such as inhibition and reward.

Activity 6 - Stellar Laboratory (Fig. 1F): In this activity, the player must collect elements (numbered and colored “spatial vitamins”) that appear in four colored and numbered tubes. The tube’s numbering corresponds to four buttons on the screen, which the player must touch with his hands and feet in order to collect the elements at a specific tube position. However, if the number or color of the element does not match its tube, then it shouldn’t be collected. Thus, the player must inhibit the tendency to collect all the elements automatically, keeping him constantly aware of the tubes and its elements.

Activity 7 - Challenge of Opposites (Fig. 1G): In this minigame, the player must collect objects that appear to his left or right, using hands or feet according to what is voiced by a character present in the game named Tivo. During a few moments of the match, another character (Ovit) can appear and give voice instructions, which must be performed opposite to what is indicated by this character. So, the player stimulates inhibitory control and verbal comprehension, inhibiting the tendency to always perform the voice commands.

3 Adaptation of the Exergame Aimed for EF Stimulation to Mobile Platforms

3.1 Theoretical/Methodological Assumptions for the Development of the Mobile Version

A digital game is a creative product, a result of a multidisciplinary effort applied in its development. The gaming industry requires distinct skills and formations from professionals in areas such as computer science, design, communication, music, game developers (specific formation), among others, as domain experts, e.g. present in the development of educational games.

Thereby the adaptation of digital games from one platform to another is not just a matter of changing player’s controls or inputs. It requires the transposition of several questions and among them the most important of all: the fun element [9]. In this context, Kanode and Haddad [7] propose a discussion about the challenges faced in the software development (SD) processes to achieve an immersive experience. On this topic, for a game to be enjoyable, it should keep its ludic and fun features. There are known cases of products, after being ported from one platform to another, have become difficult to interact with due to the lack of adequate controls compared to the previous platform, becoming exhaustive or uninteresting, mainly because of the SD process adopted. Therefore, this adaptation must take into account SD issues and user interaction [7], as well as aspects such as gameplay, balance, and design aimed for a fun experience [9].

In the context in which a game is produced with an evolutionary model (with recurrent revisions), which has an interactive nature of development, the model proposed by Baba and Tschang [1] describes a development spiral specifying the different required steps, which is used in the adaptation process of Apollo & Rosetta. Thus, prototypes are used as a means to allow programming tasks to occur alongside the user test and evaluation, in order to influence new tasks in a cyclic and spiral way. Thereafter, this technique divides the development process into five steps, which are repeated at the end of each cycle according to the result of the last step.

Based on this evolutionary model of software development aimed for games from Baba and Tschang [1], this first technique works according to 5 stages: inspiration, concept, design, development, and evaluation/testing. At the end of each evaluation, the results are analyzed and the process is restarted according to the analysis performed by the development team, raising new questions to be addressed.

3.2 The Course of the Adaptation Process

In the first step, **Inspiration**, the intended ideas and objectives are discussed summarily with the whole team in order to mark the directions of the project. In this case, the meetings were held with part of the original Exergame development team to establish the adaptation goals with the other researchers.

Then, in the second step, **Concept**, occurs the representation of what was discussed in the previous step, with conceptual sketches, as well as the definition of goals and spreadsheets for the modifications necessary to allow the development of the new game, where each member of the team has a role and tasks to fulfill.

Next, the **Design** step, the team has already defined, organized and reviewed the basic structural changes needed for the game adaptation, such as programming issues, game design, animation and instructions that need modifications.

In the fourth step, **Development**, the execution of the planned tasks begins, such as revision of 3D elements, programming changes, creation and implementation of animations, migration from the project to the other platform and optimization of application to run on tablets without any hardware related problems.

In the last step, **Test/Evaluation**, the user test occurs with the target audience of the product. The evaluation consisted of a user test that occurred with two volunteer subjects from the target audience (children from 6 to 10 years old) who have never had any contact with the project or the game.

The user test was performed in three sessions, for three weeks, with one session per week, lasting approximately one hour. The game was installed on two Galaxy A Tablets, one for each subject, where children could interact freely with each other while playing the activities, according to the Fig. 2. All the user tests were recorded by a camera positioned to record player's interaction with the mobile platform while the researchers took notes through non-participant observation of children's interaction with the equipment and the mini-games. At the end of the activities played, around 5 min each, the semi-structured interview was conducted by the researchers to write down the impressions of the players in relation to the recently played game, before following to the next activity.

After the user test, the project development team watched the recordings, categorized the taken notes during the application, analyzed the interviews and, based on these information, organized spreadsheets with the necessary changes for the mobile game.

Fig. 2. Volunteer children in the user tests.

After the changes established in the first user test were implemented according to the evolutionary cycle, a second user test was performed with two different children from the target audience, following the same model to verify if the previous questions were properly solved.

The Figs. 3 and 4 in the next section synthesizes the interface modifications executed on the "Explorer" activity, comparing the original version (Exergame) (Fig. 3) to the mobile version (Fig. 4) according to the issues identified and adjusted by the team after preliminary user testing with the four subjects.

Thus, with the results obtained, it was possible to identify and execute the necessary changes, demonstrating that this combination of techniques aimed at game development focusing on the needs raised by the user in the evolutionary development process was effective for the current product.

4 Results

The results of this paper consist of a large set of changes in the game as a whole. The initial changes raised by the development team prior to the tests can be seen in Table 1. Then, the data obtained and the modifications generated by the first application with the subjects are summed and exemplified in Table 2. On Table 3 all identified changes related to the second user test with the subjects are raised.

Following the steps of the evolutionary development technique described in the previous section, the questions of the Exergame adaptation to a mobile game were raised focusing on the input entries required by the player, and what was necessary for the player to understand in a more intuitive way the game mechanics. So the changes made in the horizontal/vertical movement of the player (originally with their body) were translated to Swipe (slide) commands with the fingers on the mobile platform. In activities that the player had to reach the objects with hands in the Exergame (such as panels with interactive elements or moving objects across the screen), the interaction with the device through touchscreen with the fingers directly in the objects was added. Since these interactions were originally performed by player's body movement that was used to animate the character in the game, it was necessary to develop motion animations for the character to interact with the game environment, included in six out of seven activities (e.g., "raise the character arm" animation, or animation for the character to stand over a hoverboard without being static). Accompanied by these changes, it took some modifications in the tutorial instructions to interact with the game as well, so that the rules of the game and mechanics are understandable by the users, according to the new platform. Table 1 shows the first changes of the adaptation from Exergame into the mobile platform.

Table 1. General changes spreadsheet for basic game adaptations before the first user test.

	Exergame	Mobile game
Programming (inputs)	Jump	Swipe up
	Crouch	Swipe down
	Use hands	Buttons for interaction (hands)
	Use feet	Buttons for interaction (feet)
	Body movement	Swipe left/right (sideswipe)
	Body interaction with object	Touchscreen interaction
	Character animation according to the body movement captured	Character animation according to buttons and object interaction in game
	Body movement for pause	Pause button added on screen
Narrative (tutorials)	Hand placement instruction	Push the hand buttons instruction
	Feet placement instruction	Push the feet buttons instruction
	General movement instruction	Swipe commands instruction
	Body interaction with objects instructions	Interact with object by touchscreen instructions
Design	Collect items with hands	Button for hands added
	Collect items with feet	Button for feet added
	Mask in the tutorials	Mask replacement
	Body movement animates the character	Added animations for character movement and interaction

After the basic changes were made for the proper running of the game to mobile devices, the first user test was done according to the last step of the evolutionary development model for evaluation. After the team's analysis, modifications arose from this user test: Swipe movements were not fit for the intended gameplay with the device, since the evaluation showed that the players would get eventually uncomfortable with the interaction required when some activities relied more on the swipe movement than others. With that in mind, the sideswipe (lateral slide) was replaced by the lateral inclination of the device for the accelerometer detection, while the activities that needed vertical swipe (vertical slide) were replaced by buttons to go up (jump) or descend (crouch). The team also noted that some of the interactive elements on the game screen were arranged too close, making interaction difficult in some cases due to proximity. To address this, buttons have been added in the interface for an appropriate interaction, which was required for the activities that had interactive elements in their gameplay.

Also, questions regarding game design were brought by the feedback from the users in this user test, clarifying that some of the activities needed a different, faster rhythm. This rhythm is related to the validation of the user interaction with the device, originally intended to a time window of 1 s after the stimulation event happen in some activities and the user interaction with the game (e.g. if the user press a button in the activity, the game would validate the play only after 1 s of continuous pressing.). Therefore, the validation for such activities was set to instantaneous. In Table 2 the first adaptations made to the mobile game are shown in comparison with the required changes raised by the development team after the analysis of the first user test, according to the observation and the feedback from the volunteers by the observation and semi-structured interview.

Table 2. General changes spreadsheet made after analyzing the collected information from the first user test with the two volunteer children.

	Mobile game on test	Mobile game after the test
Programming (inputs)	Swipe up to jump	Jump button added
	Swipe down to crouch	Crouch button added
	Swipe left/right for movement	Device inclination (accelerometer)
	Interaction with the objects on the scene	Interaction buttons added
	Play validation (1 s)	Play validation - instantly
Narrative (tutorials)	Swipe up instruction to jump	Instruction for pressing jump button
	Swipe down instruction to crouch	Instruction for pressing crouch button
	Sideswipe for lateral movement	Device inclination instruction
	Interact with object by touchscreen instructions	Interact with object by touching related buttons instructions
Design	Disposition of interactive elements on screen	Buttons for interaction added on screen
	Swipe up	Button design to jump
	Swipe down	Button design to crouch
	Sideswipe	Instruction for device inclination design

After the first user test some questions related to the design of the interface were raised by the feedback, and the footage analysis from the development team, according to the difficulties noticed on the player's interaction with the game, related those questions regarding the interface to the use and proper handling of the device due to commands and buttons added in the previous phase. Players were forced to play some activities with only one hand while the other had to hold the equipment, or play the activities with the device above their knees or some surface to manage a successful play, as well as reaching the buttons arranged near the center of the game interface. With that in mind, the development team decided to modify the gameplay by focusing on the game interface layout, so that the players could keep both hands holding the device while playing most of the activities (six out of seven), minimizing the need for any support due to the game time. Along with these changes, the buttons related to previously interactive (touchable) elements were redisposed as close to the player's hands as possible to prevent the player from stretching or contracting excessively its fingers to reach it on the interface. At this stage of development, voice recordings were also made to match the new instructions needed for more comprehensive tutorials, as shown in Table 3.

Table 3. Changes spreadsheet done after gathering all the information from the second user test with the other two volunteer children.

	Mobile game on test	Mobile game after the test
Programming (inputs)	Abrupt inclination not according to accelerometer reading (undetected)	Accelerometer adjustments
Narrative (tutorials)	Ambiguous tutorial instructions	Instructions revised and rewritten
	Textual instruction without sound or voices	Recording and insertion of speech in the game
Design	Buttons disposed near the center of the screen	Buttons redisposition for proximity to the screen borders according to the user's hands
	Buttons disposed too close to the edges of the screen	Button redisposition for proximity to the user's fingers holding the device

The Figs. 3 and 4 shows an example of one of the seven activities in the Exergame format and the latest version of the mobile game with changes to the design layout: buttons added for interaction with hands, crouch, and jump.

Fig. 3. A screen of the "**Explorer**" activity in Exergame format.

Fig. 4. The current version of the game for tablets after the user tests, showing the new layout of the list on the left and buttons for interaction, such as "use hands" and crouch/jump buttons, respectively. The lateral movement of the character is done using inclination of the device.

5 Final Considerations

The purpose of this paper is to propose a combination of end-user centered techniques to perform the adaptation of an Exergame aimed for cognitive stimulation into mobile devices. In this context, according to the presented methodology, the user tests with voluntary subjects were needed and performed to consistently and cyclically evaluate the changes made by the development team to transpose and adapt the game properly. In addition, the result of this combination of techniques effectively contributed to the development of the mobile game version, making it easier for the researchers to obtain feedback from the users through semi-structured interviews and non-participant observation. The collected data with these techniques proved valuable to understand what was needed to the game adaptation on the new platform during the cyclic development process, providing substantial contributions in the reevaluation of the prototypes and the product, focused on the observations and comments of the end users.

As future work, this game will undergo through evaluations with specialists on the executive functions area in order to validate the predominant EF component on each activity of the new version of the game, as well as questions regarding clarity, understanding and suitability of the game for the target audience. Afterwards, this game will be used in a 3-month pilot-study program with children from 6 to 10 years old in elementary school, with the goal of adjusting the game balance, as well as to evaluate the possible contributions of the new game and platform in executive functions stimulation programs through pre and post-tests with the subjects.

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References

1. Baba, Y., Tschang, F.: Product development in Japanese TV game software: the case of an innovative game. Int. J. Innov. Manag. **05**(04), 487–515 (2001)
2. Carlson, S., Moses, L., Claxton, L.: Individual differences in executive functioning and theory of mind: an investigation of inhibitory control and planning ability. J. Exp. Child Psychol. **87**(4), 299–319 (2004). https://doi.org/10.1016/j.jecp.2004.01.002
3. Christopher, M., et al.: Predicting word reading and comprehension with executive function and speed measures across development: a latent variable analysis. J. Exp. Psychol. Gen. **141**(3), 470–488 (2012). https://doi.org/10.1037/a0027375
4. Diamond, A.: Executive functions. Ann. Rev. Psychol. **64**, 135–168 (2013). https://doi.org/10.1146/annurev-psych-113011-143750
5. Diamond, A., Lee, K.: Interventions shown to aid executive function development in children 4 to 12 years old. Science **333**(6045), 959–964 (2011). https://doi.org/10.1126/science.1204529
6. Hughes, C., Ensor, R.: Executive function and theory of mind: predictive relations from ages 2 to 4. Dev. Psychol. **43**(6), 1447–1459 (2007). https://doi.org/10.1037/0012-1649.43.6.1447
7. Kanode, C., Haddad, H.: Software engineering challenges in game development. In: IEEE Sixth International Conference on Information Technology: New Generations, pp. 260–265 (2009). https://doi.org/10.1109/itng.2009.74
8. Klingberg, T., et al.: Computerized training of working memory in children with ADHD - a randomized, controlled trial. J. Am. Acad. Child Adolesc. Psychiatry **44**(2), 177–186 (2005). https://doi.org/10.1097/00004583-200502000-00010
9. Koster, R.: Theory of Fun for Game Design, 2nd edn. O'Reilly Media Inc., Newton (2013)
10. Monette, S., et al.: The role of the executive functions in school achievement at the end of grade 1. J. Exp. Child Psychol. **109**(2), 158–173 (2011). https://doi.org/10.1016/j.jecp.2011.01.008
11. Mossmann, J.B., et al.: Evaluation of the usability and playability of an exergame for executive functions stimulation and its development process. In: Harris, D. (ed.) EPCE 2017. LNCS (LNAI), vol. 10275, pp. 164–179. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-58472-0_14
12. Robert, H., et al.: Recommendations for the use of serious games in people with Alzheimer's disease, related disorders and frailty. Front. Aging Neurosci. **6**(54) (2014). https://doi.org/10.3389/fnagi.2014.00054
13. Thorell, L., et al.: Training and transfer effects of executive functions in preschool children. Dev. Sci. **12**(1), 106–113 (2009). https://doi.org/10.1111/j.1467-7687.2008.00745.x
14. Toll, S., et al.: Executive functions as predictors of math learning disabilities. J. Learn. Disabil. **44**(6), 521–532 (2011). https://doi.org/10.1177/0022219410387302
15. Welsh, J., et al.: The development of cognitive skills and gains in academic school readiness for children from low-income families. J. Educ. Psychol. **102**(1), 43–53 (2010). https://doi.org/10.1037/a0016738

Adults' Perception of MOOC as Part of a Constellation of Cultural Experiences

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Abstract. The empirical study described in this chapter used grounded theory methodology to investigate adults' accounts of their interest in and use of MOOC. Seventy-two Italian respondents were interviewed, all of them aged over 50. It was found that the participants shared a common eagerness to use MOOC, but only as one of several means of enhancing their cultural and professional experience. They recognised the growing importance of using the Internet, through computers, tablets, and mobile phones, and a variety of formal, non-formal and informal e-learning technologies as alternatives to more traditional leisure and cultural activities. Their awareness of their competence in using technology for learning scopes was linked to their cultural interests. They showed little or no interest in interacting with other participants or tutors and were critical about completing multiple-choice quizzes. The study findings illustrate how the participants' use of MOOC and other learning technologies is seen as relevant and offers meaningful and age appropriate experiences. The theoretical and practical implications of the results are also discussed.

1 Introduction

Since the term MOOC was coined in 2008 by Dave Cormier to describe the open online course offered by George Siemens and Stephen Downes, the proximity of MOOCs to lectures has been discussed (Bogost 2013), as well as the claim that "the MOOC learning experience is essentially the traditional lecture reformatted for the popular screen" (Adams et al. 2014, p. 202). Connectivist cMOOCs have been differentiated from instructivist xMOOCs. In both cases, while a better understanding of younger students' experiences has been explored, little is still known of the expectations and experiences of adult and older participants.

The aim of our work was to understand the expectations and learning experiences of MOOCs by participants over 50. In the following pages we will first briefly present a literature review on MOOCs and their use by adults, with the focus on people over 50. We will then describe the research process, including the methodology, analysis and results, before drawing our conclusions and making suggestions for future research.

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2 Literature Review

Formal and non-formal e-learning, open learning and informal learning experiences through Internet and social media have been studied in a well-established body of scholarship. MOOCs, still a more recent possibility offered to those interested in e-learning, have been analysed, and there have been attempts to frame them theoretically. A variety of possibilities have been discussed, the main two being connectivism (Bell 2010; Kop 2011) and complexity theory (DeWaard et al. 2011). The results have sometimes been controversial: MOOCs may be "a tonic for an ailing education system say some, a poison for Universities say others" (Haggard 2013, p. 12 as cited in Adams et al. 2014).

The study of participants' MOOC learning experiences is facilitated by the fact that learner-generated numerical data-sets are tracked by the platforms, allowing researchers access to these data to perform large-scale educational data mining and learning analytics.

Research has analysed students' engagement and intention (Pursel et al. 2016), making it possible to identify different typologies based on levels of engagement: lurkers, passive participants, active participants, and "drop-ins". In other cases, the pattern of engagement has been studied, showing the influence of multiple factors such as motivation and confidence with technology. Adams et al. observe that, "as with all such classification systems, they shed limited light on the experiential lifeworld dimension of learning in a MOOC" (2014, p. 204).

Analysis of retention rates has revealed that the non-completing MOOC population is in general high: more than 90% (Jordan 2015) and as much as 95% for Coursera courses (Koller et al. 2013). Limited commitment and not needing to obtain a certificate are among the causes identified for the low completion rate.

Blogs and recordings of students are another means of studying the MOOC experience, this time through the eyes of the participants. These accounts reveal the participants' sense of guilt at not working fast enough to successfully complete the course (Tze et al. 2017), and their feelings of unfairness at being penalised for the rate at which they submit homework (McCracken 2012).

Liyanagunawardena and Williams (2016) have highlighted the lack of research into the use of MOOCs by older learners (including people over 50), while establishing that they are participating in MOOCs by analyzing demographic data from 10 courses offered by the University of Reading.

3 Grounded Theory

A constructivist approach to grounded theory (GT) (Charmaz 2006; Mills et al. 2006) was chosen. A core category was not sought and there was no specific request section at the origin of the research. While large grounded theory projects aim to generate theory (Strauss and Corbin 1990), the same procedures and techniques are also a useful framework for smaller studies where theory will not be generated, particularly when the focus is on understanding more about a specific issue as in our research. In this small project, GT was used as an analytical framework, incorporating constant comparative analysis as a method of qualitative data analysis (Charmaz 2006).

In line with this approach, we used semi-structured interviews and textual analysis. When analysing interviews, we did not use researcher-chosen categories (Charmaz 2006; Glaser and Strauss 1967). Data were examined and analysis begun during the data collection process, allowing initial readings to guide further collection. According to GT methodology, research started out broadly, with the aim of identifying the phenomenon studied; it then became progressively more focused throughout the research process. Although the main themes of our research were based on discussions with colleagues and on literature review, preconceived theoretical concepts provided starting points for examining data, but did not offer automatic codes for analysis, as suggested by Charmaz (2006).

4 Methodology, Data Collection

4.1 Participants

As an initial criterion, participants had to be Italian native speakers living in Italy, aged over 50 at the time of the interview, and having enrolled in at least one MOOC, whether or not they completed it. The geographical distribution of the respondents covered twelve of Italy's twenty regions.

Seventy-two participants, twenty-three women and forty-nine men, took part in the individual interviews between June 2016 and May 2017. Their aged ranged from 50 to 74 (Tables 1, 2, 3 and 4).

Table 1. The age ranges of interviewees

Age range	Percentage
50–59	61.1
60–69	30.5
70+	8.4

Table 2. Gender distribution of interviewees

Gender	Percentage
Female	32
Male	68

Table 3. Levels of education held by interviewees

Level	Percentage
Upper secondary education	33.3
Bachelor + Master	62.5
Postgraduate	4.2

Table 4. Past or current profession (*International Standard Classification of Occupations (ISCO-08)*)

Profession	Percentage
Teaching professionals	23.6
ICT professionals	15.3
Science and engineering professionals	13.8
Government Officials	11.2
Officials of special-interest organizations	11.2
Social work associated professionals	8.3
Legal professionals	6.9
Health professionals	6.9
(Never employed)	2.8

4.2 Procedure

Recruitment

Participants were recruited initially by emailing databases of companies, public organizations and NGO members, with a total of approximately 300 addresses. In the e-mail we asked candidates if they were willing to take part in research, provided they met the criteria for interview, and/or would be willing to forward the email to others who might be interested. After three months we also used social media to invite potential participants. The number of interviews was not decided at the beginning of the research. The interviews lasted on average 40 min.

Interview Format

The interviews were carried out via Skype (video sessions only). Before each interview began, the purpose of the study was explained and informed consent was obtained. At the start of each interview, participants were asked for personal data: date of birth, gender, education, and employment status. Participant were then asked about their enrolment and participation in one or more MOOC. This opened up the interview to the area of research; the rest of the interview consisted of open-ended questions aimed at eliciting individual experiences and behaviours relating to the MOOC. The style of the interview encouraged participants to give a detailed description of events and explored their meaning to the individual (Charmaz 2006). The first ten interviews were very open. Thereafter interviews became more focused on the themes that had emerged.

4.3 Analysis Process

During analysis we applied the iterative classic grounded theory process of coding, memoing, sorting, conceptualization and constant comparison (Glaser 1965) and, as far as possible, suspended preconception (Simmons 2011). In keeping with grounded theory procedure, the first ten interviews were transcribed fully before further interviews were conducted. Before coding, we made several readings of the entire texts and noted ideas of interest. Open coding allowed us to identify sub-themes, topics, and issues in a systematic manner. Code words were then applied to sections of the text, following Glaser and Strauss' (1967) description of open coding. A list of the code words for each transcript was then compiled and checked to ensure that codes were used consistently throughout the transcripts. After following this process with the first ten transcripts, the interview schedule was modified to take into account some of the patterns emerging from the data. The remaining interviews were conducted using a continual process of interview, transcription and initial analysis. Further changes were made in relation to validation (see further on for details). As recommended by Berg (2001), a general question was kept in mind during the entire process, that is, the original objective of the research. Berg's recommendations were considered throughout the process: data must not be moulded to the study and as a result, the original purpose of a study may not be accomplished and an alternative or unanticipated goal may be identified in the data. Validation was obtained through feedback methods, cross checking interim research findings with 15 of the participants. We are aware that the appropriateness of these techniques has been questioned (Barbour 2001; Mays and Pope 2000; Onwuegbuzie and Leech 2007), but they were considered appropriate for this research given its size and scope. Although some validation was achieved (all participants provided information on the main themes in the analysis, offering a range of responses and adding dimensions to the themes), it cannot be claimed that saturation of the themes occurred due to the limited sample size.

4.4 Findings

Four main macro themes emerged from the analysis of the interviews. The first two related to participation in MOOC[1]s, the other two to interest in lifelong and lifewide learning. Two subgroups emerged early on: people still working who were also interested in MOOCs for professional reasons, and retirees whose interest stemmed mainly from cultural and leisure interests. A degree of overlap can be explained by workers having a busy cultural life, and retirees either volunteering for organisations which help migrants and the socially disadvantaged or helping grandchildren with school assignments (or both) and wishing to keep up-to-date on the topics they teach them. The choice to enrol in a MOOC varied according to individual professional status, level of confidence with foreign languages, English and French, and personal interest in lifelong and lifewide learning. The adults interviewed based their choices on personal factors and did not feel frustrated if they changed their mind and decided to leave the course. On the contrary, they seldom considered the experience a formal course, and tended to see the MOOC as another means of acquiring new knowledge or competences, assimilating the MOOC alongside books, movies and theatre as well as Youtube, TED and Masterclass.

The prevalence of MOOCs in languages other than Italian creates a selection among the native Italian speakers using them. There are still very few MOOCs available in Italian, and the interviewees all had an above average educational background with

[1] We use the more general term MOOC as respondents have enrolled in both types of MOOCs: xMOOCs, based on traditional university courses and connectivist-influenced cMOOCs (although the majority have enrolled in xMOOCs).

almost ever the equivalent of a three-year degree course. However, the availability of courses in Italian is expanding rapidly, and adult learners might make up a significant part of their users in future. The consensus among the participants was that their interest in e-Learning is best served by a variety of technological tools, and they refer to ubiquitous learning. They appreciated being able to use a tablet, mobile phone, or desktop computer to learn. Learning may be done for professional reasons, if the interviewees are still working, or for leisure and cultural reasons. The participants all appreciated being able to use technology in different places and in different ways, as 64-year-old L.T. explains:

> *I realise that seeing paintings in a museum is a different experience. But when the paintings are at MOMA and you're looking at them from your sofa, that's good enough already. I find my iPhone really handy for online cookery courses. I've put a bookstand for my phone in the kitchen so I can watch videos and try out the techniques.*

Another aspect is the possibility of cross-learning across websites and social media, as 58-year-old S.R. highlights in the next extract.

> *The MOOCs I've completed (all of them literature-based) were American. I often found that I missed out on cultural references which must be obvious for an American, just as a foreigner doing a course on Cesare Pavese probably wouldn't have a clear idea of what the Langhe region is like. Every video I watched during the MOOC was a chance to discover places, moments from history, and even figures of speech.*

While they were certainly curious about their courses, the interviewees did not express interest towards the other participants. This is seen most clearly when the MOOC is in a language other than Italian. 61-year-old T.D. sums up her perception of the other participants on a programming course which she embarked on out of personal curiosity, having done Basic programming when she was younger.

> *On one hand it's exciting to see the variety of other participants. I read the introductions and there are people from all over the world. They all seem to be young, active, and eager to interact with other people. I think it's because people like me who aren't curious don't even introduce themselves. It would feel like a waste of time, and I don't think we'd have anything in common, not only because of our ages but because we enrolled on the same course for different reasons.*

The participants all enrolled on the courses for either cultural or professional reasons. Most of them gave an extensive description of their backgrounds. MOOCs are just one of their activities, and the knowledge they gain becomes part of a network of knowledge and experiences with the same value. Participants often recommend a particularly interesting MOOC to friends with similar interests. 68-year-old A.T. describes the experience of completing a French MOOC on Impressionism.

> *We were planning a trip to Paris with two other couples. I found a MOOC which the Grand Palais was running on the Impressionists. Two of our friends did the course as well in the end; it was an alternative way of getting ready for a trip, a change from reading the Michelin guide (laughs) or lists of restaurants.*

Most of the interviewees only used part of the resources linked to the MOOCs. They watched the videos (and appreciated the subtitles and transcriptions when the MOOC was in English or French) and read the recommended texts. The number of hours per week was relatively high, and participants worked out how to fit them into their daily routine. B.S., a 70-year-old retired high school teacher, has taken part in more than 10 MOOCs on art, cuisine and literature:

> *Being able to access the MOOC at any time is excellent. I am busy with my grandchildren, a home to run and my 95-year-old mother, who I visit at her care home almost every day. I don't have much time. But I set aside the hours for myself – I need some kind of distraction. For years I taught my students how to organise their studies, and it's served me well!*

None of the interviewees had particular problems using computers or smartphones. Most of them had honed their skills at work and/or as part of their hobbies. Their good educational background, knowledge of foreign languages and past careers (most had worked or still work as teachers) made it easy for them to learn how to use other technologies. The interviewees often saw MOOCs as a natural progression from other teaching methods. 58-year-old G.R. works for a prominent NGO in the fundraising sector.

> *If I was doing a degree today, I'd do an online course. We wasted so much time waiting for professors who never turned up, sat in crowded lecture theatres were you couldn't hear anything. And that awful way they talked for hours, often with no support material. When someone showed us some handwritten transparency film with an overhead projector, we thought it was high technology. My children used to watch Power Point presentations at university, and in the 1990s that was cutting-edge. With MOOCs you have better teachers, and you can listen to them again and again, whenever you want, from the comfort of your sofa.*

Very few participants gave a positive comment of the multiple-choice quizzes. While the interviewees weren't interested in obtaining official recognition for completing the MOOC, some were eager to evaluate their knowledge so they did the quizzes. However, their comments were always negative. 67-year-old S.T. retired from his job as a philosophy teacher a year ago:

> *Of course, teaching methods have evolved. Constructivism has become part of our professional lives; I did lots of professional development courses, and in the last few years of my career I used websites, multimedia essays and anything else which would interest my students and help them connect a seemingly abstract subject to everyday life. But oral exams were always the main method of testing. I don't think I ever used written tests, quizzes or questionnaires. No doubt they require less input from the teacher, but if you want to find out whether a student knows their subject, an oral test is the best way.*

5 Discussion and Conclusion

The research observed how adults over 50 may use MOOCs for a variety of interests and professional and personal reasons, based on their expectations and learning experiences. The main limitation of the research is the small sample size, which meant that the saturation of themes was beyond the possibility of our research. If the research had been continued with more participants, the themes presented could have be given more support, or alternatively different themes might have emerged. Additional interviews would produce different results, and this is an overarching limitation of conducting exploratory, qualitative research with a small sample. According to previous research (Kop and Fournier 2011; Weller 2011), taking part in a MOOC offers chances for participants to build personal networks and make connections beyond the scope of the course. Our research shows that when the participants are adults, at a time of life when personal and professional relations are well established, interaction with others is not considered interesting enough to make them engage in activities other than watching the videos, reading the supporting documents and visiting websites and other resources suggested by the MOOC. While some of the characteristics of older people attending MOOCs described by Liyanagunawardena and Williams (2016) and Notess and Lorenzen-Huber (2007) are common to what was seen in Italy, the focus on loneliness, geographical isolation or mobility issues was not observed in our interviews. On the contrary, all the participants took part in MOOCs because they have very active professional (in some cases), cultural and social lives; the MOOC was only one part of a net of activities.

Githens (2007) categorizes e-learning programs for older adults as programs for personal growth and social change, workforce development, and workplace learning. In our interviews, the participants were interested almost exclusively in MOOCs organised by the highest ranking Universities. They chose the topics either for professional reasons or for cultural and leisure interests. None of the interviewees attended courses aimed at older people. The lack of comparable statistical data means we cannot estimate older people's interest in courses aimed specifically at them. Universities of the third age, launched in the 1970s, are very popular in Italy. In their advertising they emphasise the opportunity for socialising paired with a wide range of courses. Those interviewed apparently belong to a different group; none of them attends a University of the third age, as they are considered lower quality than what they can find online.

Other research (McAuley et al. 2010) analyses the role of participants as knowledge builders, demonstrating that some learners can see this role as alien. The experiences of the people we interviewed confirm the results of previous research. This appears to be due to three main factors. Firstly, in the case of MOOCs in languages other than Italian, language difficulties mean that participants can listen and read the foreign language but may struggle to interact with others in writing. The second factor concerns the nature of interest in the specific MOOC: when their interest is cultural rather than professional, their lack of previous competence in the subject means that participants find it pointless to interact with others whose interest is professional. The interviewees saw interacting with others as a waste of time, since they were uninterested in creating a professional network or achieving a high level of competence in a subject which they do not see as essential. Finally, the third factor lies in the fact that participants completed their education at a time when the teaching model was prevalently transmissive, and this still influences many of them years later. Teachers are seen as a source of knowledge, while interacting with other participants (who are not thought to have specific competences) is not worth the time and energy. It is worth mentioning that those taking part in Italian-language MOOCs refer to the transmissive models with which they are more familiar, appreciate the possibility to interact with other participants but blame the lack of interaction with them (in which they show little interest) on a shortage of time. Earlier research (Kop and Fournier 2011), has suggested a difference in how novices and experienced participants plan their route and their level of participation. The latter are more judicious while the former encounter difficulties in online environments, which they find challenging and troublesome. This does not correspond to our results, where even respondents who attended only one MOOC do not declare difficulties in planning and participation. Recent studies (Bencivenga 2017) offer new perspectives on the generations normally considered pre-digital users. People over 50 are still associated automatically with older groups who use computers and the Internet to a different extent, while at least some of them are competent users, who even criticise the supposedly younger generations' "natural" competence in ICT. Stereotypes still separate those who know (digital natives) and those who either do not know or have difficulties with ICT: our study shows that 'over-50 MOOC users' may belong to a typology who confidently use ICT and social media, and that their cultural background may allow them to easily organise their learning path also in e-learning. Although they certainly do not represent the majority of the population of the same age, they are still worth being investigated if we are interested in making MOOCs part of lifelong and lifewide learning.

The concept of "lifelong learning" is now complemented with the concept of "lifewide learning", that is a continuous life process stemming not only from formal and informal intentional learning, but also from unintentional learning. In particular, adult learning is considered to come from situations and sources which are merged and mixed into everyday life. "Learning of adults happens not only lifelong, but also lifewide in a multitude of traditional and non-traditional, formal and informal settings (workplaces, leisure-time, families, churches, market-places, television, "the life")" (Reischmann 2014, p. 294). Our research shows how MOOCs, seen as "formal online courses", belong more to lifewide than lifelong aspects of learning in the views of the adults interviewed. If the alternative for an evening at home is television, a MOOC or a movie, alone or with the family, we could either consider this approach to the MOOC a misinterpretation or reflect on a diverse – and relevant - use of a formal educational offer.

Adams et al. (2014) observe that the quick changes in the landscape of MOOCs diminish the historical significance of studies in the field. This continuous and rapid movement is typical of the ICT sector. However, the ubiquitous intervention of ICT in our lives is shaping us; it extends or reduces our capacities in ways interconnected with our daily lives, that include, but are not defined only by, ICT. Therefore, understanding the way adults may interpret and use MOOCs in different ways to which they were built, for example by cherry picking features of cMOOCs to use them as xMOOCs, or not being interested in interacting with tutors or other participants in a co-construction of contents, can open new perspectives for pedagogies in lifelong and lifewide learning. While the potential of MOOCs to reshape the academy (Wolfson 2013), as well as who controls the knowledge embedded in MOOCs (Altbach 2014) has been questioned, further analysis of how people are interested in MOOC for reasons other than formal learning could offer hints to instructors and MOOC design teams as well as public and private organisations interested in promoting lifelong and lifewide learning. This might lead to innovative ways of supporting and guiding new MOOC participants who are not interested in obtaining a certificate but can still make good use of a MOOC.

In conclusion, our research adds to the findings of earlier research on learner participation within MOOCs as discussed in the literature review, and investigates their use by adults not as online courses but as part of a constellation of cultural experiences, that can be source of information, knowledge and entertainment.

References

Adams, C., Yin, Y., Vargas Madriz, L.F., Mullen, C.S.: A phenomenology of learning large: the tutorial sphere of xMOOC video lectures. Distance Educ. **35**(2), 202–216 (2014)

Altbach, P.G.: MOOCs as neocolonialism: who controls knowledge? Int. High. Educ. **75**, 5–7 (2014)

Barbour, R.S.: Checklists for improving rigour in qualitative research: a case of the tail wagging the dog? Br. Med. J. **322**, 1115–1117 (2001)

Bell, F.: Connectivism: its place in theory-informed research and innovation in technology-enabled learning. Int. Rev. Res. Open Distance Learn. **12**, 98–118 (2010)

Bencivenga, R.: The "digital curious": first steps towards a new typology for mapping adults' relationships with others when using ICT. Eur. J. Res. Educ. Learn. Adults **8**(1), 55–76 (2017). https://doi.org/10.3384/rela.2000-7426.rela9117

Berg, B.L.: Qualitative Research Methods for the Social Sciences. Allyn and Bacon, Boston (2001)

Bogost, I.: The condensed classroom. The Atlantic (2013)

Charmaz, K.: Constructing Grounded Theory. A Practical Guide Through Qualitative Analysis. Sage Publications, London (2006)

DeWaard, I., Abajian, S., Gallagher, M.S., Hogue, R., Keskin, N., Koutropoulos, A., Rodriguez, O.C.: Using mLearning and MOOCs to understand chaos, emergence, and complexity in education. Int. Rev. Res. Open Distance Learn. **12**, 94–115 (2011)

Githens, R.: Older adults and e-learning: opportunities and barriers. Q. Rev. Distance Educ. **8**(4), 329–338 (2007)

Glaser, B.G.: The constant comparative method of qualitative analysis. Soc. Probl. **12**(4), 436–445 (1965)

Glaser, B.G., Strauss, A.L.: The Discovery of Grounded Theory: Strategies for Qualitative Research. Aldine Pub, Chicago (1967)

Haggard, S.: The maturing of the MOOC: Literature review of massive open online courses and other forms of online distance learning [BIS Research Paper No. 130]. Department for Business, Innovation and Skills, London (2013). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/240193/13-1173-maturing-of-the-mooc.pdf

Jordan, K.: MOOC completion rates: the data (2015)

Koller, D., Ng, A., Chen, Z.: Retention and intention in massive open online courses: in depth. EDUCAUSE Rev. (2013). https://er.educause.edu/articles/2013/6/retention-and-intention-in-massive-open-online-courses-in-depth. Accessed Feb 2018

Kop, R.: The challenges to connectivist learning on open online networks: learning experiences during a massive open online course. Int. Rev. Res. Open Distance Learn. **12**, 19–38 (2011)

Kop, R., Fournier, H.: A pedagogy of abundance or a pedagogy to support human beings ? Participant support on massive open online courses a pedagogy of abundance or a pedagogy to support human beings. Int. Rev. Res. Open Distrib. Learn. **12**(7), 74–93. (2011). http://doi.org/10.19173/irrodl.v12i7.1041

Liyanagunawardena, T.R., Williams, S.A.: Elderly learners and massive open online courses: a review. Interact. J. Med. Res. **5**(1), e1 (2016). https://doi.org/10.2196/ijmr.4937

Mays, N., Pope, C.: Assessing quality in qualitative research. BMJ **320**(7226), 50–52 (2000). https://doi.org/10.1136/bmj.320.7226.50

McAuley, A., Stewart, B., Siemens, G., Cormier, D., von Kotze, A.: The MOOC model for digital practice. Massive Open Online Courses: digital ways of knowing and learning (2010). http://doi.org/10.1016/j.im.2011.09.007

McCracken, H.: MOOC Brigade : What I Learned From Learning Online, pp. 9–11 (2012)

Mills, J., Bonner, A., Francis, K.: The development of constructivist grounded theory. Int. J. Qual. Methods **5**, 25–35 (2006)

Notess, M., Lorenzen-Huber, L.: Online learning for seniors: barriers and opportunities. eLearn Magazine (2007). https://elearnmag.acm.org/archive.cfm?aid=1266893. Accessed Feb 2018

Onwuegbuzie, A.J., Leech, N.L.: Validity and qualitative research: an oxymoron? Qual. Quant. **41**(2), 233–249 (2007). https://doi.org/10.1007/s11135-006-9000-3

Pursel, B.K., Zhang, L., Jablokow, K.W., Choi, G.W., Velegol, D.: Understanding MOOC students: motivations and behaviours indicative of MOOC completion. J. Comput. Assist. Learn. **32**, 202–217 (2016)

Reischmann, J.: Lifelong and lifewide learning - a perspective. In: Charungkaittikul, S. (ed.) Lifelong Education and Lifelong Learning in Thailand, Bangkok, pp. 286–309 (2014)

Simmons, O.: Why classic grounded theory. In: Martin, V., Gynnild, A. (eds.) Grounded Theory: The Philosophy, Method, and Work of Barney Glaser, pp. 15–30. BrownWalker Press, Boca Raton (2011)

Strauss, A., Corbin, J.: Basics of Qualitative Research: Grounded Theory Procedures and Techniques. Sage Publications Inc, Newbury Park (1990)

Tze, V.M.C., Daniels, L.M., Buhr, E., Le, L.: Affective profiles in a massive open online course and their relationship with engagement. Front. Educ. **2**(December), 1–13 (2017). https://doi.org/10.3389/feduc.2017.00065

Weller, M.: The Digital Scholar: How Technology is Transforming Scholarly Practice. Bloomsbury Academic, London (2011)

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