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JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY
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EDITORIAL

Bridging researches in Digital Education

Tommaso Minerva
[*Editor-in-Chief*]
University of Modena and Reggio Emilia – Reggio Emilia (Italy)

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In these first issues of 2020, the thought goes to the memory of the missing Gino Colazzo, who directed Je-LKS since 2008 and slowly and tenaciously shaped his identity.
Gino Colazzo has left us an important legacy characterizing Je-LKS for its methodological strictness, fairness, and editorial reliability.
I have decided to embrace this legacy and to assume the editorial responsibilities of the journal in full and committed consistency. My ambition is to offer Je-LKS a place where the various cultures, experiences, and research in e-Learning and the Society of Knowledge can meet and contaminate each other.
We are now entering the era of Digital Education. Therefore, it is essential to build bridges (not fences) between different research fields: from technological to pedagogical, from sociological to organizational, from cognitive science to new media, from data science to linguistics, and so on.
I wish to strengthen the multidisciplinary and international identity of Je-LKS within a scientific framework. Empirical and experimental submissions are encouraged, and the authors are asked to provide evidence, details, and datasets. The goal is to favor third-party replicability and to increase the methodological robustness.
We assure the authors a rigorous, respectful, and proactive evaluation process.
This ***Number 2*** (and contemporary the ***Special Issue***) is part of the legacy of the previous editor and editorial board. Prepared during the spring of last year, it is the last work of the beloved and friend Gino, and I leave it to the issue editors to illustrate it.

I would like to anticipate some news about Je-LKS.

A new Editorial Board: although not yet involved in the editing of the first issues of Je-LKS, since January 1st, a new Editorial Board has been appointed made up of esteemed international researchers and scholars who have accepted – and for this, I thank them – the task of steering Je-LKS towards international horizons. My sincere and warm thanks go to all those who have served on the Editorial Board in recent years.

New Managing Editor and Editorial Staff: Prof. Luciano Cecconi assumed the role of Managing Editor succeeding Nicola Villa, who, for his professional duties, has asked to reduce his involvement in Je-LKS. He continues to be part of the Editorial Staff together with a group of young and motivated colleagues.

New graphic layout: since these first issues, both the graphic image of the magazine and the layout and standards of the single articles are changed, approaching the most modern international standards.

New publications agenda: Je-LKS continue to be a quarterly journal, but the publication dates change to April 30th, August 30th, and December 30th, respectively.

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The publication policy will include, starting from the August 2020 issue, the *online-first formula*. In other words, the papers will be published online as soon as the reviews and editorial operations are completed. At the deadline of April 30th, August 30th, or December 30th, the issues will be composed and ready for printing.
Regular Issues and Special Issues will be separated into different issues. Always respecting the three deadlines, for each issue, there will be both the regular issue and the special issue dedicated to a particular subject (Call for Paper) proposed by the Editorial Board.

In this deadline at the end of April, we publish a ***Special Issue*** dedicated to the theme: *Smart Learning in Smart Cities* and a ***Regular Issue*** of spontaneous proposals for which an effort has been made to recover most of the submissions pending from the previous management.

A lot of news, then, and an invitation to submit papers to Je-LKS.

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A full-stack model proposal to willingly implement e-learning at small universities: The University of Trás-os-Montes e Alto Douro Case

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Abstract

This paper presents a model of a system capable of addressing the training needs identified for small universities, using the University of Trás-os-Montes e Alto Douro (UTAD) as a case study. In addition to supporting the typical needs of distance learning/education (e.g., e-learning), it is also intended that the proposed system complements the traditional classroom-based teaching. This model will have two modules: the physical/infrastructural module and the policies/practices module. While the physical module will have all the infrastructure services associated with educational practices, such as the e-learning platform, the policy module will include institutional policies and rules in the creation, development, practice and management of courses, equipment and physical spaces, such as exam rooms.

In line with these, UTAD has come to recognize that e-learning should be part of its strategy for its training offer and, consequently, is being adopting new policies, namely through the signing of protocols with other institutions with more experience using e-learning. As such, a review of other models and systems that have been successfully implemented in other international reference universities will also be briefly presented here. The courses implemented so far, and the results achieved, are also presented and commented.

KEYWORDS: E-learning, LMS, Higher Education, Collaboration

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1. Introduction and motivation

Technological developments in society over the last two decades, in particular those associated with digital communications, have profoundly changed the way people live, with particular emphasis on how they interact, how they work and how they learn. This change has a strong impact on the development of the individual's social capacities and educational skills.

E-learning, which for now can simply be defined as both a technological and pedagogical method for distance learning, can be seen as the main reason for this significant change in teaching and in the acquisition of new skills (learning). The effectiveness of the processes used in the transmission of knowledge and the rapid access to the courses are conducive to attracting new audiences. Likewise, this modality of teaching can be a complement to face-to-face teaching.

E-learning should not be evaluated as a facilitating and secondary teaching model, but rather as a new opportunity for educational institutions to broaden their educational offer and reach a new public, hitherto unattainable (Bichsel, 2013; Means et al., 2009).

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At the University of Trás-os-Montes e Alto Douro (UTAD), e-learning is considered as an "unknown-recent" teaching modality and as such, still without great prospect in this area. Although the institution shows some willingness to embrace this teaching methodology and has already done so previously by using teaching plans in the b-learning modality, it eventually collapses due to several different classes of difficulties. These can be classified into two distinct classes: technological – lack of e-learning platforms and tools for content creation; and human – lack of training in the area of information and communication technologies (ICT) and lack of training in this type of teaching (Islam, Beer, & Slack, 2015). Lack of time is often pointed out as a limiting factor: teachers see e-learning as an activity that will require a lot of time, overloading, even more, their already overfilled agenda. To this, teachers add the lack of recognition of their work and the fact that it does not have effects for progression in their professional career.

These difficulties might be overcome by implementing measures or approaches of a more or less simple nature. For example, training for teachers in ICT, technical support by specialized teams, accounting as teaching hours the time spent preparing the e-learning courses, financial incentive related to the training expenses, materials and scientific production (Paiva, 2013).

In this context, it is our aim to present a model of a system capable of responding to the training needs identified at UTAD. This model must be able to integrate a multiplatform system, effective, practical, functional and complete, leading to the actual implementation of e-learning at UTAD. This system should contribute to improve the transmission and availability of courses/ trainings, as well as helping bringing students closer together and attract new audiences. This system should also be used to support face-to-face teaching. In summary, the proposed system should: contribute to combat school failure; allow students more flexibility in scheduling their courses and training; cover a wider population of more advanced age groups; attract students from different regions and/ or countries; use more innovative techniques and technological means for the dissemination of knowledge and teaching; promote the collaboration between participants in problem solving, among other. The system should be prepared to integrate tools and able to respond to good practices for the creation of interactive contents.

In the following sections, data related to UTAD and the criteria for choosing each module of the proposed model will also be presented and discussed.

2. E-learning: a brief review and its current implementation at UTAD

Similar experiments in Universities all over the world, of about the same dimension and conditions of UTAD, have been conducted. Additionally, models and frameworks for the evaluation or assessment of the success of these implementations have also been proposed. For example, the critical success factors that influence the acceptance and success of e-learning systems in developing countries have been identified by Bhuasiri et al. (2012). In this study, the authors also compare the relative importance among ICT experts and faculty, by collecting 76 usable responses. The results showed 6 dimensions and 20 critical success factors, and revealed the importance of curriculum design for learning performance. Their findings also revealed that technology awareness, motivation, and changing learners' behavior are prerequisites for successful e-learning implementations. Moreover, the authors presented recommendations to aid the implementation of e-learning systems for developing countries, which have relevance for researchers and practitioners. Additionally, and as stated by Blin & Munro (2008), “The advent of the Internet heralded predictions that e-learning would transform and disrupt teaching practices in higher education. E-learning also promised to expand opportunities for lifelong and flexible learning, and offered a panacea for practical issues such as decreased funding and increasing student numbers”. However, this “anticipated disruption” did not happened. It is a fact that the “technology means” are now common place in most higher education institutions, but there is little or no evidence of significant impact on teaching practices. Blin & Munro (2008) discuss the transformation of teaching practices (which did or did not take place) in the Dublin City University (DCU).

On the other hand, Ozkan & Koseler (2009) proposed a learning management system evaluation model, using six dimensions: system quality, service quality, content quality, learner perspective, instructor attitudes, and supportive issues. They applied a survey to 84 learners (testing for content validity, reliability, and criterion-based predictive validity), from undergraduate and graduate levels, at Brunei University. The results showed that each of the six dimensions of the proposed model had a significant effect on the learners' perceived satisfaction. Motiwalla (2007) proposed a framework for mobile learning evaluation. The used framework “provides the requirements to develop m-learning applications that can be used to complement classroom or distance learning”, and a prototype application was tested for two semesters, with a total of 63 students from undergraduate and graduate university courses. The achieved results helped in better understanding on the role of mobile technology in higher education. Also

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related to the attempt of measuring the success of e-learning systems and models for learning, Hassanzadeh, Kanaani & Elahi (2012) have proposed a model for measuring this success in five universities: Amir Kabir University, Tehran University, Shahid Beheshti University, Iran University of Science & Technology and Khaje Nasir Toosi University of Technology. They also analyzed the opinions of 33 experts, assessed their suggestions and the questionnaires completed by 369 instructors, students and alumni, which were e-learning systems users.

Currently, e-learning at UTAD is at a very early stage, with the total number of courses available being very low. From the direct contact with teachers, it may be stated that this is due, among other reasons, to the lack of teacher training, lack of technical support, lack of specific tools and lack of institutional support policies, being this is in line with the reasons enumerated above.

An exception to this is the existence of a teaching support platform (named SIDE – http://side.utad.pt), developed at UTAD and that has been used systematically over the last decade. All the courses taught at UTAD are registered at SIDE and teachers are required to use it to record the course syllabus, assessment methodology, student attendance, class summaries, marking of assessment tests, registration of classifications, among others. However, SIDE works more like a teaching management platform rather than as a platform for the dissemination and management of online content and courses.

Over the last decade, e-learning at UTAD has been a forgotten teaching modality, not being seen as a modality for distance learning nor as a form to support and complement face-to-face teaching. However, in the last two years, e-learning is being viewed in a more constructive way. There has been an increase in the incentive to teachers, with a dedicated support team and with new platforms and tools for creating and making courses available in a very simple and easy way.

UTAD is organized in 5 Schools: School of Agrarian and Veterinary Sciences (ECVA); School of Human and Social Sciences (ECHS); School of Sciences and Technology (ECT); School of Life and Environmental Sciences (ECAV); School of Health (SH). The learning management system (LMS) that is being used is Moodle. Table 1 shows the number of courses and learning units that were registered in Moodle for the last three years, by school and study cycle. As it can be seen, the total number of learning units and courses is the same for the 2015/16 and 2016/17 academic years. For the academic year of 2017/18 it can be seen an increase both in the number of courses and learning units. From the direct (informal) contact with the teachers, it can be stated that this increase is due to a more personalized support to the teachers. These courses also support face-to-face classes.

	2015/16			2016/17			2017/18		
	1st cycle	2nd cycle	total learning units	1st cycle	2nd cycle	total learning units	1st cycle	2nd cycle	total learning units
ECHS	4	2	16	5	1	16	7	7	33
ECVA	-	3	23	5	2	19	5	3	39
ECVA	2	2	6	4	4	17	6	5	23
ECT	5	1	11	2	5	7	7	5	13
SH	1	1	4	1	-	1	1	-	5
Free curses	3		3	3		3	7	7	7
Total	12	9	63	17	12	63	26	20	120

Table 1 - Number of courses and learning units registered in Moodle for the academic years of 2015/16, 2016/17 and 2017/18.

As it can be seen, although there is still a small number of courses per school, it has been noted (mostly from the direct contact with the teachers) that there is a growing interest to make their courses available in e-learning to support face-to-face teaching. It is hoped that in a very near future the vast majority of the courses will be available. There are about 4,000 participants registered in the platform, of which 55 are teachers.

However, in addition to the degree or diploma conferring courses, others may be available entirely in the e-learning mode. An example of these are the Massive Open Online Course (MOOC) courses currently being prepared.

UTAD has come to recognize that e-learning should be part of its strategy for its training offer and, consequently, is being adopting new policies, namely through the signing of protocols with other institutions with more experience using e-learning, and namely with the Universities of Porto and of Minho. These protocols are offered under the Unorte consortium (Unorte.pt, https://noticias.utad.pt/blog/2014/11/24/consorcio-unorte-pt/, in Portuguese).

3. The proposed model for e-learning at UTAD

To fulfil the aims presented above, the physical module will have the following control and management components: e-learning platform with SIDE interconnection; website with the educational/training offer and e-learning events; media repository; file storage and sharing service; collaborative/cooperative platform; scientific repository; forum; ticket service/helpdesk; customer relationship management (CRM) service; and Learning Analytic system. Additionally, there will be a physical examination (assessment) space (e.g., laboratory), a contents production studio, and a training studio. The policies module includes the institution policies, as well as policies for the creation/ dissemination of courses, implementation of course evaluation strategies and

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continuous improvement, training policies, recognition of the merit and effort of teachers, the training in using the system, the policies for the creation of physical spaces equipped with the necessary tools (computers, cameras, video-conferencing, etc.), among other. Figure 1 presents a general view of the proposed model.

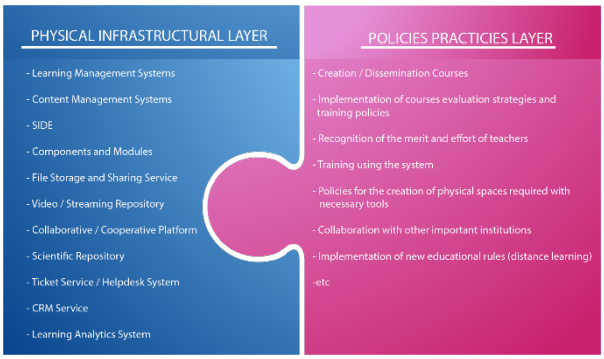

Figure 1 - The two modules of the proposed model for a successful implementation of e-learning at the UTAD.

As can be seen, it is impossible to propose a model where these two modules are not linked to each other. As stated in Reis, Santos & Ferreira (2008), "The installation of infrastructures is a relatively simple process, but using them effectively may require training and a change of habits, which are much slower and gradual processes". There is a need to motivate, train and raise the teachers' awareness of the potential of IT as a pedagogical tool. The success of any proposal for the implementation of any e-learning model can only be achieved if a complete set of policies is implemented. This proposal is based on the literature review and, particularly, in our experience (especially from the informal contacts with teachers). Next, the components of the physical module will be briefly explained.

The "Website with the educational/training offer and e-learning events" component is aimed at:

- Presenting the complete structure on UTAD e-learning;
- Providing the educational and training offer in e-learning modality;
- Searching by category and add to cart;
- Providing proficiency and profile tests;
- Presenting the application forms and access to courses.

The "Email service" is a fundamental element in the communications system of the institution. It promotes:

- Fast sharing of text and multimedia messages;
- Integration with email clients such as Thunderbird, Postbox, Outlook;
- Important for corporate issues and as a marketing tool (e-marketing);
- Customized and signed email of the institution for credibility, security and seriousness in the communication of services and information.

The "Cloud service" has the following main objectives and functions:

- Storing, reading and sharing files in different format types (files always available and accessible in any device, and can be public or private);
- Integration with other services in the cloud: Dropbox, OneDrive, GoogleDrive, Amazon Cloud, etc., multimedia player, text editor, chat, among others;
- Secure and encrypted navigation with LDAP integration;
- Backup system;
- FTP and clients for the different operating systems (Windows, OSX, Linux) and mobile systems (Android and iOS).

The "Collaborative platform service" component promotes collaboration, debate and interaction between users, allows the creation of work groups, has the ability to leverage work, information sharing and self-organizing capacity. It also serves as a facilitator of communication and creation of strategies and tasks, social network-like environment. Also included are the management of the permissions and profile assignments to users, and the creation of spaces dedicated to various themes.

Among the functions and aims of the "Online digital library service" the following ones are included:

- Information storage space in an organized way;
- Function of document conservator, cataloger and information distributor;
- Unique space that brings together all the information that is useful for student study;
- It has advanced search, and follows a catalog structure for the different subjects of study;
- Main fields of search include: title, author, year of publication, subject, ISSN, ISBN, keywords, language, deposit location and file format or content.

The "Forum service" will serve as meeting point in a distance learning model, and promotes asynchronous interaction and collaborative discussion among users. It will also be used to the sharing of information, suggestions and knowledge, and allows the sharing of links and multimedia contents.

The "Tickets/helpdesk service" provides direct support to all users of the institution. Its main features include: storing the records of requests for support, in email format and indexed to different categories; interact and register users via telephone; management of time and conclusion of tickets; possibility of integration of

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support via chat; frequently asked questions (FAQ); scheduling system; checking of registrations and new events entries; advanced search system; statistics; module for recording internal notes and a historical record of a particular ticket. It is also a single point-of-contact (SPOC), and a means of interaction between the user and the e-learning technical team for the operationalization of services.

The "CRM/ERP platform service" enables the management and organization of resources and users. It has the ability to integrate key information and institution processes into one location. Its mission is to unify processes and share information flow in a fast and continuous way among the various departments of the institution (ex: academic, administrative, financial), keeping in mind that much information depends on another. The presentation of results and other information in the form of tables and graphs is also an aim, and also preventing communications failures between departments. It also has the possibility of personalized monitoring (e.g., possible student's drop-out, users' history query). Some functionalities also included are: system of events, identification of the state of the processes, messaging service, system of campaigns and business opportunities, cataloging and marketing, document management, reports, etc.

The "Intercommunication with the SIDE platform" component aims at the unification of services and reducing efforts in the sharing of information between the various sectors of the institution. It will allow students to enroll the courses in a simplified way, and by using a simple click on a "synchronization" button, all courses that are assigned to a registered user (teacher) in SIDE are automatically created in the e-learning platform, as well as the registration of all students belonging to the appropriate courses.

As it is becoming standard, the "Learning analytic service" will have the following goals:

- Helping to improve learning outcomes;
- Allowing the realization of decision making;
- Based on students' interaction, it is possible to collect, measure, analyze, guide and disseminate data about student behavior during their educational journey;
- Enabling the knowing of levels of interest in courses and their contents;
- Can help create personalized content for different levels of difficulty found in students;
- Alignment of educational strategies and direct and accurate teacher interventions;
- Data presented as reports (presenting the trajectory of the student in each course);
- It contributes to define actions and improvement of educational structures and contents.

Finally, the "E-learning platform" aims to shorten geographic and temporal distances of users, and allowing to enjoy an improved and personalized teaching. It also allows students to learn at their own pace and manage their study time. It can be used as complement of resources and support for classes in the classroom mode, enabling fast transmission and easy access to content, clean and intuitive design with easy access to the different functionalities. It is open-source, customizable and tailored to the needs. It has a comprehensive set of pedagogical tools for interaction and resources for the development of diversified activities and for the integration with other systems of the institution. It also has modules for the creation of different types of exams, questionnaires and other specific contents, and an anti-plagiarism module. Furthermore, it enables the integration with external services such as O365, Educast, Zoom, among other.

4. Results and discussion

The data presented and discussed in this section were gathered from the "log" files of the system, from informal conversations with the students and the teachers and from a survey applied to the teachers.

A survey with 19 questions, using a 5 intervals Likert scale (from 1—low to 5—high), was applied to the teachers that actually are using the system in a regular basis, and 30 answers have been validated. The questions and the global results are presented in table 4 and figure 2. The questions were grouped in 4 classes: platform, teaching, tests/exams, and global appreciation.

As can be seen, in the platform group, the majority of the teachers (89.4%) have a good impression of the platform, consider it easy to use, are planning to continue to use it in a near future, and would recommend it to other colleagues.

Also, in the teaching group, the majority of the teachers (89.8%) consider that the platform corresponds and adapts to the teaching that is practiced in the institution, it responds to their teaching needs, and that the resources and tools provided in the platform are appropriate to their teaching practices.

As for the tests/ exams group, once again, the majority of the teachers (85.8%) consider that the students have a good reaction when carrying out their tests in the platform, that the creation of a test / exam in the platform is simple and intuitive, that the type of possibilities to create questions suits the subject their teaching, that correcting and verifying students' results automatically adds value to the platform, that answering online in the platform can help them achieve better student results, and that the student's primary enemy in conducting the tests/ exams is their time control. They also consider that

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the BYOD policy is effective and a strategic way to perform tests or other type of work on the platform, and that when the students do their tests/ exams using mobile devices they perform better than when using personal computers. As can be seen from the plot in figure 2, 47% of the teachers consider that the assessment results achieved by the students are the same, regardless of the type of the test/ exam used (in the platform or traditional, i.e., pencil and paper), 20% consider that the results are better when using the platform, and 3% consider that results are worst.

In the last group of question, 100% of teachers classify as useful the platform for teaching in the e-learning mode, and the support provided by the e-learning team.

Globally, 90.8% of the teachers consider positive the use of this platform.

The development of the system proposed here for e-learning is being seen as a useful and valuable tool for the different teaching modalities practiced at the UTAD. Since the e-learning modality educational process is still very recent in the institution, teachers try to use the system as a repository of educational content to support the traditional face-to-face modality. Teachers also consider that the system allows to distribute in a simple, fast and effective way the most varied educational contents.

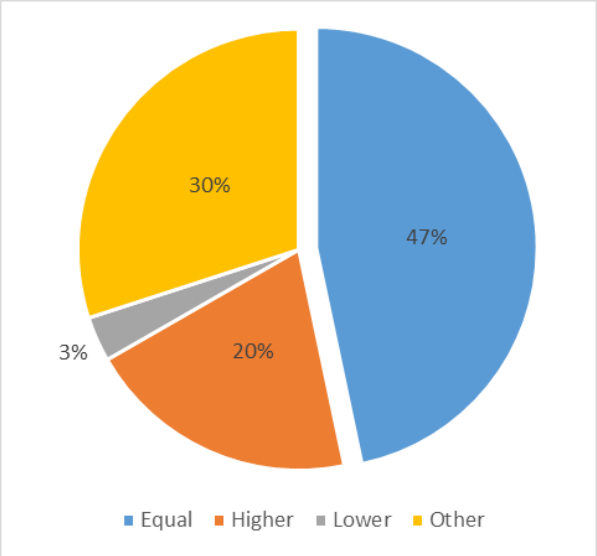

Figure 2 - Answers to the question "When compared to the traditional tests (written tests) the pass rate is:" of the survey applied to the teachers using the system in a regular basis; there were 30 valid answers.

The e-learning system is being mainly used by the teachers and students of the following courses: Veterinary Medicine, Biomedical Engineering, Informatics Engineering, Information and Communication Technologies, Nursing, Sports Sciences, and Tourism.

The activities with greatest use (retrieved form the system's log files) are homework and tests/exams, being also considered by the teachers the most important of the system, because they intervene directly in the evaluation/assessment process. In the synchronous mode, the two most commonly used activities are chat and videoconferencing. As for resources, the most commonly used features in the system are "folder" and "file".

		Scale				
		1	2	3	4	5
Platform	In your user perspective, do you consider the platform easy to use?	0 (0%)	1 (3.3%)	6 (20%)	18 (60%)	5 (16.7%)
	Do you plan to continue using the platform in the near future?	1 (3.3%)	1 (3.3%)	6 (20%)	9 (30%)	13 (43.3%)
	What is your overall impression of the platform?	0 (0%)	0 (0%)	9 (30%)	17 (56.7%)	4 (13.3%)
	How often do you use the platform?	4 (13.3%)	6 (20%)	11 (36.7%)	5 (16.7%)	4 (13.3%)
	Would you recommend the platform to other faculty colleagues?	1 (3.3%)	2 (6.7%)	4 (13.3%)	15 (50%)	8 (26.7%)
	Average	1,2 (4%)	2,0 (6.7%)	7,2 (24%)	12,8 (42.7%)	6,8 (22.7%)
Teaching	Do you consider that the platform corresponds and adapts to the teaching that is practiced in the institution?	1 (3.3%)	3 (10%)	8 (26.7%)	15 (50%)	3 (10%)
	Overall, does the platform respond to your needs in order to teach your courses?	1 (3.3%)	3 (10%)	6 (20%)	15 (50%)	5 (16.7%)
	Overall, do you consider that the resources and tools provided in the platform are appropriate to your teaching practices?	0 (0%)	1 (3.3%)	8 (26.7%)	16 (53.3%)	5 (16.7%)
	Average	0,7 (2.2%)	2,3 (7.8%)	7,3 (24.4%)	15,3 (51.1%)	4,3 (14.3%)
Tests/exams	How do you see the reaction of the students when carrying out the tests in the platform?	6 (20%)	3 (10%)	7 (23.3%)	9 (30%)	5 (16.7%)
	Create a test/exam in the platform is simple and intuitive.	1 (3.3%)	4 (13.3%)	8 (26.7%)	13 (43.3%)	4 (13.3%)
	The type of possibility to create questions suits the subject matter.	3 (10%)	1 (3.3%)	9 (30%)	8 (26.7%)	9 (30%)
	Correcting and verifying students' results automatically adds value to the platform.	1 (3.3%)	1 (3.3%)	4 (13.3%)	11 (36.7%)	13 (43.3%)
	Answering online in the platform can help you achieve better student results.	2 (6.7%)	0 (0%)	14 (46.7%)	12 (40%)	2 (6.7%)
	The student's primary enemy in conducting the test is time control.	3 (10%)	2 (6.7%)	10 (33.3%)	10 (33.3%)	5 (16.7%)
	Do you consider that BYOD (the students working on their own computers) is the most effective and strategic way to perform tests or other type of work on the platform?	3 (10%)	3 (10%)	11 (36.7%)	12 (40%)	1 (3.3%)
	When the students do their tests/exams using mobile devices (like smartphones) they perform better (when compared to the use of personal computers).	0 (0%)	1 (3.3%)	8 (26.7%)	16 (53.3%)	5 (16.7%)
	Average	2,4 (7.9%)	1,9 (6.3%)	8,9 (29.6%)	11,4 (37.9%)	5,5 (18.3%)
Global appreciation	In a global way, classify the usefulness of the platform for teaching in the e-learning mode.	0 (0%)	1 (3.3%)	2 (6.7%)	20 (66.7%)	7 (23.3%)
	Globally, classify the support provided by the e-learning team.	0 (0%)	0 (0%)	2 (6.7%)	8 (26.7%)	20 (66.7%)
	Average	0,0 (0%)	0,5 (1.7%)	2,0 (6.7%)	14,0 (46.7%)	13,5 (45%)
	Total average	1,1 (3.5%)	1,7 (5.6%)	6,4 (21.1%)	13,4 (44.6%)	7,5 (25.1%)

Table 4 - Questions and results of the survey applied to the teachers using the system in a regular basis, there were 30 valid answers. A Likert scale of 5 intervals was used, where the value 1 corresponds to a low agreement, and 5 to a high agreement.

In the English course, chat is a very useful activity for practicing written conversation between the students and the teacher. As for videoconferencing, it is also a widely used practice that favors dialogue among students, with moderation by the teacher. Videoconferencing has also been used by students who, due to illness, cannot attend classes directly in the physical space of the institution, and in classes shared with European institutions.

In the course of Veterinary Medicine there is a need to use images for the study of blades (photomicrographs), which can occupy 1 GByte of space. This problem has been solved with the integration of the cloud service.

Regarding the tests/exams, they were performed in two different modalities: controlled environment mode (face-to-face, institution room), and distance mode. Here, due to the lack of available data, it will be

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presented and discussed only the results obtained in the first mode.

Both teachers and students were pleasantly surprised by the simplicity of making tests available, performing and correcting, and they highlight the speed and the possibility of checking the classification just after the tests/ exams were completed. The students also highlighted the commitment that the institution is making to introduce new evaluation/ assessment methodologies.

Another equally striking aspect, expressed by teachers, was the flexibility and diversity in the design of the tests/ exams. Table 5 lists the courses that used exams to assess student performance. It is observed, in total, 49 exams were implemented and 1698 students were evaluated (79% of students were approved). The most prevalent questions in the exams are Multiple Choice, True & False, Correspondence, (greater use in the Computational Logic unit of Computer Engineering and Information and Communication Technologies), Development (greater use in the unit of Bioinformatics and Molecular Analysis in Veterinary Medicine and Biomedical Engineering), Missing Word Selection, Short Answer, and Drag n'Drop. Veterinary Medicine is the area with the highest number of exams and students.

It should be noted that 17 courses used the platform to present homework, and in total about 150 homework was requested. The same courses also used the platform to carry out examinations to the students and their respective evaluation.

The biggest problem pointed out by the students, which was even pointed out as the great disadvantage of the platform for conducting the online tests/ exams, is time. Students are familiarized to the face-to-face mode, where time is controlled by the teacher, but on the platform time is automatically controlled (to the second) and when it reaches the limit the test/ exam is closed, allowing no further answers. On the other hand, the use of technology, ease of testing, null costs (savings in the purchase of answer sheets), greater concentration on test and convenience were positive points attributed by the students.

From the point of view of teachers, they also consider very useful the use the platform to perform their tests/ exams, where the possibility of automatic correction is indicated as a great saving of time, implying a lower workload and the possibility of dedicating themselves to other tasks. Flexibility, ease of creation, configuration and evaluation are keywords identified as advantages by teachers.

The BYOD was used to perform the examination in the controlled environment (face-to-face) mode. One point that is emphasized in using this practice is that the student works on a system with which he/she is familiar. All devices are checked and controlled and with network restrictions so that only the exam can be accessed.

Regarding the type of preferred device, 99% of the students used their laptop computers and 1% opted for their smartphones. The teachers were asked to compare the results of the assessment process using the platform presented here with the traditional assessment methods. They concluded that the overall evaluation results obtained by the students are very similar, regardless of whether they use the platform presented here or the traditional face-to-face mode.

Course	Tests	Students	Approved	Average grade	Minimun garde	Maximum grade	Type of questions
Geotourism	1	12	12	19	18	20	Multiple choice Drag n' Drop
Horticultural Fruit Processing	2	19 18	19 18	19 18 18	15 18 18	20 20 20	Short answer True and false
Animal Reproduction	2	80 82	72 34	13 10	6 7	15	Development Short answer Correspondence Drag n 'Drop
Medical Semiology II	7	91 92 92 92 91 93 90	91 33 91 91 50 90 66	15 8 16 19 10 12 10	10 0 8 8 3 8 2	20 19 19 19 18 15 15	True & false Multiple choice Short answer Correspondence Missing Word Selection
Reproductive Medicine I	2	81 81	66 76	13 11	9 8	17 15	Multiple choice True & false
New Reproductive Technologies	1	17	16	13	9	13	Multiple choice True & false Correspondence Drag n' Drop
External Geodynamics	4	12 12 4 12	4 9 3 10	8 11 10 13	0 5 4 6	13 18 16 14	True & false Correspondence Drag n' Drop
Training Methodology and Control	1	103	103	14	11	16	Multiple choice
Computer Networks II	2	11 16	2 9	7 10	2 5	14 15	Multiple choice True & false Development
Computational Logic (Inf.)	6	9 36 48 25 26 48	5 30 45 20 18 32	10 11 11 10 11 10	6 7 7 4 5 2	15 16 17 20 20 20	Multiple choice Correspondence True & false Development Missing word selection
Computational Logic (ICT)	6	26 8 16 18 15 15	18 2 9 3 7 8	10 8 9 5 10 10	5 6 4 2 1 2	14 12 17 11 20 20	Multiple choice Correspondence True & false Development Missing word selection
Instrumentation and Sensors	7	13 13 12 12 12 14 15	13 7 12 12 12 14 15	19 10 18 12 19 18 19	16 1 17 10 18 11 15	20 19 20 20 20 20 20	Multiple choice Correspondence True & false Development Missing word selection Short answere Drag n' Drop
Bioinformatics and Molecular Analysis (Bio.)	3	17 5 5	17 1 0	15 7 1	10 4 0	19 10 3	Development
Psychology of Children and Adolescents	1	15	15	18	15	20	True & false
Bioinformatics and Molecular Analysis (Gen.)	4	14 15 19 26	13 15 19 15	13 17 15 12	0 10 12 6	18 20 20 19	Development
Total	49	1698	1342				

Table 5 - Listing of courses that have used tests/exams and the type of questions used.

In our opinion, the efforts made at the UTAD in the implementation of the e-learning system presented here and the support provided to the teachers have proven effective and very positive in this short period of time. It should be remembered here that the first courses were created on the platform presented here in 2015 only, being this platform only used as a mere repository, and that only in 2017 the platform was used to assess the students' knowledge (the first tests/ exams were created).

However, in spite of the progress made over the past three years, in particular the evolution in the number of courses presented in Table 1 and the results presented throughout this section, none of the available courses

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effectively use the full potential and advantages of e-learning.

As can be seen, the results presented here and their main conclusions agree with the ones presented in the international revised literature, presented in section 2.

5. Conclusions

It was presented a brief review of the "state of the art" of e-learning at the UTAD. In other published articles, a study was carried out comparing the most used and most recently available LMS. Based on these, it was proposed a model for the implementation of e-learning at the UTAD. This model has two modules: the physical/ infrastructural module and the policies/ practices module.

As referred in section 2.2, it was noted, mostly from the informal direct contact with the teachers, that there is a growing interest to make their courses available in e-learning to support face-to-face teaching. It is hoped that in a very near future the vast majority of the courses will be available. In addition to the courses already offered, a set of MOOC courses are currently being prepared.

It is believed that this model will undoubtedly contribute to the successful implementation of e-learning at UTAD.

On the other hand, the evaluation results obtained by the students are very similar to the traditional evaluation, raised some questions: does the student prepare him/herself adequately for the evaluation or does it looks like a game in which the evaluation process is more facilitative using the technology?

In our opinion, the results presented here show that the e-learning system and the support provided to the teachers has proved to be effective in this short period of time. Moreover, future work should also try to demonstrate that the proposed system is also applicable to other small size universities with some context tweaks.

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Online Learning Environments enriched with audiovisual technologies and its impact on the construction of virtual communities in Higher Education in prison context

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Abstract

Access to education and training has been a growing concern to different international organizations, and the concern for socially vulnerable groups at risk of exclusion, such as the prison population, in particular, has been increasingly evident. In this context, and assuming that education and training in prisons must have a similar degree of demand as regular educational institutions, Online Education, mediated by digital platforms, is an opportunity for inmates to acquire knowledge and skills. In fact, the integration of digital platforms in the context of imprisonment can be a very appropriate tool to revitalize the educational experience. It is precisely the creation of learning environments enriched with audiovisual technologies that we intend to analyse, describing their impact on the creation and development of a virtual learning community, based on the qualitative analysis of the perceptions and narratives of seventeen students attending Higher Education in prisons and having as reference the pedagogical models developed by Garrison et al. (2000) and Moreira (2017). The results show that the design of the online environment anchored in these models and in the use of audiovisual technologies can have very positive effects in the creation and development of virtual learning communities in higher education in prison context.

KEYWORDS: Education in Prisons, Audiovisual Technologies, Online Learning, Virtual Learning Communities.

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1. Introduction

The world is constantly changing as a result of globalization, which has led to the emergence of a "new society" based on information and knowledge, but also to the creation of new inequalities, adding to the vulnerability in which many people find themselves, as in the case of those in detention. It is, therefore, more and more urgent to rethink educational paradigms, educational communication processes, learning scenarios, and pedagogical models.

In fact, the right to education is related to the one of universalization (Bolívar, 2012). As such, ensuring the development of learning skills is directly related to the equity paradigm.

That is why learning programmes that shape the needs of its participants, in line with the ideas of equitable justice (Bolívar, 2012; Murillo and Hernández, 2011), truly contribute to bring different social groups together, to ensure that everyone is given access to Education,

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and, above all, to "give people the means to develop their skills and competencies that enable them to read the world and, on the basis of this critical analysis, to know how to face it and to develop themselves in a dignified way" (Hurtado, 2005, p. 7).

Access to education by detainees should, therefore, involve not only the development of skills in areas that may be useful for their reintegration in the community, but also in digital proficiency, which has been described by the European Commission (2003, 2005) as one of the most important competencies for real social integration, thus adapting their learning to labour market needs (Dias-Trindade, & Moreira, 2019).

By participating in Online and Digital Education, there is a possibility of solving the issues of distance and restrictions, promoting "not only learning by discovery, eventually even collaborative, but also the synchronization between individual development and context, promoting greater motivation, more dialogue, interaction and communication" (Dias-Trindade, & Carvalho, 2019, p. 52).

It is then crucial to find strategies that help citizens in detention to develop new learning skills by facilitating their reintegration into the community after release (Recommendation N. R(89)12, Committee of Ministers of the Council of Europe). That is why "it is required to rethink education's aims and methodologies, based on a concept of literacy that is in continuous evolution, related to the competencies required to read, understand and communicate" (Dias-Trindade, & Moreira, 2019, p. 99).

In this context, Online and Digital Education or modalities such as bLearning can achieve these goals, as they enable online and offline access to resources and learning activities. Indeed, Online Education has been recognised at the beginning of this century as very appropriate to respond to the challenges that the globalized world poses to the acquisition of knowledge and the development of digital and social skills (Garrison & Anderson, 2003; Moore *et al.*, 2011). Considering the increasing importance that technologies have assumed in society, individuals in compliance with a sentence or judicial measures should have the opportunity to use digital platforms for educational purposes.

Considering the restrictions that these individuals have in terms of access to the attendance of educational activities in Higher Education institutions, some Online and Digital Education projects have been developed in prisons, such as *Telfi* (2004), ELIS (2004), *PiPELinE* (2005), *LiCoS* (2008), *Virtual Campus* (2009), *Internet for Inmates* (2010), or *EPRIS* (2015) and *Digital Campus Educonline@pris* (2018) in Portugal. All these projects have in common the desire to contribute not only to the development of new mechanisms that foster the acquisition of knowledge and skills, but also to promote social and digital inclusion.

With the intention of promoting the development of competencies, such as communication, collaboration, or problem solving, we developed a university extension program in a Portuguese prison based on the use of the digital platform Moodle as an educational tool. The choice of an active learning methodology supported by the use of audiovisual technologies clearly takes on the responsibility of developing education for and with Image, in order to allow students to be able to analyse different sources of information and to communicate through multimodal mechanisms.

Considering the potential of Online Education, enriched with audiovisual technologies, we developed this study with the objective of evaluating the impact of pedagogical practices based on the virtual models developed by Garrison *et al.* (2000) and Moreira (2017) in dimensions such as the ability to discuss and solve problems, or in the capacity to communicate or exchange opinions, from the qualitative analysis of their perceptions and narratives.

These practices seek to meet the needs of a specific group of students, in line with Hobhouse (1992) who argued that institutions are not good because they serve the majority, but because "they make the nearest possible approach to a good shared by every single person whom they affect" (p. 121). Considering the principle of social justice (Connell, 2012; Bolivar, 2012) as a process and as a democratic model that includes participation in different social and cultural institutions (Young, 1990) is the premise on which we seek to develop this programme.

2. Pedagogical models to create and develop virtual learning communities

In recent years, we have witnessed the emergence of several pedagogical models in virtual environments related to the development of learning communities that have allowed a reflection about the "new" roles that both teachers and students are called to play in different educational scenarios.

Among the existing models on creation and promotion of virtual learning communities, we highlight, for their actuality, adaptability and relevance, the model of Community of Inquiry (Garrison *et al.*, 2000), the model of e-moderation (Salmon, 2000), Faerber's model of interaction in virtual environments (2002), Henri and Basque's model of collaboration in virtual environments (2003) and the pedagogical model centred on the "Deconstruction" of Moving Images (Moreira, 2017). From the referenced models, we will focus on the first one, because it is the one that has obtained a great empirical support, being studied all over the world, and because we based our study on its framework, as well as the last one as it is a model specifically built to develop learning activities centred on the pedagogical exploration of audiovisual resources.

The Community of Inquiry model elaborated by Garrison, Anderson and Archer for Online Education (2000), and later developed by Garrison and Anderson

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(2003), is based on three basic dimensions: cognitive, social, and teaching presence. The cognitive presence corresponds to what students can construct and confirm meaning from a sustained reflection and critical discourse. Social presence corresponds to the ability of members of a community to project socially and emotionally through the medium of communication in use. Finally, the teaching presence is defined as being the direction, the design, the facilitation of the cognitive presence and the social presence in the sense of realizing significant learning outcomes. The existence of these elements and their interrelationships are crucial to the success of educational experiences. For Garrison and Anderson (2003), this model is based on a constructivist perspective of learning where construction of individual knowledge is largely due to the social environment.

In turn, the pedagogical model for designing e-learning activities centred on the "deconstruction" of moving images is one whose lines of strength and theoretical principles are based on learning: *constructivist*, *collaborative* and *grounded in communities of practice*; based on *interaction*, assuming it as a principle underlying the pedagogical process, determining not only motivation, encouragement and mutual trust, but also regulatory evaluation of the teaching-learning process and feedback; promoter of the concept of *multiliteracies* understood as the need to help students develop new skills of discursive analysis, to the point of enabling them to transmit and represent their world through models or new multimodal formats; and *humanist*, where the student takes an active role, engaging and committing himself to his learning process and where the teacher assumes the role of a moderator that accompanies, motivates, and dialogues, fostering and mediating a positive human interaction (Moreira, 2017).

The pedagogical discourse and its theoretical elaboration were decidedly interested in the subject, given that they realized how the central concept of learning was enriched and became more ubiquitous, in a process of transformation that is also changing the very concept of education, ever more digital and networked.

3. Methodology

In line with the objective defined in the introductory section, this study seeks to answer the following question: can the pedagogical models under analysis promote the creation and development of virtual learning communities and transversal competencies even in a context of great social vulnerability, such as the case of a prison environment?

The nature of the study and the research project model (Fig. 1) led us to consider an approach such as Action Research (AR) as its empirical basis is associated with an action or with the solving of a collective problem in which researchers and participants engage in a cooperative and participative way (Thiollent, 2005).

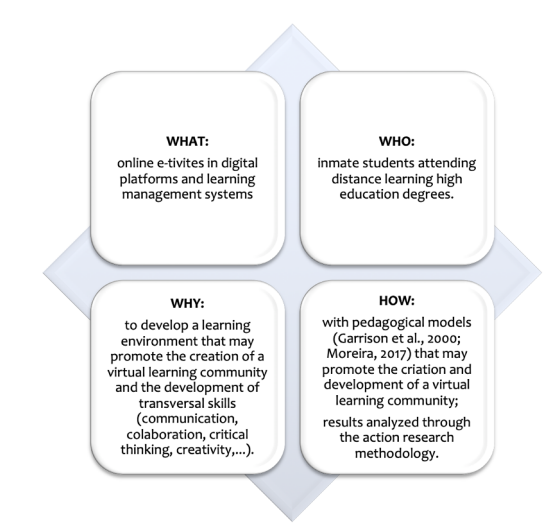

Figure 1 - Research project model (Source: Prepared by the authors)

Distinct from other research methods of social and educational areas that look only to describe the context studied, this method seeks to promote organizational change by involving all stakeholders in learning and reflection cycles about the problem at study (Cassel & Johnson, 2006).

The choice of this methodology is justified, especially, because, as Altrichter, Posch and Somekh (1996) state, it "lies in the will to improve the quality of teaching and learning as well as the conditions under which teachers and students work in schools. Action research is intended to support teachers, and groups of teachers, in coping with the challenges and problems of practice and carrying through innovations in a reflective way" (p. 4).

As Eden and Huxham (1996) refer, from the analysis of all the information gathered and the results obtained, it will then be possible to present information in an active and participative way, where "all people speak for themselves. The stories are first-person 'I' stories" (McNiff & Whitehead, 2009, p. 53).

The sample consisted of a group of seventeen inmate students from a Porto Prison (EPP) and represents all the students that were then attending undergraduate degrees in the form of DL and e-learning, at *Universidade Aberta* (Portugal). This particular prison was chosen because it has the largest prison population frequenting distance higher education courses in Portugal. This prison is classified as a High Security prison and its accommodation space is spread over four pavilions, with both individual cells and cell blocks. It has a Drug Free Unit, a Security Section and a Health Unit that allows for a range of specialist and inpatient consultations. It also has a sports field and a gym and is equipped with work rooms and a school, where inmates can frequent elementary, secondary and higher education. Table 1 presents the students' characteristics, according to variables that can give us a clear picture of the

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	Ages	Detention time	Detention regimen	Course	Crime Type
Students/ inmates (ES1... ES17)	From 31 to 60 years old	From 5 months to 6 years	Close (14) Open (3)	Management (4) Social Science (11) Environmental sciences (1) European Studies (Master) (1)	Drug dealers (8) White collar crimes (2) Murderers (2) Burglars (5)

Table 1 – Participants (Source: Prepared by the authors).

respondents' profile. These students are pre-trial or convicted prisoners awaiting transfer to other prison facilities.

The study aims to analyse the impact of pedagogical practices based on the virtual models developed by Garrison *et al.* (2000) and Moreira (2017) in dimensions such as the ability to discuss and solve problems, or in the capacity to communicate or exchange opinions, from the qualitative analysis of the students' perceptions and narratives. Because of the nature of this subject, it was important to conduct a qualitative study in which direct speech is used in an interpretative approach in order to contextualize and explain the views of respondents inside a prison in Portugal.

To obtain data for the study, semi-structured interviews were conducted. To analyse the data obtained, a research technique was used to decode the semi-free and apparently mixed statements: content analysis (Bardin, 1977; Vala, 1986).

The analysis of the data collected from interviews was based on two alternating phases: a vertical analysis of each interview was made; a horizontal or comparative analysis was made using the "constant comparative analysis" method (Miles & Huberman, 1994) to identify common and different aspects of the representations and perceptions of respondents. These data are also shown in figures, along the text, to explain the relevance of some of their opinions. This information organizational model was chosen because it will allow us to study the respondents' views in a systematic and analytical way and will give us a more adequate view of their overall ideas.

Considering the scope and purpose of the study, as well as the documentary analysis of some relevant norms in the context under study, our source of inspiration to build our instrument was the *Community of Inquiry Survey Instrument* (CoI) developed by Garrison and collaborators (2000), later adapted to the Portuguese population by Moreira and Almeida (2011). Thus, the three dimensions that constitute the CoI were those that we defined for our instrument (Table 2). The first -*Cognitive Presence*- representing the ability of group members to construct meanings through dialogical communication, sustains reflection and critical discourse; the second -*Social Presence*- representing the participants' ability to project themselves socially and emotionally through the visualised films; and the third -*Teaching Presence*- representing the teacher's ability to define direction, design, and facilitation of cognitive and social presence towards the achievement of learning outcomes.

Elements	Categories	Indicators
Cognitive Presence	Triggering Event	Perception of Doubt
	Exploration	Information Exchange
	Integration	Linking of Ideas
	Resolution	Applying New Ideas
Social Presence	Emotional Expression	Emotion
	Open Communication	Free Expression
	Group Cohesion	Incentive to Collaboration
Teaching/Teacher Presence	Design & Organisation	Definition/ Topics to Start Discussion
	Facilitation	Sharing of Personal Meanings
	Direct Instruction	Focus on Discussion

Table 2 – Codification of the COMMUNITY OF INQUIRY model (Source: Prepared by the authors)

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Based on these categories, we defined a series of open questions that constituted the corpus of the interviews.

4. Presentation and discussion of results

As previously stated, this study aims at knowing the representations of inmate students in relation to the impact of the pedagogical models presented here, for the creation and development of a virtual learning community, especially with respect to the communicational dynamics created among that community.

Thus, in the first category -*Cognitive Presence*- related to students' ability to discuss, solve problems and integrate new knowledge, there were sixteen positive records and only one negative one, which suggests that the majority of students consider that the practice developed allowed the exchange of information, connection and application of new ideas.

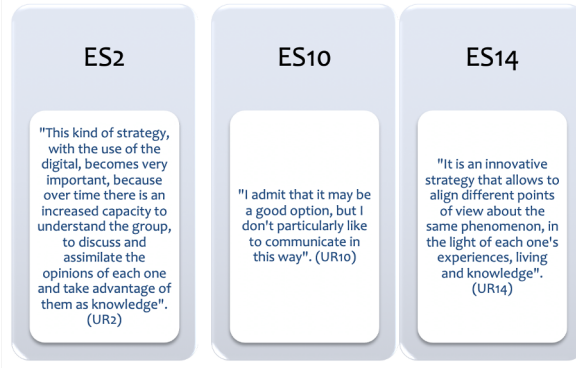

Figure 2 - Cognitive Presence (Source: Prepared by the authors)

This dimension is associated with the capacity to construct meanings from reflections and communication (Garrison & Arbaugh, 2007), competencies mirrored in the words of student -ES14- when he states that it was possible "to align different points of view about the same phenomenon", despite the different experiences of each participant, denouncing the sharing among all in the construction of their knowledge. Garrison, Anderson and Archer (2000) indicated that the cognitive presence was operationalized in four stages, starting with the initial event (visualization of the audiovisual resource), then exploration (the "deconstruction" of moving pictures) that leads to the development of critical thinking, reflection and discourse, followed by the integration of these ideas in the formation of new knowledge until the last stage, of application of this knowledge or, as stated by student -ES2-, from the discussion and assimilation of ideas "there is an increased capacity to […] take advantage of them as knowledge", that is, to apply them in new contexts, for instance, educational, or, in the case of these students, in future professional contexts.

It should be noted that this student's idea is aligned with a sociological film perspective, which assumes that "certain cultural experiences, associated with a certain way of seeing films, end up interacting in the production of knowledge, identities, beliefs, and worldviews of a large contingent of social actors" (Duarte, 2002, p. 19).

Student -ES12- in turn considers that:

> *"[…] being a method with different resources from those we are accustomed to was more captivating and led me to think and to rethink the truths that I had about certain subjects" (UR12).*

This approach and pedagogical action of the teacher proves to be extremely important, because it allows the student to, as highlighted, have an active participation in the learning process, building his own knowledge.

However, not all statements go towards building the learning community. As we can see in the second record unit, student -ES10- states that despite considering the strategy interesting, he did not particularly like it, maybe because he prefers more classical approaches, without the use of the digital, and closer to an explanatory pedagogy, which suggests that we should consider not just a closed view of a technology, pedagogy or pedagogical model, but consider different pedagogical possibilities, in a plural dimension.

With regard to the second category, *Social Presence*, also with seventeen records, the classification of the record units shows a very high number of perceptions with a very positive tendency (sixteen), which clearly indicates that the students consider that the models and the methodology made it possible to strengthen the bonds of affection among the classmates, forming a solid learning community, where the members of this virtual community expressed themselves freely and where they were encouraged to collaborate and share information

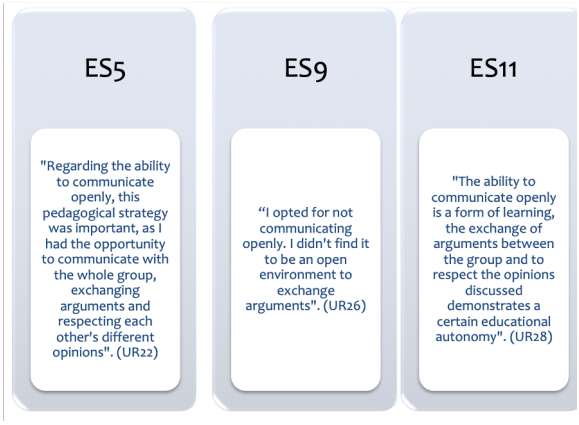

Figure 3 - Social Presence (Source: Prepared by the authors)

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and knowledge with autonomy, creativity and in a very active way.

As can be seen in the third record unit, the student -Es11- underlines the importance of collaborative work and of a virtual learning community for the success of the training when he refers to the "ability to communicate openly", the "exchange of arguments between the group" and the fact that they "respect the opinions discussed" as positive aspects of the adopted pedagogical strategy. Picciano (2002) states precisely that social presence becomes less important if there are no collaborative activities where students can benefit from the different perspectives that will surely exist.

Also, student -ES5-, in the first record unit, underlines the facility to communicate "openly" in this space without prison bars, respecting different opinions, despite cultural differences and diversity of thought among the elements of this community with even elements from different nationalities who, despite some linguistic barriers, didn't restrain themselves from participating:

> *ES12- "Of course, as a foreigner, my ability to communicate is smaller, but I didn't stop participating, on the contrary... it was a very interesting experience." (UR29)*

Most testimonies collected underline these advantages, suggesting the development of competencies related, for example, with communication, collaboration, and discussion of different ideas and points of view, which implied the "social presence" advocated by the pedagogical models and the deconstruction of pre-conceived ideas:

> *ES7- "I always expressed my opinion openly, exchanged arguments with the group members, seeking to always respect them all". (UR24)*

Also noteworthy is that, as can be seen in the third record unit, there is a student -ES9- who apparently was not comfortable with the social implication strategy, stating that the environment was not the right one for discussion, and, therefore, he decided not to intervene in the discussions. To be noted, however, that this is an isolated opinion that seems to be connected with the student not wanting to expose himself to the group.

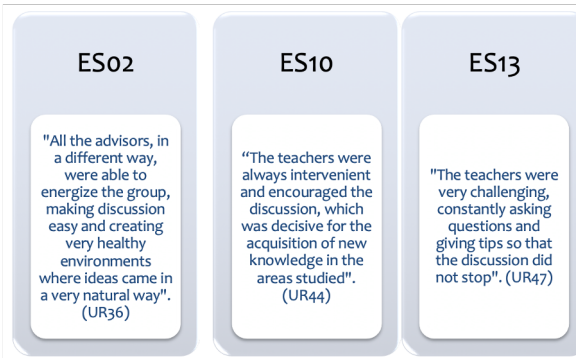

Figure 4 - Teaching Presence (Source: Prepared by the authors)

The last dimension -*Teaching Presence*- is, as seen by Garrison, Anderson and Archer (2000), fundamental for a relevant educational experience to occur and is, therefore, necessary to design the process, monitor and mediate learning. In this category, it should be noted that all students positively felt the teacher's action in the construction of knowledge.

As we can see in the three record units, the students report that the teachers' presence was very important because they guided the discussions, raising questions that invited reflection and collaborative work. In addition, they also emphasized that the teachers created an environment conducive to the exchange of opinions. For student -ES2-, the teachers had an important presence that made

> *"discussion easy and creat[ed] very healthy environments".*

This statement demonstrates the importance of the teaching presence in the "facilitation" of learning, in directing both cognitive and social processes and, therefore, in the development of meaningful learning. It should be noted that this student is referring to the teachers as "advisors" and facilitators of the process of acquiring knowledge. This role of teacher-advisor, teacher-facilitator, teacher-mediator is related to a new learning culture intrinsic to the proposed models, which presupposes that teachers rather than just transmitting or dictating information, should promote in their students competencies in searching, selecting and interpreting available information, assuming themselves as mediators, moderators, and facilitators (Salmon, 2000).

Another interesting testimony is the one from student -ES6- when he states that

> *"the teachers assumed the role of moderators and were always guiding the discussions in an oriented way. Even though it seemed they gave no opinions, they were influencing and guiding the discussions in the digital space". (UR40)*

These perceptions and the others not transcribed here, as they are very similar, reveal that one of the major potentials for implementing this methodology, using digital technologies, has to do with the interactivity and interaction that can be established among the different participants. In this interaction process, one can see that the teacher is responsible for identifying relevant knowledge and proposing experiences that lead to critical thinking and reflection.

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5. Conclusions

The result of our study, and answering our initial question, reveals that the implemented pedagogical practices based on the virtual models developed by Garrison et al. (2000) and Moreira (2017) can have very positive effects on the creation of virtual learning communities, with impact on the development of competencies such as collaboration, communication, creativity or critical thinking.

Through the analysis of students' perceptions in both Cognitive and Social Presence dimensions, we were able to conclude that the pedagogical strategy, using digital tools and audiovisual resources, allowed to create a favourable environment, promoter of a process of critical thinking, where information and knowledge were shared, with autonomy and creativity. With regard to the dimension Teaching Presence, we can conclude that the students consider that this was a very important element in the process, as the teacher sought to implement and develop the virtual community and guide the learning of its members.

Based on these perceptions, we can then affirm that these pedagogical practices, based on visualisation of films and anchored by constructivist pedagogical models, allow the formation and development of consistent virtual learning communities, even considering that the members of these communities are confined to a physical space, but can be "set free" with the digital and navigate to other spaces and times with the help of cinema.

However, in spite of these evidences, a careful reading of the results also indicates that there is a minority of students who did not feel very comfortable communicating in such a virtual learning space, indicating the need to create alternative and personalised educommunication spaces that respond to the needs of all the students. With this in mind, we have started a new research cycle based on the concept of personal learning environments supported by bLearning systems that allow, for example, the creation of hybrid learning communities, combining face-to-face and virtual environments, modalities, tools and digital technologies.

Regardless of these limitations, we think that this study is a positive example of adapting education to the needs of those who are on the verge of exclusion and social futility in situations of extreme social or risk vulnerability, seeking, on the one hand, to find ways to approach these citizens, in a context of reclusion, of greater equity and social justice and, on the other hand, to reduce possible forms of discrimination by accessing, or not, education (Young, 1990; Honneth, 2010).

In summary, we are convinced that if education is to fulfil its purpose of building a more just and democratic society, it will have to foster awareness of the conditions of oppression and ways of eradicating injustices in these contexts of imprisonment and of mobilizing social justice critique, to denounce and announce new educational policies of inclusion.

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Generation of e-Learning tests with different degree of complexity by combinatorial optimization

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Abstract

The major challenge in the digital era is the management of big data. A substantial share of digitization is taken from the e-learning. In this respect, the current article deals with generation of questions for testing the acquired levels of students' knowledge. For this purpose, an algorithm for generation of questions for tests with different level of complexity is proposed. The main stage of this algorithm is using of mathematical combinatorial optimization model. Using this model makes it possible to formulate different tasks, whose solutions determine a subset of questions that correspond to different degree of test complexity. Essential part of this model is the use of binary integer variables to determine whether a question will be a part of the test or not. The advantage of the proposed approach is the flexibility to decrease or increase the number of questions used to compose the test preserving the required score in accordance to the particular level of test complexity. The conducted investigations over a year show, that the effect of testing can improve retention of knowledge and lead to improved end results. The applicability of the proposed algorithm along with the formulated mathematical model is demonstrated in a case study on the excerpt of questions from the web programming course. The proposed algorithm could be used for generation of tests with different degree of complexity for other learning contents.

KEYWORDS: Combinatorial optimization, e-learning, Mathematical model, Questions difficulties, Test generation

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1. Introduction

The contemporary technologies of ICT along with the capabilities operations research make possible to develop new tools to support different aspects of business intelligent decisions in digital era. The new business challenges require involving the modern technology as business intelligence tools in order to improve the product quality and user satisfaction. In this respect, the latest trends in e-learning are focused not only on the e-learning content but involve the proper system to evaluate the acquired knowledge (Mustakerov & Borissova, 2017; Borissova & Keremedchiev, 2019).

In the field of digital technologies, quality gains a key role for success of the Universities that seek to be up-to-date in the modern learning technologies (Salas-Rueda, 2018). It is shown that the usage of contemporary ICT and e-learning contribute to enhancing the innovation and quality of higher education (Terzieva et al., 2020; Pavel et al., 2015). Due to the importance of evaluation of the level of acquired knowledge by the students from different learning forms variety of approaches have been proposed. Some authors investigate the effects of the

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use of different question types on the engagement and performance of programming learning for non-computer science majors (Arunoprayoch et al., 2018). The evaluation should be seen not only as describing achievements but as a powerful driver of change in the education system leading to quality improvement and higher standards of education (Borissova &. Mustakerov, 2009; Wolf et al., 1991). A test or exam can be applied on paper or on a computer and is designed to measure the knowledge of the tested student. The design of the test is complex, continuous and in some of its phases an iterative process of research that includes the stages of planning, development, confirmation and analysis of the data.

Big data contributes to the change of the e-learning process by involving new systems able for providing better user experience (Manca et al., 2016). To ensure that any single module is understood the proper monitoring system based on some kind of tests is needed to show how effectively the e-learning is. In the context of testing, a conceptual approach for development of educational web-based e-testing system is proposed (Mustakerov & Borissova, 2011). This approach allows the generation of sequential questions or shuffle, or random by predefined testing pages with questions. Another "self-testing" tool is discussed in (Mustakerov et al., 2004). This tool aims to help the trainee or student in evaluation of acquired knowledge level before official examination.

In addition, it should be noted that the peer and self-assessment in the Moodle e-learning environment could be realized by using some kind of gamification activities (Tuparov et al., 2018). In this context, the usage of friendly environment for the learning content and proper description and visualization contribute for better understanding and improving the skills in computer programming (Mustakerov & Borissova, 2017; Borissova, & Mustakerov, 2015). It should be noted that competency of problem-solving is highly correlated to the adequacy of e-learning (Kerzic et al., 2018).

The essential advantages of the web-based e-learning and online examination systems are capable to deliver the needed content to the learner irrespective of the used device with just a web browser available. This is the reason to develop online examination system suitable for distance learning compatible with mobile device (Bursalioglu et al., 2016). To improve the effectiveness of the learning process a multi-agent system with five-layer architecture is proposed (Arif et al., 2015). The e-learning supported by agents enables the users to collect different material and allows personalization and adaptation of educational content. The correct implementation of the assessment and evaluation exams is critical issue in Learning Management Systems. Therefore, a modern agent-supported academic online examination system is proposed (Tasci et al., 2014). The architecture of the proposed system provides integration between creating and updating of questions' pool, exams created by intelligent agents in decision-making processes, managing student feedback, etc. Together with classical tools for supporting e-learning, some authors propose to create e-mentor for online learning to support the students in learning by using of email, online chat, etc. (Omar et al., 2012). The existence of dashboard in e-learning platforms allows monitoring the progress of students in real time and gets some useful information about future course designs (Dipace et al., 2019).

The inquiry-based learning model is used to explore a learning program and to test how participants' cognitive-affective factors influence on their interest in using such model (Hong et al., 2019). Authors propose "prediction-observation-quiz-explanation" model for the purpose of green energy generation learning program. A systematic literature review concerning self-regulated learning strategies using e-learning tools for computer science is described in (Garcia et al., 2018).

Modern learning management systems (LMS) give the opportunity to create and manage learning content including different forms of exams and tests (Aldiab et al., 2019). Tests can be designed and developed with automatic grading options. Although setting up the question bank is a time consuming activity, test elements can be reused and students' exams are automatically graded. Furthermore, the immediate scoring of online exams permits students to receive rapid feedback regarding their achievements.

In contrast to the other approaches for test generation, the proposed in the current article mathematical optimization model guarantees that the selected questions for a particular test are best suited.

The rest of the article is organized as follows: Section 2 provides problem description along with the proposed algorithm for generation of questions for tests with different level of complexity. Section 3 describes the input data and formulated mathematical model for generation of e-learning tests with different degree of complexity. Section 4 describes a case study utilized to demonstrate the applicability of the proposed approach. Section 5 contains the obtained results and conclusions are given in Section 6.

2. Problem descriptions

Considering the fact that ICT is so widespread, e-learning is probably the area best suited to deploy the new technologies. The use of different mathematical methods makes possible to propose different tests using quizzes or open questions to check the level of

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knowledge. For the purposes of self-testing, the student could select different test complexity. This allows testing different degrees of acquired knowledge. For example, if the student passes the test with lower level of complexity he/she can do the next test where questions are more difficult. Different test levels are needed to ensure that the student will not give up if he/she first chooses the test with high complexity. In this case he/she can select the test from the previous level and check if his/her knowledge is enough to pass or he/she should select an easier test.

The process of user interaction with the system for generation of questions for tests with different level of complexity is illustrated in Fig. 1.

The algorithm starts with selection of the level of test complexity (test with highest complexity, test with middle level of complexity and test with lower level of complexity). There is no restriction on the sequence of tests and the user can choose one of them. Next the user can choose between two different cases. The first one considers generation of test questions without using the option for "restriction about the question number", while the second one involves this restriction about the number of questions. Depending on the selected level of test complexity and the option concerning the limit of the number of questions, the proper mathematical model is needed to determine the suitable questions and their number to comply with the given restrictions.

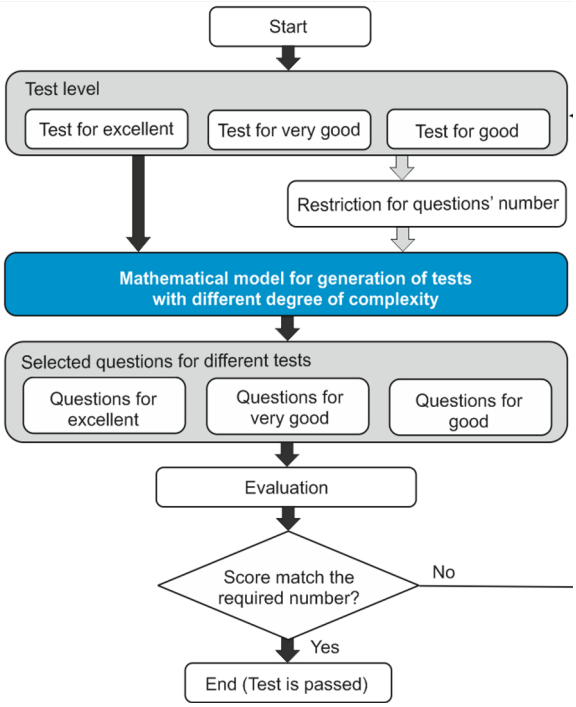

Figure 1 – Algorithm for generation of questions for tests with different level of complexity.

This model should provide the possibilities to formulate different optimization tasks whose solutions will determine the needed test questions corresponding to the selected test level. Once the needed questions for the test are known, the next evaluation step could be implemented. For the purpose of evaluation the questions' answers should be checked and the obtained scores should be checked whether they correspond to the needed scores for test level or not. In case of match with the needed score the algorithm ends. If there is no match, the user can do another test with less complexity, or do another test with the same level of difficulty where the mathematical model will guarantee that he/she will get different questions for this level of complexity.

The problem in the current article deals with the formulation of a suitable mathematical model for generation of tests with different degree of complexity that is described in the next section.

3. Mathematical model for generation of e-learning tests with different degree of complexity

Involving the big data into e-learning provides vast possibilities in making learning more effective. With customization of e-learning by the use of analytics and large data, it is possible to ensure the interactive individual learning and skills testing in accordance to the goals and expectations of each user. For this purpose, it is necessary to develop appropriate tools with the capability to process big data. The focus of this article is to provide a flexible approach for generation of tests with different degree of complexity for the purpose of e-testing. Determination of the tests with different degree of complexity requires predefined set of questions from which the selection could be done. Furthermore, each question should be evaluated toward difficulty by using of some scale in advance. To guarantee only one selection of the question within a particular test, it is needed to assign binary integer variables for all predefined sets of questions from which the selection is realized. All of these input data together with three different level of test complexity are shown in Table 1.

The set of questions is denoted by Q and is composed of M number of different questions, i.e. $Q \in \{q_1, q_2, ..., q_M\}$. For each question the degree of difficulty is determined within the range $1 \leq d_i \leq N$, where 1 means the less difficult while the value of highest difficulty is denoted by N. There is no relation between the number of questions and degrees of difficulty, but it should be noted that the sum of scores for questions' difficulties should be bigger than the required value corresponding to the excellent evaluation. Decision variables x_i are assigned to each question to realize the needed level of test complexity. Three types of complexity levels are

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Questions	Difficulty	Decision variables	Test complexity levels		
q_1	d_1	x_1	L-1	L-2	L-3
q_2	d_2	x_2			
... q_i ...	... d_i ...	... x_i ...			
q_m	d_m	x_m			

Table 1 – Questions, difficulty and tests levels.

determined – excellent, very good and good. For these types of complexities some lower and upper boundaries are to be determined. Taking into account all of these considerations, the following optimization model for generation of e-learning tests with different complexity is proposed as follows:

$$maximize\left(L = \sum_{i=1}^{M} x_i d_i \right) \quad (1)$$

subject to

$$\sum_{i=1}^{M} d_i = D \quad (2)$$

$$L_{max} < D \quad (3)$$

$$L_{min} \leq L \quad (4)$$

$$L \leq L_{max} \quad (5)$$

The objective (1) seeks to maximize the overall scores according to the selected test and its level of complexity – test for excellent, test for very good and test for good evaluation. The questions' difficulty (D) is expressed by summing the difficulties of all questions as shown by the relation (2). The upper boundary (L_{max}) about the test for excellent evaluation is determined by the lecturer and learning content. It should be noted that the sum of questions' difficulties (D) is not the upper boundary (L_{max}) for the highest complexity of tests (test for excellent evaluation) as it is expressed by inequality (3). The restrictions (4) and (5) are used to determine some acceptable range to get the excellent evaluation. It is not needed the student always to get the full number of scores. In most cases some acceptable limit could be used to distinguish different levels of complexity and corresponding ranges for particular level. These considerations about different levels for test complexity are expressed by the restrictions (4) and (5) where the boundary values could be expressed in percentages and then converted into scores. For example, in case when assessing the acquired knowledge for excellent, the acceptable percentage range could be determined within the interval of (100-94) %. That means that all students with score in the range of 94 % to 100 % should have excellent. For the next level that match the very good performance of the knowledge another percentage limit of 9 % could be used, namely (93-85) %. Similarly, the level determining the assessment as good is expressed by the limit of other 10 % or by using the range of (84-75) %. In such way, it is possible to determine the acceptable ranges for different test complexity. The usage of binary integer variables guarantees the single selection of questions from the given list when generating the particular test.

If it is necessary to decrease the questions number the following restriction can be added to the described above model:

$$\sum_{i=1}^{M} x_i \leq K_{\max}, x_i \in \{0, 1\} \quad (6)$$

The restriction (6) allows setting up the upper boundary for the number of questions within the tests.

The direction of objective function (1) can be inverted and instead seeking maximal value of L could be seeking the minimal values as:

$$minimize\left(L = \sum_{i=1}^{M} x_i d_i \right) \quad (1a)$$

In this case, the next restriction (7) could be used to provide selection of more questions for a particular test complying with the upper (L_{max}) and lower (L_{min}) boundary at different test complexity:

$$\sum_{i=1}^{M} x_i \geq K_{\min}, x_i \in \{0, 1\} \quad (7)$$

Both boundaries for the lower (K_{min}) and upper (K_{max}) limit toward the questions' number could be used too. The restrictions (6) and (7) provide flexibility by providing the possibilities to select small number of questions, but with high difficulty and vice versa – to select more questions.

4. Numerical application

In this section, a case study is utilized to demonstrate the applicability of the proposed mathematical model for generation of e-learning tests with different degree of complexity. The numerical application of the proposed model (1) – (7) has been used over a year to generate e-learning tests with different degree of complexity using more than 200 questions for web programming course. To demonstrate the applicability in this section, a limited number of 30 questions and difficulty degree range for these questions between 1 and 10 are used. The corresponding score boundaries for different test difficulty are as follows:

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- Test for excellent: L^E_{max} = 150 and L^E_{min} = 135
- Test for very good: L^{VG}_{max} = 134 and L^{VG}_{min} = 120
- Test for good: L^G_{max} = 119 and L^G_{min} = 100

The numerical testing of the proposed approach is based on usage of the described mathematical combinatorial optimization model (1) – (7) and the mention above boundaries. Two different scenarios are investigated: 1) generation of questions for tests without using restriction about the number of questions that compose the test, i.e. mathematical model (1) – (5), and 2) generation of questions by using restrictions about the questions' number, i.e. mathematical model (1) – (7). Each of these cases is tested at three different levels for the degree of complexity of the tests. The obtained results from optimization tasks solved under the both scenarios are shown in Table 2.

Set of questions	Difficulty	Scenario-1			Scenario-2		
		Values of x_i Excellent	Values of x_i Very Good	Values of x_i Good	Values of x_i Excellent $K_{max} \leq 17$	Values of x_i Very Good $K_{max} \leq 14$	Values of x_i Good $K_{max} \leq 12$
1	5	0	0	0	0	0	0
2	7	0	0	0	1	1	0
3	10	1	1	1	1	1	1
4	9	0	1	0	1	1	1
5	7	0	0	0	1	1	0
6	6	0	0	0	0	0	0
7	3	0	0	0	0	0	0
8	5	0	0	0	0	0	0
9	8	1	0	0	1	1	1
10	9	1	1	0	1	1	1
11	6	1	1	0	0	0	0
12	7	1	1	0	1	0	0
13	8	1	0	1	1	1	1
14	4	1	1	1	0	0	0
15	10	1	1	1	1	1	1
16	5	1	1	1	0	0	0
17	7	1	1	1	1	0	1
18	10	1	1	1	1	1	1
19	9	1	1	0	1	1	1
20	8	1	0	1	1	1	1
21	6	1	1	1	1	0	0
22	3	1	1	1	0	0	0
23	5	1	1	1	0	0	0
24	4	1	1	1	0	0	0
25	7	1	1	1	1	1	0
26	5	1	1	1	0	0	0
27	10	1	1	1	1	1	1
28	6	1	1	1	0	0	0
29	8	0	0	1	1	1	1
30	3	1	1	1	0	0	0

Table 2 - Questions, their difficulties, and values for binary decision variables.

The value 1 of binary decision variables indicates that the corresponding question is selected to be included in the test, while the value 0 means that the question should be omitted. Once the values of decision variables become known that means the number of questions is also known and the score for test complexity could be calculated. Therefore, the use of binary integer variables in the formulated optimization combinatorial model (1) – (7) plays an important role in forming the set of questions for the generation of tests.5. Results analysis and discussion

The proposed mathematical combinatorial optimization model makes possible to determine the number of questions taking into account the difficulty of all questions under given restrictions for the test scores and questions' number. The comparison of the obtained result for three different levels of test complexity is shown in Fig. 2.

In the case of scenario 1 and generation of test for excellent, the obtained objective function value is equal to 150 (*L-1* = 150) and the selected number of questions are 22 (*K* = 22). For the second test level corresponding to the very good evaluation the results from the

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optimization task solving is as follows: objective function values 134 (*L-2* = 134) and the selected number of questions are 20 (*K* = 20). The results for the third test level representing the good evaluation are: objective function values 119 (*L-3* = 119) and the selected number of questions is 18 (*K* = 18).

The scenario 2 expresses the situation where additional restriction for the number of questions could be added. As it could be seen from Table 3, in the formulated optimization task only one upper restriction for the questions' number is used.

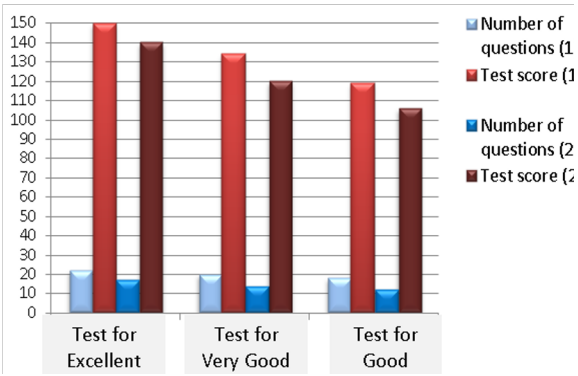

Figure 2 – Number of questions and score for different level of test complexity.

The obtained values for the tests score and selected number of questions are as follows: for test with excellent level *L-1* = 140 and *K* = 17; for test with very good level *L-2* = 120 and *K* = 14; for test with good level *L-3* = 106 and *K* = 12.

All of these show the applicability of the proposed modelling approach to generation of tests with different levels of complexity while considering some limits about the number of questions to compose the test preserving the required score. For example, to achieve the excellent evaluation the number of questions can vary between 22 and 17. In case of very good evaluation the number of the questions is between 20 and 14, and in the case with the lowest test complexity the number is between 18 and 12. The range of variation of the relevant questions for the particular test depends on the total amount of the used questions. Also, there is a high dependence relation between the number of questions in a given test and the degree of difficulty of the questions from which the tests are generated.

Reducing the number of questions for a particular test means that the solution selects less questions but with higher difficulty and vice versa. The imposing of restriction for the minimum question number allows more questions to be selected but with less complexity to satisfy the needed score for the test. This fact could be used for future investigations where the time parameter together with the test score will determine more objective estimation.

All of the obtained results prove that the proposed algorithm for generation of questions for tests with different level of complexity along with formulated mathematical model could be used for the purposes of e-learning. There is no limit for the questions from which the selection could be done to form the test complexity.

During the development stage of the web-based system for generation of tests with different degree of complexity one group of students is involved. For the goal of validation of the proposed algorithm and mathematical model randomly selected group was chosen and all of these students periodically are passed tests corresponding to the learned material. At the end of the educational year, another random group of students was selected to compare the results obtained with the group of students who were periodically tested by tests.

The conducted testing over the last year show, that the effect of testing can improve the retention of knowledge and to encourage the users to pass periodically different online tests. The obtained results are summarized in Table 3.

	Male	Female	Results	
			Excellent evaluations	Number of fails
Using tests periodically	23	21	32 (72.72 %)	0 (0 %)
Without using tests periodically	20	21	28 (68.29 %)	2 (4.87 %)

Table 3 – Testing results

The results show, that the students using tests periodically have a little better evaluations compared with the students that are not tested periodically. For example, the excellent results from students using tests periodically exceed the excellent results from the rest with about 4.42 % (72.72 % vs. 68.29 %) and the fail results are 0 to 2 in favor of the periodically tested students (0 % vs. 4.87 %). This could be explained by the retention of knowledge due the passing of tests periodically. All of these mean that the testing effect can improve the learners' habits, thus make more efficient learners.

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6. Conclusions

The article describes an algorithm for generation of tests by selection of questions with different level of difficulty for different levels of tests. A distinctive feature of the proposed algorithm is the formulation of a mathematical model for questions selection under three different level of test complexity. The formulated model is of type mixed-integer linear optimization. The selection of questions for tests relies on predefined set of questions with different degree of difficulty. The determination whether a question will be part of the test or is not is realized by using binary integer variables.

The applicability of the proposed algorithm and mathematical model is experimentally demonstrated in a case study on the excerpt of questions for web programming course and two randomly selected groups of students. Two scenarios are investigated: 1) selection of questions for tests without restriction for the questions' number, and 2) selection of questions with restrictions about questions' number. Both of these scenarios are numerically tested under three different levels about the degree of complexity of the tests. It is shown that tests with the same level of complexity could be implemented by means of different number of questions. This is due to the fact that the given set of all questions are with different degree of difficulty.

The advantage of the proposed algorithm respectively the formulated mathematical model is the flexibility to generate the tests with different degree of complexity using binary integer variables. Taking into account the vast amount of the e-learning content variety the proposed approach could applied in different learning content where some types of tests are to be generated to test the acquired knowledge and to show how effectively the learning is. The conducted testing over a year show, that the effect of testing can improve retention of knowledge and lead to improved end results. Further investigations are planned for detailed analysis concerning the influence of periodically checking by tests and final evaluation.

The proposed algorithm could be realized as web-based application for generating of questions for tests with different level of complexity. Different databases could be established and used for test generation depending on the learning contents.

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The impact of using virtual reality on student's motivation for operating systems course learning

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Abstract

This paper develops a virtual reality education system for mobile devices through mobile virtual reality technology with virtual reality glasses. The purpose of this study was to investigate the impact of mobile Virtual interactive e-Learning environment on 3D operating system course learning motivation. The paper aims to increase students' interest and enhance their learning motivation for understanding CPU process scheduling algorithms in an operating systems course. A total of 110 students from the department of computer sciences at Sadat Academy were invited to participate. A 5-point scale was adopted based on the ARCS model to stimulate learning to collect student data. A one-way analysis of variance (ANOVA) was performed to assess if the apparent difference was significant. Perform a data factor analysis to determine the appropriate factor ($p = 0.000 < 0.05$). The results show that mobile virtual reality game-based learning is an effective pedagogical tool for operating systems education, and it can promote students' motivation and interest in learning 3D animation.

KEYWORDS: e-Learning, Game-based Learning, Mobile Learning, Learning Motivation, ARCS

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1. Introduction

Learning does not mean repetition and retention; it means acquiring the abilities, skills and way of thinking required in a variety of situations (Jong 2012). The rapid development of the Internet has been attached with rapid evolution in e-services. E-Learning, one type of e-services, is one of the most important developments in both schools and universities (Violante, 2015). The advent of virtual reality, along with the adoption of games or play features, makes the learning process more motivating and dynamic (Braga, 2019).

Virtual reality (VR) is becoming increasingly important as an educational tool in schools as well as in universities because of its interactive and animated features (Abdelaziz, 2014). VR can be an effective way to educate and support complex concepts by enabling learners to interact with visualization tools. The approach that combines VR technology with e-Learning is a different teaching method that enhances students' ability to analyze and think through problems.

Unity3D is the most common 3D video game development engine, a flexible graphics engine that is currently available in the market and offers a wide range of resources. It is easy to learn and use and provides a free version compatible with VRs for project design both in 2D and 3D. By being common to platforms, it can export any project to both mobile devices (Android and IOS) and desktop operating

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systems (Windows, Linux, and Mac OS). Therefore, this engine - Unity3D - was used in this research (Vergara, 2017).

Therefore, to motivate the student's interest in both learning and entertainment, virtual reality game-based learning has been considered on mobile devices.

The educational game should not be more fun than just teaching. The learner must learn in a more motivating way (Braga, 2019). Motivation is an important concept in human behaviour and plays a key role in student learning and the way educators can help students learn better (Li, 2018). This research focuses on the motivational side of the learning process. Most teachers easily agree that motivating students is an important variable to consider when developing, monitoring, and evaluating educational effectiveness in educational games. It is generally recognized that there is a positive relationship between motivation and learning. The more motivated a student is, the more likely he is to study at this course.

One of the theories supporting this research is the attention, attention, trust and satisfaction model (ARCS) created by Keller (Bixler, 2006). It provides teachers with systematic guidance that motivates students to learn. The ARCS model has three advantages: it emphasizes motivation and emotional motivation; it can be coordinated with other theories and instructional designs; and promotes learning and learning effects (Wu, 2018). Thus, the ARCS model can effectively integrate the learning strategies of traditional operating systems and use a systematic design to enhance learners' learning motivation and combine theory and practice.

The study has developed a Mobile Virtual Reality Game-based Learning system (MVRGBL) through mobile virtual reality technology with VR Box (Virtual Reality glasses). The purpose of this research is to increase learners' interest and motivation to learn CPU scheduling algorithms of the operating systems course and achieve higher levels of performance.

In this paper, the authors decided to select the course of CPU scheduling as teachers often use text descriptions only, students sometimes find it difficult to understand the task of maximizing the use of CPU and how the processes that are in memory and ready to execute are selected and allocates the CPU to one of them. To solve this problem, mobile game graphics can be used.

2. Literature review

Many studies integrate virtual reality systems into mobile devices because they provide students with highly dynamic learning content according to their way of life.

A Pallavicini (2018) study describes mobile virtual reality and highlights the features that describe it. It discusses the enhancement of mobile virtual reality supported by concrete examples and research analysis studies. Christof Sternig (2018) developed a prototype math game at a school for students aged twelve to thirteen, through a range of mobile devices and virtual reality. The result of the game's evaluation was very positive, and students were motivated and excited to use virtual reality game-based learning in schools as a learning tool (Sternig, 2018). A study by Sonia Cruz (2017) taught Portuguese history to students through mobile games. The game was developed to motivate students and engage them in learning history through dialogues along with characters, adventure and challenging tasks. The results showed that playing games gives students a desire to understand what happened in the past and at the same time to achieve better scores in the game.

The previous studies mentioned above illustrate the gap in the current research; it has been observed that the games for operating systems course can fill an educational gap.

Marwa Abdelaziz (2019) developed a virtual reality game-based learning for memory management of operating system course but did not discuss increasing the interest of learners and motivating them to learn scheduling operations on the CPU for the operating systems course.

The selected experiment course of "CPU scheduling" is the core concept of operating systems. As lecturers often use text description only, students sometimes feel difficulty in understanding the different scheduling algorithms. There is a need for more practical activities for this course to represent the reality of the profession, and thus, the possibility of improving operating systems education is created. A mobile 3D CPU scheduling learning system, through mobile virtual reality technology, with VR Box is a new trend that is in line with the current environment that desires to improve learning motivation and achievements. The aim of this study is to see if the game of this study has any motivational effect on the students. In this article, the basic algorithms of CPU scheduling, including "first come first served" scheduling as well as shortest job first scheduling and priority scheduling, are incorporated into the game design.

3. Motivations

Most educational approaches are boring, causing a low motivation to learn. VR integration and mobile devices provide great potential for using digital gaming-based learning concepts to create an immersive learning environment.

Surveys on the combination of VR game-based learning and mobile learning are few, so this study combines these elements to develop an Android

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smartphone application. This research can help to enhance students learning motivation.

4. Problem statement

Students who enrol in the course of operating systems have low motivation because this course is considered a boring course. For this reason, there is a strong motivation to incorporate game-based learning into the teaching of this course. A little research has been done to explore virtual reality game-based learning as a way to learn operating systems course. Moreover, most completed studies do not conclusively compare the effects of mobile education technology with traditional methods.

There are different modules of the Operating Systems course including: computer system architecture, operating system architecture, processing unit, synchronization, CPU scheduling, deadlock, memory management, and file system management.

CPU scheduling while learning operating system course is one of the most critical and complex tasks. Most of the teaching methods for this part are boring, causing low learning motivation. Because of all these factors, students can be frustrated in their learning and often have less motivation, which leads to abandonment of the course. This complex part of operating systems can be enhanced by integrating technology into the learning process. In particular, digital games can be helpful to make this dull part of learning more enjoyable since they are motivating learning tools for the students. Mobile technologies represent a good platform for gaming applications.

No studies have implemented the use of mobile virtual reality game-based learning system in the CPU scheduling of operating systems course. So, developing this learning model will provide an interactive learning environment.

5. Objectives

This research proposes to introduce the content of the educational modules in the way of games to attract students. A mobile virtual reality game-based learning application was developed to be used in teaching CPU scheduling algorithms by aiming for the following:

- to create a game integrated with the course content of the Operating Systems course and utilize it in teaching;
- to promote and raise students' interest and motivation to learn the various techniques associated with memory management;
- to make students achieve higher levels of motivation;
- to learn in an informal way, so that the students do not feel bored;
- to contribute to the use of educational technologies to review the knowledge that the students have just acquired.

5.1 Study contribution

With the introduction of virtual reality viewer (VR Box/glasses), a combination of mobile devices and VR was created. This integration has opened up a wide range of possible and inexpensive virtual reality applications that everyone can take advantage of. This research applied the virtual reality game on mobile devices to assess the need for such educational games, and to support and motivate students for the course of operating systems. The results of this study were very positive and showed high motivational potential combining mobile devices and virtual reality game-based learning and its utilization in universities as educational tool.

5.2 Research questions

This study contains the following basic research questions:

- does the type of learning methodology used in course development affect student motivation?
- does the students' gender have a significant effect on how well the mobile virtual reality game-based learning will motivate him or her to learn about the operating system course?

5.3 Significance of the study

This study will be of interest to the instructor to provide another way to teach the operating system course using a variety of teaching methods, using virtual reality games to make students interact with the course and support the efficiency of the course.

6. Development of Virtual Interactive Game-based Learning System

For digital 3D content in VR Mobile, Autodesk 3D max was used to produce 3D object models. Photoshop was used for the interface. In addition, the produced models were introduced to Unity3D and connected with the hardware, VR box, through Google VR SDK (Linowes, 2016) as shown in Figure 1. The Google VR SDK for Unity allows developers to effortlessly adjust a current Unity 3D application for Virtual Reality or build the VR experience from scratch. Learners can therefore place the "VR Box" headset on a smartphone to use and operate the VR mobile learning system via Bluetooth controllers, such as the pause, play, loop and exit function.

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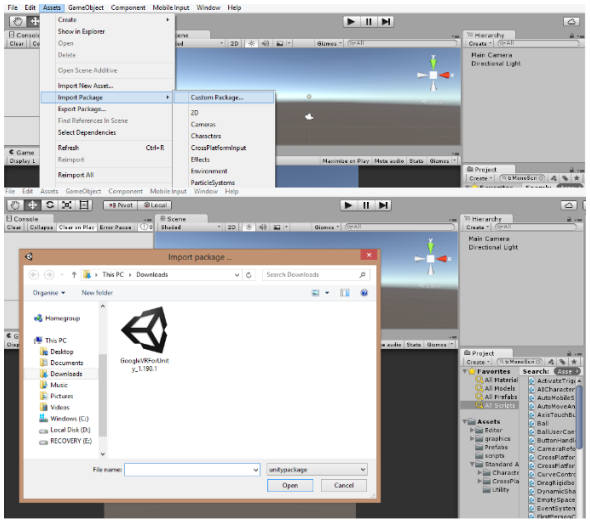

Figure 1- Google VR SDK import for Unity
Source: Abdelaziz et al.

As shown in Figure 2, the player will select any type of the CPU scheduling algorithms such as "first come first served" scheduling, shortest job first scheduling and priority scheduling. The player will draw the Gantt chart by assigning the processes in order according to the chosen type of scheduling algorithm and calculate the average waiting time. For example, if the chosen scheduling type was "first come first served", the player will allocate the CPU with the process which arrives first and calculate the average waiting time.

The scoring will depend on how many times he/she failed as shown in Figure 3 and 4 and it will be marked from a count of 100% with each mistake deducting 5% (assumption from the researcher).

In the shortest job first scheduling method, the player will allocate the waiting process with the smallest execution time to execute. In priority type, the player will assign the processes with their arrival time, burst time and priority. Then Sort the processes, according to arrival time if two process arrival time is same then sort according process priority if two process priority are same then sort according to process number.

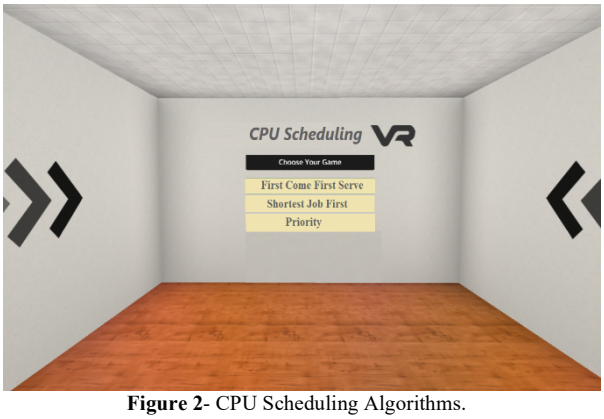

Figure 2- CPU Scheduling Algorithms.
Source: Abdelaziz et al.

Figure 3- The Scoring Result.
Source: Abdelaziz et al.

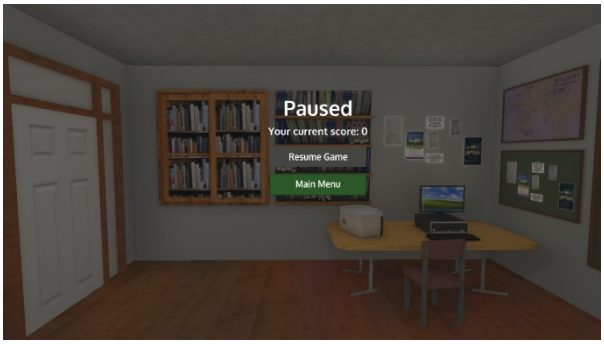

Figure 4- Resume Game.
Source: Abdelaziz et al.

7. Experimental Procedure

The execution of the experimental procedure continued for more than three weeks. The first phase (first week) included the different algorithms of CPU scheduling. In the second phase (second week) the students were asked to fill out the learning motivation questionnaire, which was used to collect pretest data. In the third phase (fourth and fifth week), the two learning conditions were implemented. The learning activity was performed in the CPU scheduling area. In the fourth phase (week 6), after the end of the experiment, the students completed a learning motivation questionnaire, which was used to collect posttest data. Finally, a one-way analysis of variance (ANOVA) was performed to show if the apparent difference is significant. Figure 5 shows the implementation stages of this study.

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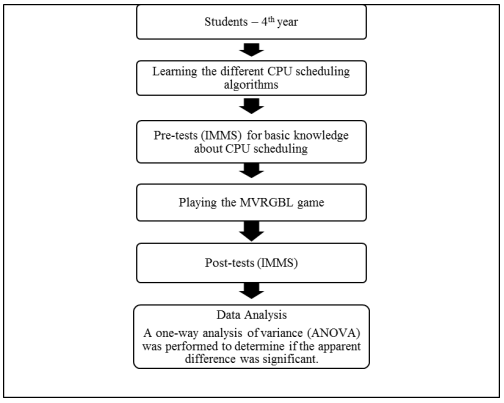

Figure 5- Stages of The Research Execution.
Source: Abdelaziz et al.

8. Experimental Participants

The language research's game is English. The students' level of English proficiency is fluent. It targets the fourth-year students of computer sciences department of Sadat Academy for Management Sciences. A group of these students was asked to fill out the learning motivation questionnaire, which was used to collect pre-test data. Then, the game operation was explained to the students, including instructions on how to play the game on PC or on mobile phone. Afterwards, the students began to play the game. After the experiment was over, the students filled out the learning motivation questionnaire, which was used to collect posttest data. These two questionnaires were a part of the Instructional Materials Motivation Survey (IMMS) (Appendix A). This survey measures the motivational effect of the mobile game-based on Keller's motivational model (Keller, 2010) that comprises of four factors, namely, Attention, Relevance, Confidence, and Satisfaction (ARCS). The questionnaires were used to gather data on learner motivation. Later, a one-way analysis of variance (ANOVA) was performed to determine if the apparent difference was significant.

9. Data Analysis

The course was taught through the main method of education. Once the course was taught, the phases of the research method started. The research method had three different phases: pre-test survey, playing the game, and posttest survey. The posttest survey had the same questions as the ones used in the pre-test except that they were prepared for the game. The same group of students with a pre-test as well as a posttest. The questionnaire format ranged from *Strongly Disagree* to *Strongly Agree* developed by Keller (2010). The results of the posttest survey were statistically analysed along with the results from the pretest to evaluate the motivation level of the game. The IMMS survey instrument is an essential part of ARCS model designed by Keller to measure students' motivation levels. The IMMS survey consists of 36 items and 4 factors. The 4 factors are attention (12 items), relevance (9 items), confidence (9 items), and satisfaction (6 items). It measures learners' motivation level by applying a 5-point symmetrical Likert scale (Huang, 2016).
Once the data was gathered, a statistical analysis was performed to determine the results of the research. The data that was analysed was the data collected from the revised IMMS sections of the pretest and posttest surveys. The independent variables were the type of educational material (traditional method of education and the mobile virtual reality game) and gender. The dependent variables were the motivational factors as described by the ARCS model (attention, relevance, confidence, and satisfaction) as well as total motivation. The answers to the Likert scale ranged from 1 to 5 in the ascending order: 1 denoted *Strongly Disagree*, 2 denoted *Disagree*, 3 denoted *Neither*, 4 denoted *Agree*, and 5 denoted *Strongly Agree*. The data were analysed independently as indicated by the ARCS factors utilizing one-way ANOVAs using the Statistical Analysis Software (SAS) package.

10. Results

10.1 Mobile Virtual Reality Game-based Learning system

The main research question was: Can the type of learning methodology used in course development affect student motivation? Each component of the ARCS model was analysed, and the results obtained before playing the game were compared with the results obtained thereafter.
It was found that the mean scores were higher after the game than they were before, as reported in Table 1 and Figure 6.
A one-way analysis of variance (ANOVA) was performed to show if the apparent difference is significant. Alpha is the value for determining significant or insignificant results. The value is usually 0.05. When p-value is less than 0.05, the result was significant. When p-value was more than 0.05, the result was not significant. The results showed that there is a statistically significant difference in the students' total motivation (p=0.03), as shown in Table 2 and Figure 7 before and after they played the game. Moreover, the confidence factor of ARCS (p=0.02) and satisfaction (p=0.01) showed a statistically significant difference, but attention (p=0.15) and relevance (p=0.53)

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Factor	Survey	N	Mean	Std Deviation	Smallest	Largest
Attention	Before game	110	3.7	0.27	3.2	4.1
	After game	110	3.9	0.34	3.3	4.5
Relevance	Before game	110	3.6	0.35	3.1	4.4
	After game	110	3.7	0.36	3.1	4.4
Confidence	Before game	110	3.7	0.35	3.2	4.4
	After game	110	4.1	0.37	3.4	4.8
Satisfaction	Before game	110	3.3	0.22	2.8	3.6
	After game	110	3.3	0.28	2.6	3.7
Total	Before game	110	3.6	0.19	3.3	3.7
	After game	110	3.8	0.34	3.6	4.1

Table 1 - ARCS Data for Instructional Materials.

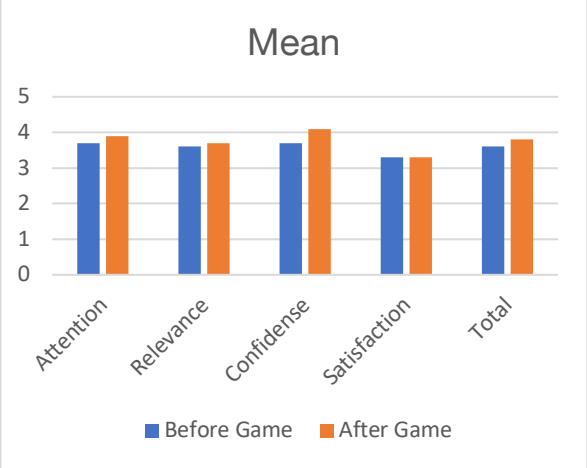

Figure 6- The Mean Scores for Pretest and Posttest.
Source: Abdelaziz et al.

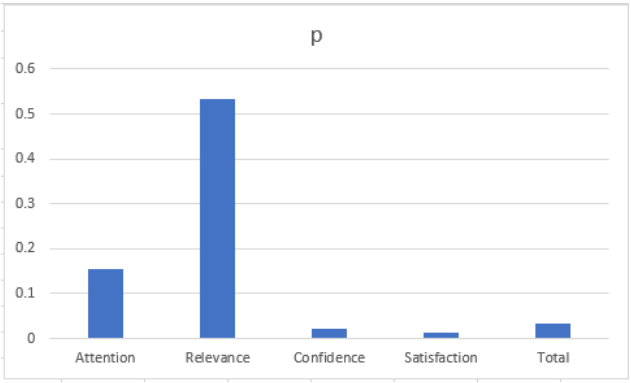

Figure 7- The P-value for Determining Significant or Insignificant Results (the Effect of the VR Game on ARCS).

Factor	*df*	*f*	*p*	*Cohen's d*
Attention	*1*	*2.190*	*0.154*	*0.631*
Relevance	*1*	*0.402*	*0.533*	*0.27*
Confidence	*1*	*6.257*	*0.021*	*1.067*
Satisfaction	*1*	*7.226*	*0.014*	*1.146*
Total	*1*	*5.207*	*0.034*	*0.973*

Table 2 - ANOVA and Effect size for Instructional Materials.

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factors did not as shown in Figure 7. This proved that Confidence (d = 1.06), Satisfaction (d=1.14) and Total Motivation (d = 0.97) have a large effect, while Attention (d =0.63) and Relevance (d = 0.27) have a medium effect on student motivation.

10.2 Gender and Motivation

The second research question was: Does students' gender have a significant effect on how well the mobile virtual reality game-based learning will motivate them to learn about the operating systems course, such as the part of CPU scheduling algorithms? To answer this question the ARCS scores that were recorded after the game were compared between males and females.

The results of these ARCS scores can be seen in Table 3 and Figure 8, from which it is apparent that the mean scores were higher for males than for females.

A one-way analysis of variance (ANOVA) was performed to show if the apparent difference was significant. The results showed that the students' gender does not have a statistically significant effect on the total motivation (p = 0.24), as shown in Table 4 and Figure 9. However, it has a statistically significant effect on Confidence (p = 0.02). The effect size test shows that this effect for Confidence is large (d = 1.58).

Factor	Gender	N	Mean	Standard Deviation	Smallest	Largest
Attention	Female	40	3.7	0.29	3.3	4.0
	Male	70	3.9	0.36	3.5	4.5
Relevance	Female	40	3.5	0.35	3.1	3.9
	Male	70	3.7	0.38	3.4	4.4
Confidence	Female	400	3.8	0.37	3.4	4.2
	Male	70	4.3	0.25	4	4.8
Satisfaction	Female	40	3.1	0.10	3.1	3.3
	Male	70	3.3	0.37	2.6	3.7
Total	Female	40	3.5	0.31	3.1	3.8
	Male	70	3.8	0.42	3.3	4.3

Table 3- ARCS Data for Gender Groups.

Factor	*df*	*F*	*p*	*Cohen's d*
Attention	*1*	*3.883*	*0.080*	*0.612*
Relevance	*1*	*0.743*	*0.411*	*0.547*
Confidence	*1*	*7.289*	*0.024*	*1.584*
Satisfaction	*1*	*1.076*	*0.327*	*0.738*
Total	*1*	*1.531*	*0.247*	*0.813*

Table 4 - ANOVA and Effect Size for Gender Groups.

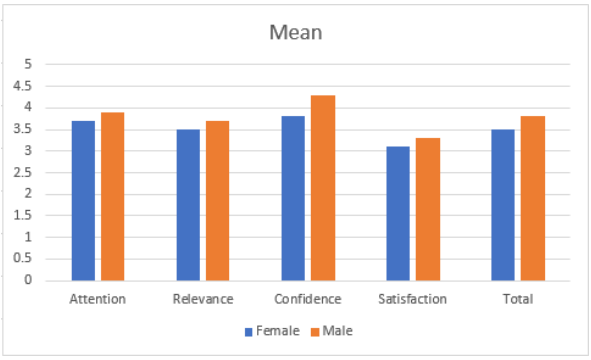

Figure 8- The Mean Scores for Male and Female Students
Source: Abdelaziz et al.

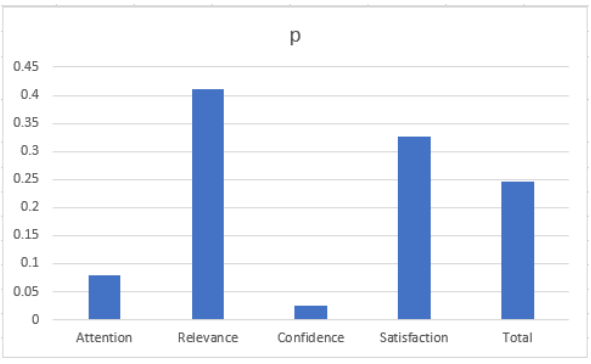

Figure 9- The P-value for Determining Significant or Insignificant Results (the Effect of Gender on ARCS).
Source: Abdelaziz et al.

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11. Conclusion

This research paper has developed a mobile VR-enhanced operating systems education using a gaming approach to improve the learning process.
The game was developed using Unity3D's virtual reality environment, which was chosen for ease of use. The purpose of this study was to discover whether the created game had any motivational effect on students. The paper was quantitative following a classic quasi-experiment design, where one group of participants conducted a pretest and a posttest survey. The students' motivation was measured with the Instructional Materials Motivation Survey (IMMS) and the data analysis of the results showed that there is a statistically significant difference in the students' total motivation as well as the two factors of confidence and satisfaction. However, there was no statistically significant difference for the attention and relevance factors. Also, the results showed that the students' gender does not have a statistically significant effect on the total motivation. However, it has a statistically significant effect on confidence.

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Appendix A

Instructional Materials Motivation Survey (IMMS) (Keller, 2010)

There are thirty-six statements in this questionnaire. Please think about each statement in relation to the instructional materials you have just studied and indicate how true it is. Give the answer that truly applies to you, and not what you would like to be true.

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Think about each statement by itself and indicate how true it is. Don't be influenced by your answers to other statements.
Record your responses on the answer sheet that is provided and follow any additional instructions that may be provided in regard to the answer sheet that is being used with this survey. Thank you.
Use the following values to indicate your response to each item:

1 (or A) = Not true
2 (or B) = Slightly True
3 (or C) = Moderately True
4 (or D) = Mostly True
5 (or E) = Very true

1. When I first looked at this lesson, I had the impression that it would be easy for me.
2. There was something interesting at the beginning of this lesson that got my attention.
3. This material was more difficult to understand than I would like for it to be.
4. After reading the introductory information, I felt confident that I knew what I was supposed to learn from this lesson.
5. Completing the exercises in this lesson gave me a satisfying feeling of accomplishment.
6. It is clear to me how the content of this material is related to things I already know.
7. Many of the pages had so much information that it was hard to pick out and remember the important points.
8. These materials are eye-catching.
9. There were stories, pictures, or examples that showed me how this material could be important to some people.
10. Completing this lesson successfully was important to me.
11. The quality of the writing helped to hold my attention.
12. This lesson is so abstract that it was hard to keep my attention on it.
13. As I worked on this lesson, I was confident that I could learn the content.
14. I enjoyed this lesson so much that I would like to know more about this topic.
15. The pages of this lesson look dry and unappealing.
16. The content of this material is relevant to my interests.
17. The way the information is arranged on the pages helped keeps my attention.
18. There are explanations or examples of how people use the knowledge in this lesson.
19. The exercises in this lesson were too difficult.
20. This lesson has things that stimulated my curiosity.
21. I really enjoyed studying this lesson.
22. The amount of repetition in this lesson caused me to get bored sometimes.
23. The content and style of writing in this lesson convey the impression that its content
24. I learned some things that were surprising or unexpected.
25. After working on this lesson for a while, I was confident I would be able to pass a test on it.
26. This lesson was not relevant to my needs because I already knew most of it.
27. The wording of feedback after the exercises, or of other comments in this lesson helped me feel rewarded for my effort.
28. The variety of reading passages, exercises, illustrations, etc. helped keep my attention on the lesson.
29. The style of writing is boring.
30. I could relate the content of this lesson to things I have seen, done, or thought about in my own life.
31. There are so many words on each page that it is irritating.
32. It felt good to successfully complete this lesson.
33. The content of this lesson will be useful to me.
34. I couldn't really understand quite a bit of the material in this lesson.
35. The good organization of the content helped me be confident that I would learn this material.
36. It was a pleasure to work on such a well-designed lesson.

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The relationship between self-directed learning and students' social interaction in the online learning environment

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Abstract

In the online learning environment, learners play an important role in attaining successful learning. Considering the students' self-directed learning is important to university because of online learning is done in unlimited space and time. Through online mode, the learners do the social interaction. The interaction in online learning is categorized into four dimensions namely the interaction between the teachers and students, students and students, teachers and topic, and students and topic. This study emphasized the relationship between self-directed learning and students' social interaction in the online learning environment. Statistical associations between variables were inspected with parametric correlation and statistically significant differences between independent samples were examined with a one-way analysis of variance. This study showed a significant relationship between students' self-directed learning readiness (SDLR) and their social interaction, and there were different social interactions between students based on their SDLR levels.

KEYWORDS: Online Learning Environment, Self-directed Learning, Social Interaction, Intensity, Quality

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1. Introduction

In recent years, the learning environment has changed due to the rapid development of the internet and information technology. The interaction between teachers and learners is continually enriched and changed because of explosive development in the technology of computers and the internet. Online learning environment (OLE) has dynamically developed over the world giving many chances for independent learning and collaboration in unlimited space and time. The online learning system offers easy access to the domain of knowledge and learning process anywhere, for anyone, at any time. Through online, the learners can also access much information and many resources such as books, videos or web pages including technological tools or systems used to create a collaborative environment. Many online learning environments have been developed to support learning and assessment or evaluation (Deperlioglu, Sonugur & Suzme, 2015). The use of the OLE applications provide many facilities supporting the process of sharing, negotiation, and discussion beside done in the face to face class setting (Hadjileontiadou, Dias, Diniz & Hadjileontiadis, 2015). Therefore, Milicevic and colleagues (2017) stated that online learning becomes a real alternative to augmenting the traditional classroom.

In an online learning environment, learners play an important role in attaining successful learning (Morris, 1995; Shaikh, 2013). Some of the factors that influence the success of online learning include student technical skill namely computer literacy, independence in learning, interaction in learning, and flexibility in content (Picciano, 2002). However, considering the students' self-directed learning is important because online learning happened in unlimited space and time. Previous studies have shown that self-directed learning

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readiness or the ability to manage self-learning is more significant (Guglielmino & Guglielmino, 2001; Morris, 1995; & Shaikh, 2013). The individual's knowledge and attitude give a good foundation to learn independently. In addition, attitude and skill will create the students' positive behaviors to succeed in online learning (Guglielmino & Guglielmino, 2002). If the learners are ready for online learning, the learning process will be an efficient and effective approach (Guglielmino & Guglielmino, 2003). Otherwise, the learners will do unstructured learning and, in the end, get failures in the learning process.

Today, schools and institutions learnt the importance of self-directed learning (SDL) skill. It is considered as an indicator of learning outcome that is necessary in the 21st century (Murnane & Levy, 1996). SDL is "a process where an individual takes an initiative with or without the others' help" to diagnose their learning needs, formulate the learning goal, identify the learning resources, choose and apply the learning strategy, and evaluate the learning outcome (Knowles, 1975; 1990). Therefore, the teachers and students should have not only academic skills but also SDL skills (Areglado, Bradley & Lane, 1996).

Self-directed learning is beneficial to stimulate motivation, and self-control since online learners are expected to be able to learn without an instructor (Skaggs, 1981). Many researches have been conducted to measure the level of students' self-directed learning in online learning by using self-directed learning readiness (Saks & Leijen, 2014; Kovalenko & Smirnova, 2015; Cazan, & Schiopca, 2014). Another study found that students may have SDL until a certain level (Shaikh, 2013). Most of the literature (for instance, Bernard et al., 2000; Clark & Mayer, 2002; Broadbent, 2016) agreed with Guglielmino (2003) in considering the self-directed learning readiness (SDLR) as an essential factor in online learning. The level of self-directed learning readiness in using online technology is very significant to reach academic success as well. In this case, self-directed learning readiness is defined as the learner's readiness to learn independently. Regarding this case, Cazan and Schiopcal (2014) found that self-directed learning correlates to the students' learning outcomes. According to Saks and Leijen (2014), self-directed learning due to its adult education roots is mostly used for describing the learning activities outside the traditional school environment and involves the aspect of designing learning environments. The high relevance of self-directed learning in today's educational discourse would suggest that the term is precisely defined and used in literature. To facilitate a learning environment in which students can acquire a necessary level of understanding, it is necessary to apply an active learning paradigm, which recognizes that student self-directed and interaction is critical to the learning process (Jeremić et al., 2011).

The online learning environment requires students' engagement in the online system. The OLE applications provide many facilities supporting the process of sharing, negotiation, and discussion besides done in the face to face class setting (Hadjileontiadou et al., 2015). Through online mode, the learners can also create a collaborative learning process. Moreover, McLoughlin & Lee (2010) stated that teachers who adopt social software tools should not do so merely to appear conversant with the tools but to ensure integration of the tools with sound pedagogical strategies to facilitate authentic exchange and dialogue with and amongst students. Students with a certain level of SDLR will engage in a learning process (Saks & Leijen, 2014).

This study will reveal in more detailed the effect of SDLR on social interaction in OLE. Figure 1 shows the plan of our investigation with an emphasis on two main elements: SDLR, and social interaction. Social interaction can be described as a subset of online learning environment, that is students' activities in an online learning environment, then an online learning environment is a subset of the learning process. Students' SDLR as a variable of student's characteristic that expect the students' activities in OLE.

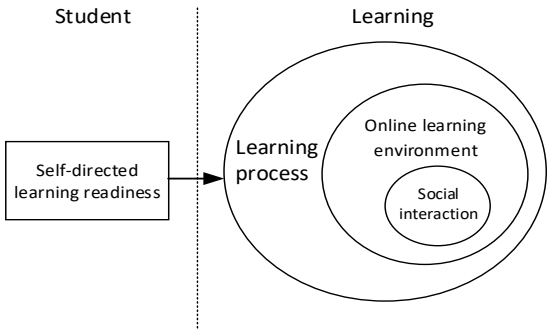

Figure 1 - Point of view of SDLR, learning process, OLE, and social interaction.

This study focuses to examine the relationship between SDLR and social interaction in an online learning environment. The main objective was to examine whether and how self-directed learning readiness is related to student's social interaction in OLE. According to Kožuh and colleagues (2015), social interaction refers to a reciprocal relationship between two people or more. Garrison & Anderson (2003) stated that there are four interactions in education namely interaction between teacher and students, student and student, teacher and topic, and students and topic. In this study, the intensity and quality of social interaction are related to academic achievement but there is no

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relationship between social presence and academic success. This case is in line with the finding of Picciano (2002) stating that there was no correlation between social presence and final exam outcomes. Otherwise, there was a strong relationship between social presence and the students' performance in writing.

Regarding this case, Kožuh and colleagues (2015) has investigated the relationship between social interaction and the student's academic success in the personal learning environment. They have evaluated the proposed concept in a classroom setting, using a specific social interaction tool and a specific social presence tool. The findings revealed that although the use of the social interaction tool was positively associated with students' academic success, the perceived ease of using the social presence tool was negatively related to students' success, unfortunately, this study doesn't consider the students' characteristic that is also probably affected to their social interaction in the online learning environment.

Therefore, we propose integrating SDLR as students' characteristics into an analysis of the student's social interaction in online learning environments. We focused on the relationships between two main elements of the student's social interaction: the intensity of social interaction and the quality of social interaction.

We identified the following research questions to be examined:

RQ1. *Is there a relationship between SDLR and the intensity of social interaction in the student's online learning environment?*

We expect to find a positive relationship between these variables, anticipating that the more intensive the students' social interactions are, the better their success will be.

RQ2. *Is there a relationship between SDLR and the quality of social interaction in the student's online learning environment?*

We expect to find a positive relationship between these variables, anticipating that if SDLR increases, students' quality of social interaction will also improve.

RQ3. *Is there a relationship between the intensity of social interaction and its quality in the student's online learning environment?*

A positive association is also expected to be found in answering the third research question. We assume that as the intensity of social interaction increases, its quality will also increase.

RQ4: *Are there statistically significant differences between student groups with a higher SDLR and student groups with a lower SDLR in the intensity of social interaction?*

It is expected that the intensity of social interaction will differ between student groups according to the student's SDLR. We assume that the members of a student group with a higher SDLR will report higher mean scores in the intensity of interaction than students with a lower SDLR.

RQ5. *Are there statistically significant differences between student groups with a higher SDLR and student groups with a lower SDLR in the quality of social interaction?*

It is expected that the quality of social interaction will differ between student groups according to the student's SDLR. We assume that the members of a student group with a higher SDLR will report higher mean scores in quality of interaction than students with a lower SDLR.

2. Materials and Methods

2.1 Participants

The participants in this study were 98 students (52 male, 46 female) of Education Faculty, State University of Malang Indonesia, who attended online learning as the samples selected randomly. Before the experiment, we examined their self-directed learning readiness (SDLR) and they should attend a few-hour training courses where the main features of the system were presented. We classified them into two groups namely high levels of SDLR and low level of SDLR. The sizes of the groups were based on their SDLR scores.

2.2 Instruments

The measuring instruments were classified into two groups: (1) scale and (2) server log files. Scale was used to collect self-directed learning readiness. We also analyzed a dataset of the server log files to define the intensity and quality of social interaction. In this way, the results from the questionnaires were elaborated with research findings from the server log files analysis.

2.3 Self-directed learning readiness scale (SDLRS)

Assessing the self-directed learning adopted from the self-directed learning readiness scale (SDLRS) developed by Guglielmino (1989) was to measure the students' self-directed learning readiness. This SDLRS consisted of 38 items to assess the students' SDLR. Each item has 5 points-Likert scales with the description namely "1 = *I am almost never right*", "2 = *I am usually wrong*", "3 = *I am sometimes right*", "4 = *I am always right*", "5 = *I am almost always right*". The summation of all 38 items scores would be similar to SDLRS total scores. This scale consisted of 34 items stated positive and 4 items stated negative used to avoid the same answer among students (Guglielmino, 1989).

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All SDLRS scores were employed to represent the students' SDLR. The validity and reliability of the students' SDLR were supported by some research. According to Guglielmino (2008), SDLRS was assessed by Finestone (1984) and Wiley (1981) to know the reliability of test-retest and reach the high test-retest reliability score of 0.82 (Finestone, 1984) and 0.79 (Wiley, 1981). SDLRS also could read the reliability coefficient above 0.70 minimum for all sub-scales in the instrument (Boden, 2005). This showed that SDLRS has high reliability. Besides, SDLRS had a significant correlation with the SDL level (Finestone, 1984; Skaggs, 1981), preference of challenge, curiosity to learn, and scholastic competency felt (Posner, 1989). This showed that SDLRS had a high validity to assess the participants' SDL.

2.4 Students' social interaction

To reach the goal of this research, the scores of the students in online discussion for the subject of Mobile Learning were accumulated at the end of the second semester. We measured two separate elements: the intensity and the quality of social interaction. Two different categories of forum posts were considered adopted from Vuopala and colleagues (2016), namely the interaction related to the group and interaction related to the task.

The first category included the interaction related to the group:

1. Answer or comment:
   - Declarative comment, rule: agrees, states, repeats;
   - Comment with an explanation, rule: explains, justifies, clarifies;
2. Socio-emotional expression:
   - Expressing cohesion, rule: helping, rewarding, acknowledging;
   - Accompanying: mumbling topics that are not related to the course content or group work.

Each post was assessed by the teacher by considering the significance of the posting raised by the student, according to the given task and providing another possibility of the question being answered by other students and by the teacher.

The second category comprised discussion forum posts where the interaction is related to the task:

1. New knowledge:
   - Theory-based, rule: bring a new topic based on the theory of the source of information;
   - experience Based, rule: bring a new topic based on the experience or opinion;
   - Statement, rule: bring new topic as a statement without explanation;
2. Question:
   - New question, rule: brings a new question into the discussion;
   - Clarifying question, rule: clarifying the previous question or asked for clarification;
   - Suggestion, rule: states or suggests and wait for comments.

The intensity was measured as an average number of discussion forum posts per student in each group. Students engaged in six forum discussions. Table 1 shows the number of discussion posts of student.

The quality of the student's social interaction was defined by the teachers' assessment of students' discussion forum posts in the students' online learning. The teacher assigned a mark on a scale of 0 to 5 for each post. The mark 0 was assigned if no post was published by the student and the mark 5 was assigned to an excellent post.

The assessment of these posts was also based on the significance and technical correctness of the posts from the viewpoint of the task content; the factor of predicting how relevant the post was for its ability to guide the user to a proper solution was considered as well. The teacher's marks for the discussion forum posts were summed up for each group of students. The results were divided by the number of posts in the group, then the average mark of posts per group was computed.

2.5 Procedure

The experiment was conducted at the State University

Students' forum posts in OLE	Discussion forum					
	I	**II**	**III**	**IV**	**V**	**VI**
Interaction related to the group:						
Answer or comment	2	1	1	2	2	2
Socio-emotional expression	1	2	0	1	2	2
Interaction is related to the task:						
New knowledge	1	1	2	1	1	2
Question	0	3	2	2	2	1
Suggestion	1	0	1	1	2	0
Total	5	7	6	7	9	7
Mean	6.83					

Table 1 - Intensity score of social interaction of students.

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of Malang Indonesia and was performed in four steps: (1) assessment of the students' SDLR, (2) demonstration of using the online learning system along with a training session, (3) working with the online learning system, and (4) assessment of the student's social interaction in the online learning environment.

In the first step, the participants filled in the questionnaire to assess the self-directed learning readiness. In the second step, we demonstrated the system's functionalities during a training session where an example of the assignment was introduced. The participants were informed about the evaluation criteria to become aware of the teacher's expectations regarding their activity in the online learning environment.

The third step included the main experiment. The teacher gave each group its tasks. The tasks were topics of discussion, and assignment. The online learning environment systems used the Moodle Learning Management System. Although all members within each group received the same tasks, they were asked to submit their solutions. The assigned task was complex and challenging so that it could elicit a constructive learning process in students (Van Merrienboer & Paas, 2003). Learning process design in OLEs has its roots in various theories. The proposed opportunities for communication are related to the Social Learning Theory (Bandura, 1977) and collaboration (Dillenbourg, Baker, Blaye & O'Malley, 1994), referenced together as social interaction learning theory, where social interaction is a crucial element in learning. In the fourth step, throughout the course, the teacher was fully engaged in the students' learning process and available 24 hours a day.

2.6 Statistical analyses

The internal consistency reliability of a set of items for one variable was checked with the Cronbach's Alpha coefficient (Cronbach, 1951). Statistical associations between variables were inspected with parametric correlation (Pearson's correlation coefficient).

Statistically significant differences between independent samples were examined with an analysis of variance (One-way ANOVA) statistical model and a parametric correlation (Howell, 2002). All analyses were performed using Statistical Package for the Social Sciences (SPSS) version 23.0 software.

3. Results

Table 2 presents observations of students' SDLRs.

	N	Range	Min.	Max.	Mean	SD
SDLR	98	80	98	177	140.36	16.18

Table 2 - Descriptive statistics of SDLRs.

The student's SDLR score was categorized into two-level: *High* (if SDLR >= mean), and *Low* (if SDLR < mean). We found 47 students with a low level of SDLR and 51 students with a high level of SDLR, from a total of 98 students. Considering the equality of group, 47 students with a high level of SDLR engaged in this online learning. The total participants of online discussions in OLE were 94 students.

Table 3 shows the mean scores of these variables for student groups, using descriptive statistics. The students in group High level of SDLR reported the most intensive social interaction (M = 9.85) and also reached the highest quality level of social interaction (M= 3.49, SD = 0.38).

Student		Social interaction			
Group		Intensity		Quality	
SDLR	Number of Students	Mean	SD	Mean	SD
Low	47	7.72	3.21	3.18	0.20
High	47	9.85	3.15	3.49	0.38

Table 3 - SDLR and intensity and quality of social interaction.

A parametric correlation analysis was conducted to further investigate the first three research questions. A statistically significant positive relationship was found between the SDLR and the intensity of the social interaction, $r = 0.281$, $p < 0.01$. Likewise, a statistically significant relationship was demonstrated between the quality of social interaction and SDLR, $r = 0.432$, $p < 0.01$, meaning that as the SDLR improved, their quality of social interaction in the online learning environment also improved.

Also, a statistically significant positive relationship was found between the intensity and the quality of social interaction, $r = 0.693$, $p < 0.01$. It indicates that as students were more active in discussion forum postings in the online learning environment, the quality of their posts improved.

Considering student groups with different levels of SDLR concerning using the social interaction tool in OLE, we analyzed with one-way ANOVA to detect statistically significant differences between student groups in all variables.

The results demonstrated statistically significant differences between the groups in the variable "intensity of social interaction", $F = 10.509$, $p < 0.05$. Likewise, statistically significant differences were found in the variable "quality of social interaction", $F= 24.542$, $p <0.01$.

For the fourth and fifth research question, we found that there were statistically significant differences between student groups with a higher SDLR and student groups

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with a lower SDLR in intensity of social interaction and there were statistically significant differences between student groups with a higher SDLR and student groups with a lower SDLR for quality of social interaction.

4. Discussion and Conclusions

4.1 Discussion

This study found a significant relationship between students' SDL and their online performance measured by social interaction scores. This finding is in line with the conclusion of Hsu and Shiue (2005), Morris (1995), and Harriman (1990). From the results, it can be concluded that students are dependent on themselves in the online learning environment and they may have a possibility for greater academic achievement. To include the proper learning strategy to fulfill the students' needs, the university should not only assess their academic skills by selection (especially new students) in online learning but also use SLDR as the clarification variable.

According to Gibbons (2002), self-directed learning is the improvement of knowledge, expertise, achievement, and self-development where an individual uses many methods in many situations. Self-directed learning needed since it could give the students the ability to do the task, combine the skill development with character development and prepare the students to learn the whole of their life. Self-directed learning includes how the students learn every day, how the students could adapt to the very fast-changing, and how the students could take self-initiative when there is no chance. According to Kovalenko and Smirnova (2015), self-directed learning is a sequence of students' activity models individually or in a group in the class or at home without the teacher's involvement. Considering the relationship between SDLR and online learning activity, a study was found that online learning contribution to learning success is about 50%.

Therefore, online learning can be much more effective than other single direction, passive learning methods. There is a growing interest in online learning all over the world (Deperlioglu et al., 2015).

Kožuh and colleagues (2015) found the intensity and the quality of interaction were related to the learning outcome. According to Choy and colleagues (2016), in an online learning environment where learners and instructor are separated by space and time, creating proper structure (i.e., design) and developing meaningful interaction (i.e., online discussion) are hailed as the fundamental element in generating a strong sense of learning community.

Self-directed learning is being important to direct students to positive behavior supporting the success of the learning process. Self-directed learning enables the students to adopt the right behaviours and managed themselves to have discipline in the learning process. Likewise, in the online learning environment, self-directed learning is needed to make students have a responsibility in managing and make themselves discipline.

4.2 Implications

This study revealed that considering SDLRs before student engagement in online learning is important. This information is useful to prepare the appropriate online learning mode to support the student with different SDL levels that enable to improve the academic achievement. Besides, it will have implications for the selection of features that will be used in an online learning environment.

These results of the study will add more research themes on the factors predicting academic success in online learning among university students. Despite the online learning technological system that may have a positive effect on learning, many empirical studies have found that some factors that could influence the intention to use the technology give an impact on the learning effectiveness as well. This factor could be a point of view on the future works. The intended factors are user's perception of the use of a certain technology such as the easiness and the user's attitude in using technologies. Moreover, learning preference in using a certain technology is also essential to assess the success of online learning (Hsu et al., 2015). Concerning SDL, providing options for students and encouraging students to adapt to their needs is the ideal approach for educators. However, lecturers must clearly explain the options and some students might need support in choosing modes that will maximize their learning. University administrators should be aware of the patterns of access so they can ensure degree programs allow for the flexibility students need, as well as providing up-to-date technology and adequate support to faculty and students. More courses are taking a blended learning approach, where online resources (not just lecture recordings) complement face-to-face techniques, and universities in the future will need to continue to innovate (Chapin, 2018).

4.3 Limitations

This study focused on SDLR and social interaction. Whereas there are still several factors that influence the success of online learning, including learning styles, cognitive load, etc. This study is limited in several aspects that must be addressed in future research. First, SDLR was not confronted with the students' academic success. Accordingly, future research shall include experimental settings in which learning designers use

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analytics results for advancing online learning environments after learning topics are completed. Second, due to limited access to student data (e.g., learning styles, cognitive load, prior knowledge), a more holistic perspective to design the online learning environment of individual students and their relationship is important. Hence, future studies shall link additional student data and therefore provide further insights into these complex relationships.

4.4 Conclusions and future work

This study revealed the relationship between self-directed learning and students' social interaction in the online learning environment. This study found that there was a significant relationship between self-directed learning and students' interaction in the online learning environment and there were significant differences in students' interaction in online learning environment based on their level of self-directed learning readiness. Therefore, self-directed learning readiness is recommended to be one of the factors contributing to higher academic achievement in the online learning environment. Considering the self-directed learning readiness in the online learning process may be beneficial for the students to be successful in the online learning environment. Further research can assess self-directed learning readiness in the other universities by considering the other variables such as gender and different prior knowledge. The current research findings provide clues as to how the university to carefully design and develop the online learning process or integrate self-directed learning readiness to curriculum and online learning environment.

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The Effect of Color Use in Designing Instructional Aids on Learners' Academic Performance

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Abstract

As a result of the rapid development in educational technology, the design of instructional aids has been gaining a lot of significance. To date, researchers have studied the effect of using instructional aids on the learners' academic performance, and a positive effect has often been proven. This study reviews and analyses existing literature and empirical evidence in relation to color use in designing instructional aids. Two major areas reviewed in the study are the Color Theory and the psychological and physiological impacts of color on learners. The results show that using colors in designing instructional aids plays an important role in enabling learners to concretize concepts and relations. Results also indicate that the effects of using color reflect on both the learners' and the teachers' emotional experiences. The results of the study may benefit educators, teachers, and pre-service teachers in designing the right and favourable learning environments for their teaching strategies.

KEYWORDS: Color, Instructional Aids, Academic Performance, Color Theory.

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1. Introduction

It is a rule of thumb that learners construct increasingly complex knowledge through the active involvement with the instructional materials and aids (Dienes, 1973). And colors are acknowledged to have a powerful effect that produces profound physiological and psychological reactions. Several studies have shown that there is a strong relationship between color preferences and academic performance in the learning environment (Boyatzis & Varghese, 1993; Imhof, 2004; Karp & Karp, 2001; O'Connor, Sofo, Kendall, & Olson, 1990; Terwogt & Hoeksma, 2001; Wilkins, 2003). A student-centered approach has been adopted, and the integration of teaching materials in the learning environment has been strongly emphasized. Thus, teachers, within this framework, are requested to use instructional aids in their learning environments efficiently enough to produce the intended effects (Billstein, et al., 2009; Gürbüz, 2010).

Using instructional aids in classroom situations has, recently, gained special significance in concretizing concepts and relations; it is proven to be an effective instructional strategy used specially to increase the learners' successful understanding of the concepts included in the content or the skills being taught (Sherman & Bisanz, 2009). And, as indicated in (Carbonneau et al., 2013), for the abstract concepts to be successfully understood, it is important that models be used. With the help of instructional aids, learners usually develop positive attitudes towards learning and, hence, instructors can easily arouse their interest, ensure their active participation, and enhance their critical thinking skills (Apperson et al., 2006). Therefore, instructional aids have become one of the most important instructional elements that enable learners to develop good conceptual understanding of the content or skills taught and to represent abstract concepts. Generally, in classroom situations and learning environments where abstract concepts (e.g., mathematics) are represented by different models, students are enabled to construct abstract understanding (Moyer, 2001). Learners are also

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enabled to associate these abstract concepts with their previous knowledge and experiences. As learners interpret their accumulated experiences more easily, it is important for them to construct their own abstract knowledge. Instructional aids are of great help in offering learners all these opportunities in spite of the

> *"practical and pedagogical issues in relation to utilizing instructional aids in the classroom situations makes it difficult for teachers to implement them effectively" (Ünlü, 2017).*

2. What does Research Tell us about Using Instructional Aids in the Classroom?

In the last few decades, and in our increasingly visual world, the use of instructional aids in creative and meaningful ways that help enhance learners' understanding has been greatly capturing researchers' attention. The increase in the number of educational institutions adopting instructional aids, esp. the technological ones, in the classroom environment has urged educators and scholars to find out which designs and which colors of instructional aids are the best and the most engaging.

Eulho and colleagues (2019) study explores which instructional design components influence learner control. The study revealed that all course design factors, transactional interaction between student and content structure and assessment, were significant predictors of learner control and sense of progress.

Yufi (2018) investigated the importance of Teaching Aids, and their role in the teaching process in teaching Arabic language at the University of Education, Indonesia. He found out that using the Teaching Aids, in teaching Arabic language, has a big role to make the teaching useful for non-Arabic speakers; it helps the teacher to be an investigator and an executor, It also assists to present, perform, control and verify the course in the education situation.

Lorkpilgh and Adalikwu (2017) identified the effect of educational aids on academic performance of students in the secondary stage. They found out that students who were taught with educational aids performed much better than those who were taught without educational aids. They also found that the use of educational aids enhanced the student's understanding of the concepts and, hence, led to better achievement.

Hassan (2016) identified the colors that kindergarten teachers use in coloring the educational aids they produce for kindergarten children. The teachers used 9 colors in coloring the educational aids that they produce manually for the kindergarten child. He discovered a statistically significant difference between the use of parameters for red in coloring educational aids and children's preference for it in favour of children's preference. He also noticed the presence of statistically significant differences between the use of parameters for green, brown, white and black on the one hand and children's preference for these colors on the other hand in favor the teachers.

Jennifer and colleagues (2015) explored the implications of technology transience on instructional design. They indicate that the impact on quality, currency, and effectiveness in the design of learning experiences needs to be considered in relationship to the ways technology changes the learning environment.

John and colleagues (2014) used the ratio of instructional theory and laboratory practice to define the learning context. They found that the use of the aid was not associated with any measurable gains for participants when used in year two.

Jan and colleagues (2013) examined design factors that may evoke positive emotions in learners and investigate the effects of these positive emotions on learning. They found out that well-designed materials induced positive emotions and facilitated comprehension, though transfer performance was not affected by emotional design. The study also found that warm colors alone did not affect learners' emotions.

Manthra and colleagues (2018) study investigated the effect of teaching aids on student's academic performance in professional courses. They found out that the majority of students are aware of teaching aids and that 94% of the students wanted teaching aids to be implemented in the lecture classes by professors.

Altakhaineh and colleagues (2020) examined the effectiveness of using colors and learner's intelligence quotient (IQ) in teaching new vocabulary in Arabic (L1) and English (L2) to children with autism spectrum disorder (henceforth, ASD). They discovered that the children's IQ played a crucial role in learning L1 and L2 vocabulary. They also found out that using colors had no significant impact on the children's performance in the test.

Ayoola and Adebule (2016) investigated the effectiveness of the use of educational aids on the academic performance of students in the subject of Alrabadia. The study showed that there was a difference of statistical significance in the performance between students who were taught using educational aids and those who were taught using traditional methods

Bakrawi and Husayn (2019) examined the introduction of teaching assets in teaching primary schoolchildren. They found out that Audio-based aids such as radio, cassette players, visual-based aids such as pictures, posters, maps and the globe were very effective. At the end of the study, the two students made a few recommendations, which may guide teachers and gain good results.

Apondi (2015) investigated the Impact of instructional materials on academic achievement in Mathematics in public primary schools in Sayaia County, Kenya. The study showed a statistically significant difference in children's performance between the control group and the experimental group.

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3. The Role of Instructional Aids in Classroom Situations

Instructional aids help to reinforce and supplement the teacher's communication during the presentation of the lesson. In classroom situations, instructional aids can be presented in the form of physical objects or in a software form in a digital environment. So, instructional aids are classified into two forms: the physical form represented by solid materials, and the computer-produced form represented by digital materials (Burns & Hamm, 2011; Moyer, 2001). In classroom situations, manipulative materials are used for concretizing abstract concepts and relations being taught. Instructional aids, if used properly, help the teacher to communicate effectively by adding realism and substance to ideas, descriptions, and explanations being presented in the classroom situations. It should be pointed out that for an effective use of instructional aids in the classroom, a teacher must use appropriate procedures and techniques; i.e. the time as well as the method of introducing the aid in the lesson are very important factors.

Digital manipulations are computer-assisted instructions and web-based applications. And computer-based teaching can be accessed online. Hence, computer-assisted instruction is widespread in schools since materials are easy to access. Electronic aids enable teachers to integrate pictorial, verbal, and nonverbal representations of

Category	Findings	Source
Red	Connected with the base of the spine and motor skills	*Torrice & Logrippo, 1989* *Morton, 1998*
	Raised blood pressure Increased respiration	
	Fastened Heart beats Heightened sense of smell	*Engelbrecht, 2003*
	Associated with excitement and happiness Positive reaction - girls more positive than boys	
	High preference for 7-year-olds	*Terwogt, & Hoeksma 2001*
	Associated with anger, pain, happiness, and love in 4th graders	*Karp & Karp, 2001*
Blue	Favorite color for 7 and 11-year-olds	*Terwogt, & Hoeksma 2001*
	Correlates to eyes, ears, and nose – seeing, hearing, smelling	*Torrice & Logrippo, 1989*
	Favored by sight and hearing impaired children	*Torrice & Logrippo, 1989*
	Calming effect on heart rate and respiratory system	*Engelbrecht, 2003* *Torrice & Logrippo, 1989*
	Lower body temperature	*Morton, 1998*
	Reduced appetite	*Walker, 1991* *Morton, 1989*
	Positive reaction - girls more positive than boys	*Boyatzis & Varghese, 1993*
	Associated with sadness in 4th graders	*Karp & Karp, 2001*
Yellow	Chest, heart and lungs affected Favored by children with asthma and other breathing problems	*Torrice & Logrippo, 1989*
	Highly preferred by seven-year-olds Associated with honesty in 4th graders Most bright and shiny. In large quantities, irritating for the eye	*Terwogt,& Hoeksma, 2001* *Karp & Karp, 2001* *Morton, 1998*

Table 1 - Outlines findings, issues, and associations related to specific colors.
Categories, Issues, and Findings Related to Color (adapted from Gaines, K. S., & Curry, Z. D. 2011).

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problems more easily. The main difference between physical and digital aids (hard and soft copy) is that physical aids are touchable (Karakirik & Aydin, 2016). So, while digital instructional aids help learners develop their flexibility manipulating them, physical aids help learners develop their psychomotor skills as they address the sense of *touching* (Olkum, 2003).

Instructional aids in computer-based education provide various opportunities for interactivity; learners can rotate, flex and reshape the object easily in virtual environments. With this respect, it is important for learners to interpret the concepts through real and concrete experiences. Burns and Hamm (2011), however, found only a few studies in support of the idea that web materials should be used more than physical materials. Likewise, Reimer and Moyer (2005) stated a similar finding:

> *"the only advantage of implementing web materials rather than or tangible materials is that web-based materials are easily accessible and they associate visual images".*

Thompson (1992) went even further when he reported that using instructional aids in classroom situations does not significantly affect students' success. Similarly, other researchers found no positive or negative effect of using instructional aids on students' achievement in mathematics, for instance (McNeil & Jarvin, 2007; Moyer-Packenham & Suh, 2012). In my opinion, it must, however, be emphasized that instructional aids cannot solve all problems of teaching; they can only make the teaching learning process more effective.

4. The Color Theory and Color Perception

An explanation of the Color Theory and color perception is important for shaping a better understanding of the pedagogical responses to color.

When sunlight shines on an object, its surface reflects the colored light. The reflected color/s is/are received through the receptor cells of the eye retinal wall (Morton, 1995). These retinal receptor cells absorb the hues and send messages to the brain, which, in turn, sends impulses to the major endocrine-regulating glands, causing some emotional and psychological responses (Nielson & Taylor, 2007).

The standard Color-Wheel Theory (Morton, 1995) is based on the standard Color Wheel composed of twelve colors. Red, yellow, and blue are the three primary colors, which cannot be formed by the combination of other colors. There are also three secondary colors, usually formed by mixing the primary colors, and six tertiary colors, that emerge from mixing primary with secondary colors. An unlimited number of colors can be obtained by mixing the twelve colors of the wheel along with white and with black.

Color has three basic attributes: hue, value, and saturation (Morton, 1995). *Hue* is another word for *color* such as blue, red, or yellow. *Value* is the relative lightness or darkness of a color. A hue may be lightened (by adding white), or darkened (by adding black). *Saturation* (also intensity or chroma) is the purity of a hue. A decrease in the purity causes the hue to be muted or dull (Morton, 1995).

Color is also classified according to visual temperature; half of the colors on the wheel are classified as *warm*, and the other half as *cool*. Colors associated with red and yellow are described as warm because they remind us of things like the sun and fire evoking a warm feeling. Cool colors, which are associated with blue and green, remind us of things like grass and water evoking a cool feeling.

How the eye perceives the color is usually influenced by the physical characteristics of the color itself and by the physical environment surrounding the color. Color perception is influenced by the different wavelengths; warm colors tend to advance in a space whereas cool colors tend to recede affecting the perception of depth. This visual temperature (the relative warmth or coolness of the color) may also be affected by the intensity (saturation) of the color (Nielson & Taylor, 2007). In general, preschool and elementary children prefer warm colors, and secondary students prefer cool colors (Engelbrecht, 2003). Color perception is also influenced by lighting; placing a blue painting under a bluish light (such as a cool LED light) will heighten the blueness of the painting. However, a red painting under a blue light will become dull and grayish because no red color waves are being made by the light. A study by Styne (1990) showed that a space painted with cool colors under cool florescent lighting resulted in spaces that seemed larger, quieter, and cooler. A space with warm colors under warm incandescent lighting resulted in a more active space that seemed smaller, warmer and louder. Such information provides useful insights when designing instructional aids.

5. Psychological and Physiological Reactions to Color

There are two types reaction to color: a scientific (physiological) reaction, and an emotional (psychological) reaction. Studies (Engelbrecht, 2003; Morton, 1998) conducted to investigate the physiological responses to color have reported changes

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Category	Findings	Source
Physiological Differences	Color discrimination: Distorted along blue-yellow system with ADHD	*Banachewsk et al., 2006*
Physiological Reactions	Eye fatigue relieved Changes in blood pressure and brain development observed	*Engelbrecht, 2003*
	Color rays detected by eyes and skin Autonomic nervous system stimulated by bright war colors, but retarded by soft cool colors	*Morton, 1998*
Psychological Reactions	Colors can have an adverse effect on the behaviour of students with ASD Monotone environments create restlessness	*Shabha, 2006* *Gaines, 2008*
	Warm, neutral colors prevent overstimulation	*Engelbrecht, 2003* *Clay, 2004*
	Both blind and sighted children react to color	*Myler et al., 2003*
	Color preferences change with age	*Engelbrecht, 2003* *Terwogt & Hoeksma, 2001*
Mood	Subjects unable to screen environmental stimuli were angrier in an office painted white and depressed in the office painted red	*Morton, 1998*
Attention	Improved with colored paper Use of color improves attention Workers in offices with saturated colors reported more vigor – blue and green highest scores Easily distracted subjects scored lower in proofreading in a red office Subjects not easily distracted scored lower in a blue offic	*Imhof, 2004* *Zentall & Dwyer, 1989* *Engelbrecht, 2003* *Morton, 1998*
Productivity	Improved academic performance White and off-white environment less efficient	*Engelbrecht, 2003* *Morton, 1998*
Accuracy	Improved academic performance Improved in reading with colored lenses and overlays	*Engelbrecht, 2003* *O'Conner, 1990* *Imhof, 2004* *Wikins, 1996*
	Drop in accidents with the introduction of color	*Engelbrecht, 2003*

Table 2 - Summarizes physiological and psychological reactions to color.
Categories, Issues, and Findings Related to Physiological and Psychological Reactions to Color
(adapted from Gaines, K. S., & Curry, Z. D. 2011)

in blood pressure, eye strain, and brain development. For example, exposure to red causes the heart to beat faster, the blood pressure to increase, and the sense of smell to become stronger. In contrast, blue causes a slower pulse rate, a lower body temperature, and a reduced appetite (Engelbrecht, 2003). Psychological responses to color include changes in mood and attention span (Engelbrecht, 2003; Shabha, 2006). The brain releases a hormone which affects the mood, mental clarity, and energy level when color is perceived through the eyes (Engelbrecht, 2003). For example, pink may suppress aggressive behaviour in prisoners (Walker, 1991). Interestingly, color's impact is not limited to visual aspects since color wavelengths are also absorbed by the skin (Torice & Logrippo, 1989). Wohlforth and Sam (1982) also supported this claim in their study. Their findings show that changes in the color of the environment result in a drop of blood pressure and, hence, reduction of aggressive behaviour in both blind and sighted children.

6. Color and the Learning Environment

Some learners' responses to color are temporary while others' responses may last for a long period of time. In addition, many reactions are immediate (Morton, 1998). A number of studies have addressed the impact of color on the classroom environment (Engelbrecht, 2003; Grangaard, 1995; Imhof, 2004; O'Connor et al., 1990; Wilkins, 2003). But the findings of these studies are not consistent enough for determining the color choices to opt for in the learning environment.

Therefore, the following information serves to provide functional guidelines and explains the importance of color in the classroom.

The research conducted by Torice and Logrippo (1989) has shown that active children prefer cool colors, but passive ones are more comfortable surrounded by warm colors. Morton, 1995 concluded that color purity and contrast are more important than color temperature. In other words, a strong green may stimulate an individual as much as a strong red (Morton, 1998). Additionally,

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color quantity should be considered in the physical learning environment; large amounts of color over-stimulate individuals regardless of the color temperature or preference. Verghese (2001) discusses the process of visual search and the attention span in regard to the Signal Detection Theory. This theory states that the human mind continuously strives to organize visual information. Too much color, motion, or pattern functions as distracters making this process of visual search more difficult. Thus, a stressful learning environment will result from excessive use of color. Studies by Shabha (2006) and Gaines (2008) explored the impact of visual environmental stimuli for students with special needs and in general education schools. Teachers were surveyed, and they determined that visual triggers (including lighting color) in classrooms have an adverse effect on the behaviour of students with disabilities. Some observed behaviours included staring at light sources, repetitive blinking, moving fingers in front of the eyes, and hand flapping. The outcome of these behaviours may lead to poor concentration, communication, and social interaction.

Grangaard (1995) explored the effects of color and light on learning for 6 – year old students. Off-task behaviour and blood pressure were measured in two environmental conditions. One classroom had white walls and cool-white fluorescent lights. Another classroom was modified with light blue walls and full-spectrum lights. Findings showed that off-task behaviours decreased by 22 percent in the modified room. Additionally, blood pressure readings showed a nine percent reduction in the second classroom. A study at Texas University in Austin (Kwallek, Lewis, Lin-Hsiao, & Woodson, 1996) was conducted using 675 college students. Test offices (the four walls and the door) were painted 9 colors; including red, white, green, orange, yellow, blue, beige, grey, and purple. Students were evaluated on the basis of task performance, mood, and color performance. Findings showed gender differences in color preferences; males preferred white, green, blue, and grey work environments and did not like yellow, orange, and purple spaces. Whereas females preferred green, red, and beige offices and did not like the grey and orange spaces. Overall, white, blue and green offices received the highest scores; purple and orange work environments were the least preferred. Gender differences regarding mood in different colored environments were also observed. More depression, confusion, and anger were experienced by females in spaces with low-saturated colors of white, grey, and beige. Males experienced negative emotions in high-saturated environments of green, blue, purple, red, yellow, and orange (Kwallek et al. 1996). Most participants stated they prefer to work in beige or white offices. However, more errors occurred in task performance in white offices than in blue and red workplaces. Characteristics should be taken into consideration while designing them in classroom learning situations.

7. Conclusion

In conclusion, the use of color can have a significant impact on the learners' mood, attention, productivity, accuracy, communication, classroom performance and their overall achievement. As the reviewed studies indicate, color affects our emotions and moods and stimulates our feelings either positively or negatively. Thus, learners' feelings about their learning tasks can be positively or negatively influenced by the introduction of color in the learning environment. Instructional aids are definitely an important element in an active learning environment. The proper use of color in designing these instructional aids has recently been gaining greater importance due to its educational value reflected in attracting learners' attention, stimulating their participation, and helping them to concretize abstract concepts. When choosing color in instructional aids, the functional aspects of color (i.e. the psychological impact of the color on the students' reaction), rather than the aesthetic ones, should be emphasized. The key to a proper and functional use of color in designing instructional aids is to take into consideration the learners' age and gender; the color's visual temperature and the surrounding environment; and the effect each color has on the mood and feelings. A study by Benjamin et al., (2000) concludes that, people subjectively feel that colors other than white and black are more pleasing and exciting; they are able to tell us so in their self-reports. This feeling, which is not reflected in the underlying meaning of emotion, may stem from some inherent quality of color. For instance, color could increase the iconicity of photographic representations and, thereby, elicit more powerful and positive emotional responses (Messaris, 1997). In light of the results of the previous literature, instructional aids

8. Recommendations

8.1 In designing their instructional aids, teachers should choose colors that promote comfort and inspire a good learning environment.

8.2 Since color is an integral part of children's positive perception of life, it is a good idea to use bright colors that stimulate them and motivate learning.

8.3 It has been proven that light colors such as yellow and blue elicit positive, lively and energetic feelings while dark colors such as black or grey elicit negative feelings of boredom, depression, and sadness.

8.4 The colors green and blue are usually associated with relaxation, calmness, peace, and comfort. So, they are great options for overactive or hyperactive children.

8.5 The colors red and orange have been known to cause anxiety in some children, so they must be used in small quantities for attracting learners' attention to some details.

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8.6 The color pink is known to be a feminine and calming color; it promotes warm and comfortable feelings. So, it is a perfect choice for children with aggressive behaviour. But, like the red color, it must be used in small quantities because of its calming effect on the nerves, which may lead to physical weakness.

8.7 For certain children, the teacher is the best judge on what colors motivate learning. And in some cases, it would be fun to allow them to vote on it, or even take part in designing and producing the instructional aids.

8.8 When a combination of colors is used in one instructional aid, these should complement each other in a way that stimulates learning and not cause a distraction.

8.9 The key to creating a learning environment that is conductive to learning is to make sure that learners are not over-stimulated by the use of large quantities of bright colors, or over-tranquilized by the use dark or calming colors.

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How to Become an Open Educator?

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Abstract

The teachers in higher education (HE) could take a better advantage of the existing vast numbers open educational resources (OER) as well as invite their students in the process of sharing and knowledge co-creation, if they started using and adapting existing OER and/or creating their own OER. The question of this research was whether involving teachers into OER creation and providing them with a tool of a collaborative platform would increase their openness and readiness to share and become open educators? The research was performed on design-based research methodology and intervention, offering a group of university teachers in Lithuania to create, adapt and share OER in the format of slides, providing them with a collaborative platform as a tool, facilitating open-licensed content creation and publishing. After the intervention most of the participating university teachers emphasized the importance of openness, the feeling of more responsibility while preparing their open slides, expressed better understanding of OER, and even changed their pedagogy. Besides, OER integration had a direct impact upon student awareness on OER, overcoming the barriers towards openness, and their ability to contribute to the course.

KEYWORDS: Open Educational Resources (OER), Open Educator, Openness

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Introduction

The existence of multitudes of Open Educational Resources (OER) in the ever-changing environment of non-stopping streams of information offer a tremendous up-to-date potential for higher education teachers to include these materials into their courses. At the same time, academic community is still rather reluctant to open and share their resources with others as a memory of the times, when universities could enjoy the monopoly of knowledge and education. The teachers in higher education (HE) could take a better advantage of the existing open educational resources, as well as invite their students in the process of sharing and knowledge co-creation, if they started using and adapting existing OER and/or creating their own OER. *The question of this research* was whether involving teachers into OER creation and providing them with a tool of a collaborative platform would increase their openness and readiness to share and become open educators? *The aim of this research* is to study and discuss the impact of OER creation and integration into HE curriculum upon pedagogy and teacher attitude towards openness and readiness to share.

The research was performed on design-based methodology and intervention, offering a group of university teachers to create, adapt and share OER in the format of slides, providing them with a collaborative platform as a tool, facilitating open-licensed content creation and publishing.

This research refers to OER as: "teaching and learning materials, which are freely available and openly licensed" (Atenas & Haveman, 2014, p. 1).

In order to clarify how the design-based research interventions may facilitate teachers to become open educators, the open educator was defined as the one, who used: "open approaches, when possible and appropriate, with the aim to remove all unnecessary barriers to learning" (Nascimbeni & Burgos, 2016, p. 4).

An open educator implements openness through four main activities (Nascimbeni & Burgos, 2016):

1. implementing open learning design by openly sharing ideas about his/her teaching activities;
2. using open licences;

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3. adopting open pedagogies and fostering co-creation of knowledge with students;
4. using open assessment practices such as peer and collaborative evaluation, open badges or e-portfolios.

Digitalization in education is irreversible, however in this light it is vital to rediscover the practices of effective teaching (Siemens, Gašević, & Dawson, 2015). Openness in education is related to progressive educational practices, change, learner empowerment and promotion of unrestricted access to education (Knight, 2008; Spiro & Alexander, 2012; Boudreau, 2014). The openness of education (Peter & Deimann, 2018), courses (Phili & Admiral, 2016; Sanchez-Gordon & Luján-Mora, 2014) and different dimensions for opening them up (Clark, 2013; Gilliot, Garlatti, Rebai, & Belen-Sapia) are analysed in different research. Technologies only open possibilities for interaction and sharing (Boudreau, 2014), and the collaboration of learners and teachers may open deep levels of interaction and guided discussions (Bates, 2014). Curriculum transformation by using OER is a deliberate process among other things involving responsiveness to social context, epistemological diversity and renewal of pedagogy and classroom practices, all supported by an institutional culture of openness and critical reflection (Mays, 2017).

This research mainly focusses on OER creation and integration in HE curriculum. Knox (2013) points out 2 scenarios for OER use within a curriculum: (1) use of OER as a way of sharing teaching resources, which are embedded into an educational experience; or (2) use of OER as entire educational experience. Although both scenarios focus on teaching and learning as educational experience, in this article they are seen as stressing the sharing of teacher perspective and representing teacher centred approach, or focusing on collaborative activities, which may be more learner centred.

OER integration in the curriculum is a challenging activity, mentioned in a number research (Wiley, Bliss, & McEwan, 2014; Judith and Bull, 2016); however, the mentioned challenges are form the perspective of OER reuse rather that the creation, which is the focus of this research. The openness and teacher readiness to share may foster student involvement in knowledge co-creation, providing learners with broader concept approach, or creating opportunities for learners to be a part of the open learning community.

2. Materials and Methods

2.1 Methodological Design. Research background

Vytautas Magnus University is an Artes Liberales university in Lithuania used to be a traditional, face to face learning and teaching institution, which moved all courses to virtual learning environment for technology enhanced learning and created the offer of an alternative blended mode courses for university students since more than 10 years. University has several online programs and is organizing their studies with the focus on liberal arts; it is also open for innovations and technology integration in the studies. With the gaining popularity of OER use in teaching and learning activities worldwide and constant teacher trainings on what OER are, what are the benefits of using them, and how to use them in the University, the problem of teacher resistance and vague OER integration in the University courses remained.

Design-based research methodology was used to answer the aim of the research. This methodology is

> *"not so much an approach as it is a series of approaches, with the intent of producing new theories, artefacts, and practices that account for and potentially impact learning and teaching in naturalistic settings" (Barab & Squire, 2004, p.2).*

It may be defined by the following characteristics (Anderson & Shattuck, 2012): being situated in a real educational context; focusing on the design and testing of a significant intervention; using mixed methods; involving multiple iterations; and involving a collaborative partnership between researchers and practitioners.

Thus, a group of 15 teachers (lecturers, assistant professors and professors) at Vytautas Magnus University were invited to open their course curriculum, by creating their course slides as OER, using a suggested OER development platform, and integrating the open slides in their blended or online courses. The suggested OER development platform provides a possibility to create slides and make them open as OER under CC-BY SA licence (see Figure 1).

One can also collaborate there on the OER creation, sharing, downloading and see what content was shared, downloaded, or created a new OER based on selected author's initial work. The design-based research method was selected for a deeper research with the focus on OER creation and integration in curriculum impact on course pedagogy and teacher attitudes towards openness and readiness to share.

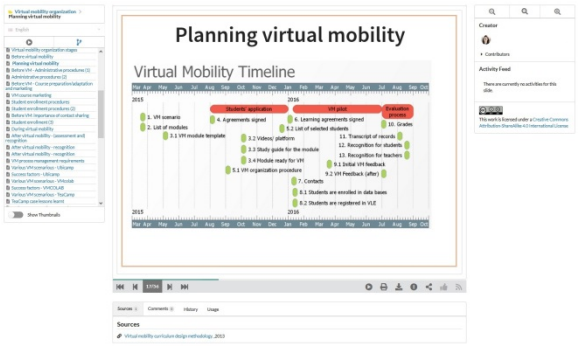

Figure 1 - Example of teacher created slides in the platform.

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One of the strengths of design-based research is the possibility to combine and integrate various research methods at different phases of research and development (Squire, 2005), thus curriculum design, teacher surveys and semi-structured interviews were organized. Second, the design-based research "has an interventionist nature that aims to solve problems in educational practice" (Oh & Reeves, 2010, p. 266).

Reeves (2006) suggests the design-based research process for refinement of problems, solutions, methods, and design principles as an ongoing process, starting with (1) the analysis of the problem by collaboration of researchers and practitioners; followed by (2) solution development integrating existing design principles and innovative, technological solutions; (3) testing and refining the solutions in practices; and (4) reflecting to test and define new design principles. The process of design-based research was created following Reeves indicated design-based research stages and was as follows (see Figure 2).

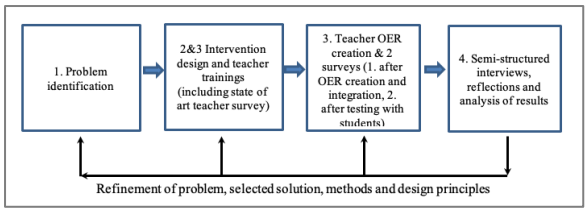

Figure 2 - Design-based research process.

First, the problem identification, analysis and search for possible solutions were implemented by collaborating researchers and practitioners in January-March 2018.

Second, the designed intervention (the creation of the open slides, their integration into online or blended courses, and test with students) was suggested for teachers during the trainings about the possibilities of the platform for OER creation in April 2018. In order to monitor teacher attitude towards openness and readiness to share the *State of art* survey was organized with the teachers after trainings.

Third, teacher OER creation using suggested OER creation platform, integration of created OER into curriculum, and testing was followed. The creation of OER was started in May 2018 and took until the end of August 2018. Teachers were creating their course materials as OER at their own pace, having a possibility to consult with learning specialists if there were any challenges or issues met. In September-October 2018 they tested the new OER in their online or blended university courses, delivering lectures, collaborating with, or engaging students to further develop the course materials on the same platform. The OER creation, integration and testing process was intervened with 2 teacher surveys – the first one after creation and publishing of the slides (in September 2018), and the second one after testing them with their students (in November 2018).

As the three surveys have served more the purpose of teacher attitude change towards openness and readiness to share, the individual semi-structured interviews were conducted with the same university teachers to get the deeper knowledge and identify the OER impact on the pedagogy used, and on teacher attitude towards openness and readiness to share. The interview questions required teacher reflections on OER creation and integration process from content creation, teaching and learning perspectives, skills necessary for the OER development and integration, and teacher attitudes towards openness and sharing. The 15 interviews with university teachers were conducted in November 2018, after the newly created OER slides were already tested in the courses.

Finally, the result analysis and generation of new ideas from the research were carried out and summed up in this paper.

2.2 Research instruments and participant profile

The state of art and 2 follow up teacher surveys aiming to measure teacher attitude towards openness and readiness to share were based on the ATOER questionnaire (developed, tested and validated by Mishra, Sharma, Sharma, Singh, & Thakur, 2016), where a confidence scale, Cronbach's α is 0.897; for calculations, the reliability coefficient is respectively 0.89 and 0.715 for sharing and adaptation. The adapted questionnaire consisted of 17 statements with a Likert scale template. The collected data was analysed using MS Excel, comparing the 3 periodical survey results. The questionnaire for teachers who developed OER slides, consisted in a set of statements reflecting their attitudes towards OER, readiness to share, knowledge of and skills on licencing and OER adoption.

The semi-structured interviews included 5 broad questions on the change of teacher attitudes towards OER and openness, skills necessary to create OER, on the impact of OER creation and integration towards curriculum design, teaching and learning in the course, and on the impact of the selected OER creation tool towards changes in curriculum design, teaching and learning.

The content analysis of the interviews was conducted and is discussed focusing on teacher attitude change towards openness and the changes needed while opening curriculum with OER from curriculum content, teaching and learning, and teacher skills perspectives.

The university teachers who were selected for the OER creation have already been involved in teaching their university courses in either an online distance mode, or in a blended learning mode. The selected teachers were predominantly women (14 women out of 15 participants) that were selected randomly, not according to the sex, but according to their experience in teaching distance or blended courses and willingness for trying a new platform. Among them there were 4 professors, 3

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associate professors and 8 lecturers (2 among them with PhD). Their age was from 29 to 66, the average age is 44 years. Their experience in teaching raged from 4 to 32 years, the average teaching experience was 15 years (14.7 years), while their experience teaching in distance or blended mode raged from 2 to 10 years (the average teaching in online or blended mode experience was 7 years, exactly 6.8 years).

3. Research Results

3.1 The change of teacher attitude to openness, OER, and readiness to share

The results of periodical surveys (filled in before creating OER, after the process of integrating the new OER slides in their blended courses, and after their use while delivering courses) demonstrated rather considerable change in the university teacher attitude towards openness and sharing.

The first part of the questionnaire for teachers who developed OER slides, consisted in a set of statements reflecting their attitudes towards OER and sharing, possibilities and feelings OER sharing provokes, and attitude towards OER adoption. The survey results demonstrated a clear increase in terms of teacher openness to share and their disclosure to the values of sharing in the second round of the survey (after having created their OER slides) and further on after having tested OER with the students.

The biggest shift in teacher attitude representing statements was recorded for the idea that teachers adopt OER as the requirement of students (an increase recorded from 3 teachers agreeing to statement before OER creation, to 13 after OER creation and testing). The OER testing activities with students had the largest impact on teacher obligation to share all created resources (from 7 of teachers that agreed to the statement after OER creation before testing to 12 after testing OER with students, see Figure 3). Teachers also have expressed a positive shift in attitudes towards the benefits that creating and sharing OER brings them, their professional growth, identity and respect through the statements like these: OER promotes collaboration and consortia (from 9 to 12 and 15), OER helps to disseminate my ideas (8, 12, 14), sharing of educational resources improves my professional respect (6, 8, 11), sharing enhances personal and organizational reputation (9, 12, 15), sharing enhances my confidence as I see myself in part of larger community (7, 10, 13).

The change in the attitude towards OER and their use was also recorded in the content analysis of interviews with the teachers. Teachers stressed that they as professionals may reach something more if they share what they have created (T4, T7), that OER creation and sharing widens their area of vision (T5), opens possibilities for promoting their ideas, programs and topics (T7); others stressed their cognitive understanding on how to use OER practically (T7, T11). There were also some, who pointed out the cognition of the negative aspects, such as the amount of low-quality learning content, which is created and launched in the air without any responsibility (T1). Anyway, most of the teacher supported the importance of opening what they have created, of sharing and making learning content available as OER; and stressed the importance of OER and openness for higher education.

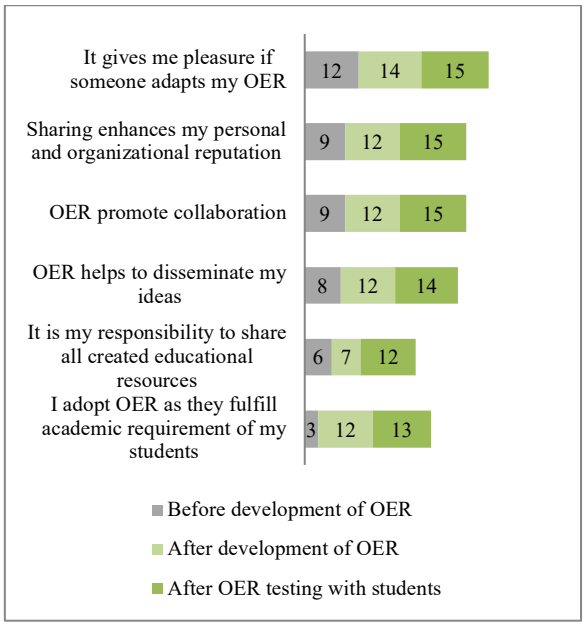

Figure 3 - Change of university teacher attitudes towards openness and OER before and after intervention.

The challenge of overcoming openness barrier was noticed by some teachers in students, but it was also a case for many teachers:

- *"before creating OER for this platform I would have said that I had no barriers, I was totally open, but it showed up it was not" (T3);*
- *"yes, there was some internal barrier I felt, and it was a good opportunity to overcome it" (T9).*

Student creation of OER as a task for a course resulted in student awareness on OER and openness: it was also new and interesting for students (T4, T6, T8) to work together, create a joint product (T4), they felt modern and trendy, creating new things, important things (T6), to learn the challenges of creating an open work, so they're more aware (T7),

- *"it was useful for them to learn about what is OER, that you need to share" (T4),*
- *"it is a new experience for students, ... more responsibility for them, on what they do, on what kind of works they share" (T8).*

However, there were teachers who stated that they were not sure, if students became really aware, perceived of the challenges you meet when sharing your work openly

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(T9). Some teachers marked the resistance for student OER creation (T7, T9, T15) – some of them did not do the activity or asked for preparing a regular ppt (not open) (T7), some raised questions why they should make their slides open (T15), resuming that it was not what they were used to do (T9).

To sum up, OER creation and integration in curriculum had an impact towards teacher attitude to openness and readiness to share as they felt more obliged to share after intervention, they saw how this impacts their students, and learnt more possibilities to open learning content.

3.2 The impact of OER creation and use from curriculum design perspective

The content analysis of the teacher interviews revealed that integration of OER in the curriculum design process first, impacts the process of the curriculum content creation, as the

> *"same content is provided in a different way"(T15)*

or

> *"when you know that it is OER, you address the topic more broadly" (T14, T2),*
>
> *"you feel the need to explain, reveal more" (T1).*

Some teachers stressed that selection of the topics to be prepared as OER resulted in the revision of course topics (T1, T14, T15) and selection of those that have more potential to be made interesting for the public, and not only for the students (T14). The introduction of OER in the course curriculum also required the integration of OER as one of the course topics (T3, T14, TI15).

Not only the revision of topics was necessary, but also the revision of learning content itself (T2, T5):

> *"you need to think about something new, additional, how to elaborate the topics and make them consistent, not separate" (T2).*

It is an inventory and renewal of the prepared content and selected resources (T9, T13). It also requires more accurate citations (T3, T10, T13) and revision of the selected resource licence (T9), as making an OER you make it public. The revision of course topics may result in the selection of different resources, if the possibility of making the resource results public is not clear (T7, T10). However, there were some teachers who stated that no major changes in curriculum design process is needed for using OER in the courses:

- *"the same planning and content structure" (T4);*
- *"no major changes in the course subject" (T7).*

Second, the integration of OER in the curriculum design process may lead to the new types of assignment or new learning methods. Trying to make use of the openly accessible tool there were some teachers who designed new assignments, such as

> *"created the slides, presented them during the lecture; and at home students… could contribute to the slides by elaboration on the provided ideas" (T6),*

or gave students the assignment of creating the OER in the platform (T9), or encouraged the co-creation of learning content together with the students (T11). However, there were some teachers who did not like the tool, and this resulted in retention of student activities using OER creation tool (T1, T5, T10).

To sum up, there were 6 teachers (out of 15), who planned student OER creation activities or active collaboration using the platform, and 9 teachers, who just created OER using this platform and used them as resource sharing, not asking for more engaging student activities or student OER creation.

3.3 The impact of OER introduction from teaching and learning perspectives

Most of the teachers indicated that the use of OER resulted in no changes in delivery or learning organization regardless of the student active or passive engagement with OER: there was no difference in lecture delivery or assignments (T5, T13), the learning process was similar (T15, T9), the methods used were the same (T10). Teachers, who created OER, but used them only for presentation of learning content, also indicated no change in student-teacher interaction:

- *"there were no major changes in interaction with students" (T3);*
- *"I could not say that I did something differently" (T13).*

However, there were some, who stressed the use of different learning methods, and this raised more questions than there were answers known (T4).

The content analysis of the interviews revealed student open collaboration or the change in student-student interaction after OER integration in curriculum: the students

> *"jointly created the presentation, but it was done not in a way that one prepared one slide, the other prepared another, and then presented, no, they created together, and there was a difference, and in the platform I see that they check each other's slides, they are interested and promote each other's slides with likes" (T9).*

During the interviews, teachers indicated that the use of open tool for OER creation lead to more engaged students:

- *"the tool and how I used it contributed to student engagement in the subject" (T6),*
- *"they became more active" (T12).*

The use of open tool for learning activities had an impact for teachers in understanding the student thinking:

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"the impact for me here was that I saw if, in general, they were interested during the lecture, I could see, what worked and what didn't. I could understand how they thought" (I6).

Furthermore, the change in teacher authority for students was also mentioned:

"I got rid of the students' attitude that I know everything and best" (T12).

The need for more responsibility for work, when it is to be made open, was stressed:

- *"when everyone may evaluate your work, you have a different approach at it" (T8);*
- *"the responsibility is higher, indeed, it acquires a different form, as the work is accessible publicly" (T9).*

As the subjects were delivered in the similar way they were done before (either fully online, either in blended learning mode), no changes in delivery methods, nor student-teacher interaction were recorded. However, OER integration in curriculum and the use of online tools for OER creation might be used for activities to foster student engagement and student open collaboration.

3.4 The impact of OER creation and use from teacher skills perspective

The analysis of periodical surveys revealed that creation of OER had the impact for teacher ICT skills to adopt and use OER in their courses: from only 5 out of 15 teachers stating that they hold the ICT skills necessary to adopt and use OER in their courses before they engaged in creating OER themselves, to 9 after having created OER slides, and to 13 after testing them. The trust in their own competencies to use OER has grown from 3 teachers agreeing that competences they possess help them adopt OER to 12 teachers after OER development and 13 after testing OER with students (see Figure 4).

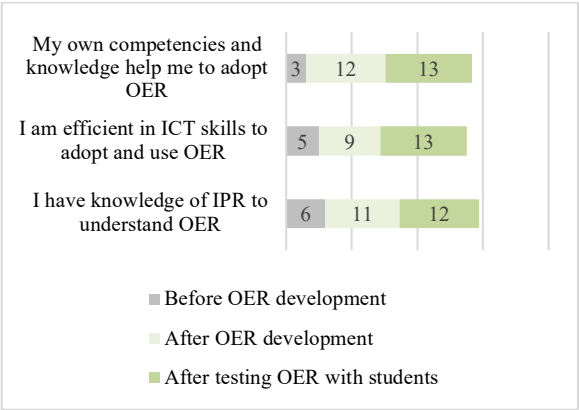

Figure 4 - Change of university teacher skills and competences before and after intervention.

However, the content analysis of teacher interviews has revealed that the dramatic change in the skills for OER development was not because teachers created OER and learnt how to do this, but more because they felt more comfortable in doing this afterwards, i.e. before creating OER teachers thought that more ICT skills are needed than they have, and creating OER and integrating them in the curriculum they have realized that they possess the necessary skills. Teachers only mentioned necessity for trainings on regular computer literacy and specific tool management skills, while creating OER. The content analysis of teacher interviews also stressed that teachers learned more about licencing and better understood what OER are (T4, T5, T15):

"I was more precise while quoting/citing and I noticed more student mistakes in citing" (T3).

The content analysis of interviews from technological perspective revealed the need for coherent instructions and consultations, if a new, specific tool for OER creation is suggested:

"without reading instructions I was not successful, but succeeded after reading them" (T3),

some tool possibilities were not noticed nor used (T10, T8). Nevertheless, teachers stressed the importance of the user-friendly OER sharing platform (T1, T6, T8, T15) and the importance of institutional policy to open. It was noted that the non-user friendly or imperfect tool limited their creativeness (T8) and limited their wish to use it creating OER in the future (T1).

Discussion

The research results revealed that the use of OER may have different impacts on the design of curriculum – it impacts course topics and the content itself, but it has no major impact on content structure and subject itself (minor changes may be found in some cases). The selection of learning methods and assignments depends more on teacher attitude and willingness to make use of the open tools or willingness to change learning methods, rather than the learning content type they use.

Gilliot and colleagues (2013) among dimensions of course openness identify organization of the learning activities, organization of the group work and collaborative coproduction. Sanchez-Gordon and Luján-Mora (2014) indicate the importance of open course content, generated by course participants. Mays (2017) refers to curriculum transformation through OER and a deliberate move from traditional lecture-based teaching to teaching and learning practices, related to activities and open resources, integrating OER, combining summative and formative assessment and different learner support strategies, supported by an institutional culture of openness and critical reflection as well as using wisdom of open and distance learning community.

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The OER intervention in our research revealed that using open platform for lecture slides may lead teachers to change their teaching practice and move from lecture-based teaching, to more engaging learning methods; however, it depends a lot on a teacher – if a teacher does not like the platform or find it difficult to use him/herself, he or she may stay using the open slides and keep the lecture-based teaching. However, there are teachers who like to innovate, and a possibility to open their slides lead them to changing their delivery methods and using more learner engaging activities, where the process of learning moves to an open online learning community, where students also become creators of learning content, and not just information receivers.

Ritchie (2018) notes the changing student and teacher roles, emerging co-creation of learning content, challenges of negotiating learning processes, and reach of more personal learning goals. The teachers from our research reported the possibilities for teachers to understand students learning better and the diminishing teacher authority for students. Knox (2013) mentions 2 scenarios for OER use within a curriculum- as a way of sharing teaching resources or OER as entire educational experience. Both of the suggested scenarios were recorded in our intervention: and although the suggested scenario focused on OER integration in curriculum as an educational experience, an opportunity for teachers to use created OER as sharing of teaching resources was possible, and it depended on the teacher, which of the scenario was more appropriate to them. During and after intervention our teachers shared their teaching activities, used open licenced content, and fostered their learners to do so, which lead that they embedded three out of four (i, ii, and iii) of Nascimbeni and Burgos (2016) indicated open educator activities.

Sanchez-Gordon and Luján-Mora (2014) mentioned the use of open technology and/or platform for course offer as the part of course openness. Our research confirmed the importance of platform and user-friendly technology for the use of open course content. Siemens, Gašević and Dawson (2015) emphasize the importance of rediscovering the practices of effective teaching that work in a new technological environment. Teachers from our research stressed that opening curriculum with open slides provided them the possibility to revise and update their teaching methods leading not only to the practice revision in new technological environment, but also to more engaged students, which were provided with the possibility of participation in an open community of learners and educators. Peter and Deimann (2018) refer more to the change of values of openness than the role of technologies in the process of opening educational resources. However, our research findings revealed that teacher openness to share and engage students in the open education practice depended more on the tool (in)appropriateness rather that the openness itself, as teachers who found the tool to complicated, did not encourage students to create OER using the platform. However, our research findings also stress the importance of openness for higher education and note that technologies create opportunities to foster openness.

There have been many studies (Ritchie, 2018; Wiley, Williams, DeMarte & Hilton, 2016; Wiley, Bliss & McEwan, 2014; Atenas, Havemann & Priego, 2014; Judith & Bull, 2016; Rennie, Jóhannesdóttir & Kristinsdottir, 2011) stressing the challenges for teachers in OER integration in the curriculum. Our research defined the ones, which are more related to OER creation and use while creating: overcoming openness barrier, selection of different resources instead of those which are used in the class (mainly due to the licence limitations), associated with the use of a specific tool or OER sharing platforms, and the student resistance for OER creation or opening of their work.

There also are lots of benefits for educators, learners or institutions that OER bring. Schuwer and Mulder (2009) notes that experimenting with OER results in positive experience and contributes to confidence of OER potential use. Our research confirmed the changed teacher attitude towards OER and potentials of their use in the future. It also expressed a positive shift in attitudes towards the benefits that creating and sharing OER brings to them, their professional growth, identity and reputation, increased networks and sphere of influence, profile amongst peers and others, and chance of recognition at a global level.

Conclusions

To sum up the research findings, the simple intervention – changing the use of teacher created course slides with the OER slides and engaging teachers in creating open content – resulted in teacher deeper understanding of OER leading to see the broader possibilities of its usage, and even change in their pedagogy: some teachers not only created open slides themselves, but also invited students in joint course content creation and learning in open community. Although the intervention did not have the same effect upon all teachers, almost all of them stressed the importance of openness, the feeling of more responsibility while preparing their open slides and better understanding of OER. Thus, the selected intervention increased teacher confidence and responsibility to share and promoted them to become open educators. Teachers not only used open licences and fostered co-creation of knowledge with students during intervention, but openly shared their practices and planned to apply them in other courses.

OER integration had direct impact upon students, especially upon their awareness on OER, and overcoming the barriers towards openness, as well as change in student attitude towards the teacher, and the change in student-student interaction.

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Research also revealed that teachers, who developed OER not only increased their skills of OER development, but more importantly, they realised that they possess skills to create OER.

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A blended learning approach for general chemistry modules using a Moodle platform for first year academic students

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Abstract

Three academic years have been considered for the evaluation of the impact of an online tutoring course of general and inorganic chemistry for freshmen students of the University of Camerino (Italy). The online material mainly consists of video tutorials, other open source web tools and multi-choice self-assessment exercises. During the academic year 2016-2017, the e-Learning course was not available yet, but then the online course was first implemented (2017/18) and fully adopted (2018/2019).The online tutoring support was activated alongside a traditional general chemistry course, adopting a blended mode, with the aims of: (i) homogenizing freshmen's chemistry knowledge; (ii) fostering the most appropriate method of study in a multi access modality; (iii) implementing the Johnstone's three levels' knowledge and (iv) increasing students' self-confidence, by the means of a self-evaluation training process. Differently from previous studies, the online course herein aimed mainly to develop a correct method of study of chemistry topics, with a punctual description of what-and-how to do. The results, i.e. the exam's scores, the time spent in the platform, and the successful percentage of students per year, have been collected and analysed through qualitative and quantitative methods. Apart a general satisfaction of the students perceived by the answers to a survey questionnaire, the analysis of the data shows an increase of 11 % of students passing the final exam within three exam sessions together with an improvement and a positive correlation between the time spent on the platform and the mid-term scores achieved.

KEYWORDS: Moodle, Chemistry Education, Blended Learning, ICT, Tutorial Online

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1. Introduction

The use of information and communication technology (ICT) in Higher education chemistry teaching has expanded rapidly since its first introduction (Dori & Rodrigues, 2013). ICT can support learning processes and facilitate the transition from a teacher-centred instruction towards a flexible student-centred learning process in which students actively build their knowledge using different sources (Brouwer & McDonnell, 2009). Blended learning is a commonly adopted learning approach in higher education, which combines face-to-face teaching with online instruction and feedback. This pedagogical model fosters students to learn in an interactive and collaborative environment, offering flexible time frames that can be personalized to fit individual learning needs (Saltzberg & Polyson,1995). Learning strategies adopting blended learning models were reported and widely discussed even in the context of higher education (Collis, 2003; Garrison & Kanuka,

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2004). Among the wide range of blended learning models reported, the Graham's framework with enhancing blends are the most commonly adopted at university. In this model, technology increases student productivity, extending the amount of information students can learn or increasing the richness of the material (Graham, 2007). Moreover, according to the Resource-Based Learning (RBL) pedagogical approach, materials can be delivered through study packages in a digital, user-centred learning environment (Hill & Hannafin, 2001), helping students to recognize their learning needs, locate suitable resources, assess their progress and manage their learning. A virtual learning environment (VLE), as a Moodle platform, is a software tool that provides a single framework within which students can access a wide range of online resources, allowing staff and students to interact using different communication tools at any time. Different assessment tools, as in example self-test quizzes, provide instant feedback to learners about the knowledge and the skills acquired in face-to-face lectures. Several authors have described the use of VLEs in Chemistry courses in Higher education, often addressed to first year undergraduates, reporting an improvement in student achievement and satisfaction (Vician & Charlesworth, 2003; Lovatt, Finlayson & James, 2007; Williams, Bland and Christie, 2008). On the other side, from the didactics' point of view, in the first approach to the study of chemistry, students deal with difficulties and relative misconceptions due, for example, to the overlying of three different levels (macro, sub-micro and symbolic), according to Johnstone's model (Johnstone, 1982). More specifically, since the mid-1970s, it has been established that most of the resistance to change the misconceptions of the students are due to inadequate or inaccurate mental model at the sub microscopic level (Kleinman, 1987; Lijnse, 1990), even among students who were performing well in formal examinations (Nakhleh & Mitchell, 1993). Molecular animations, video demonstrations and simulations help students to better correlate all three levels of representation, as described by several authors (Williamson & Abraham, 1995; Sanger & Greenbowe, 1997). Russell and colleagues (1997) reported that the use of simultaneous-synchronized macroscopic, microscopic and symbolic representations through a specially designed software provides an improvement of students' conceptual understanding and ability to create dynamic mental models. Velazquez-Marcano (2004) described the successful use of both video demonstrations and molecular animations in the conceptual understanding of three chemical phenomena by the students of the first year chemistry course. The constructivist VisChem Learning design (Tasker & Dalton, 2006) investigated the mental model of the students regarding a substance or reaction at the molecular level before showing animations portraying the phenomenon, enhancing a deeper comprehension of the threefold representation of matter. Task-based video tutorials are another effective way to support students in acquiring fundamental knowledge regarding chemical principles and concepts, optimizing time and resources in chemistry education in universities. Experimental results indicate that online video tutorials are a valuable, flexible and cost-effective tool to improve the ability of the students in chemistry problem solving (Tallmadge & Chitester, 2010; He, Swenson & Lents, 2012; Roggenkämper & Waitz, 2017).

In Italy the development of e-Learning system in Universities has taken place in the absence of significant regulatory action but through independent initiatives for elevating the quality of traditional didactics with the support and integration of different online communication (Baldi et al., 2006; Capogna, 2012). In 2008, the University of Genoa successfully implemented an online support for first year students, undertaking an inorganic chemistry module. Students were required to afford some series of stoichiometry online exercises, supplemented by several face to face tutorials, and to complete a pre-lab online activity incorporating an explanatory video (Cardinale, 2008).

In the University of Camerino, the degree courses in Biology, Biotechnology, Geology and Natural Sciences are attended by international groups of European and non-European students with different backgrounds in terms of university entry points and prior knowledge of chemistry, and for whom English is not their first language. In the first semester of the first year, the course in General and Inorganic Chemistry is organized with lectures in the traditional way and with class sizes of more than a hundred students, making hard to give individualized student attention and timely feedback on formative assessment. A rough analysis of students' performances at the mid-term test and at the final exam of the last ten years (2006-2016) shows that, even though most students pass the exam within one academic year, the scores are low or medium-low for 50-60% of them. These results highlight a superficial knowledge of the Chemistry topics covered and, above all, difficulties in critical thinking and problem solving skills, even more evident in the resolution of stoichiometric problems, as already referred in educational research (Gulacar et al., 2013). Moreover, first year students have incomplete mental models and often represent scientific problems in a superficial way showing problems in understanding and correlating the three levels (Figure 1), described by Johnstone (Johnstone, 1991).

The heterogeneity of the initial levels of students, coming from different education systems and the related widely varying interest and motivation in the subject, combined to a mostly memory based method and a limited attitude to self-evaluation, represent further challenges for lecturers (Zusho, Pintrich & Coppola, 2003).

It becomes clear that for many of current students learning chemistry is a complex and demanding process that requires something extra beyond the material presented in a textbook or lecture.

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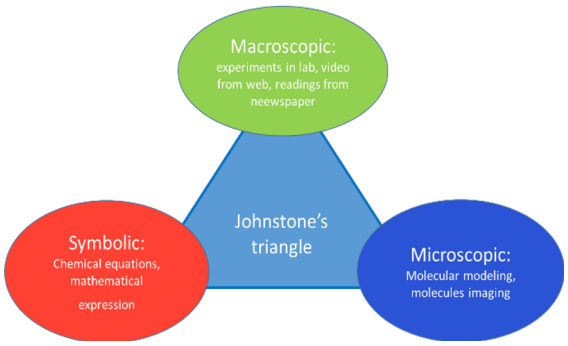

Figure 1 - Schematic representation of the three levels of chemistry and their expression in chemistry taken in consideration in this study.

Therefore, in 2017, we decided to implement a supplemental online tutoring course, in order to fill the background's gaps and to support students in their first weeks of learning path, providing guidance and organization for study in the period afore the mid-term test of stoichiometry. Our general aim was to improve student performance in terms of exam's success, consisting of both grade level and time spent to get the exam. Additional learning targets lie on the development of learning skills such as to interrelate the chemistry levels of learning, to accelerate the adoption of a proper method of study, to develop sensitivity to a self-evaluation process. For this purpose, we have chosen a blended learning approach, in which e-Learning is integrated into the teaching, the learning, the assessment and a real-time feedback of the topics, beyond to a face-to-face teaching which is still retained. Based on the previous experiences of the use of the Moodle platform in the teaching-learning process of Chemistry described in literature (Lovatt, Finlayson & James, 2007; Benedict & Pence, 2012; Milner-Bolotin, 2012; Lau González et al., 2014), we integrated them in an innovative way, designing a course in a virtual learning environment that not only delivered the needed inorganic chemistry and stoichiometry contents for the mid-term test, but that aimed to: (i) illustrate the method for solving the stoichiometry exercises through video tutorials and with the help of an "Overview" section, which details the step-by-step procedure showed in the video tutorial; (ii) show representations of the Johnstone's three levels involved in the chemical phenomena related to each stoichiometric exercise, through videos of aboratory experiments (macro level) and computer animations (sub microscopic level).

Since the 2017/18 Academic Year, the online tutoring course was structured in seven modules, designed, prepared, uploaded, and delivered in the Moodle platform of the University of Camerino. First year students of Natural Sciences, Earth Sciences, Biology and Biotechnology in two different academic years (2017/2018 and 2018/2019) have practised the modules as a preparation for the mid-term stoichiometry test. The course provides two mid-term exam on stoichiometry and a final exam on the general chemistry themes.

In this paper the platform's design and the results of these two years are discussed to evaluate the impact of the VLE in terms of exam success and the degree of students' satisfaction with the blended learning approach.

The evaluation of students' usage of the online tutoring course has been examined through the following research questions:

a. Will students use the online resources available through Moodle and, if so, how they use them?
b. Do students who access the online material have a better general performance and in the mid-term evaluation test?
c. How do students perceive the effect of online resources on their examination performance and chemical concepts' understanding?
d. What are students' opinion regarding online tutoring?

To obtain answers to these research questions, a blended teaching model has been planned and adopted. The didactics model was structured with classical frontal lessons delivered together tutoring materials (Figure 2). These latter indicate step by step how to face up the chemical reactions study correlating the three levels of chemistry, approaching the problem solving and the issue of the self-assessments. The mid-term results were extrapolated from the platform and examined on comparison with those obtained when the platform was not adopted yet. Moreover, the outputs of the final exams of the different academic years together to the answers to a survey questionnaire uploaded in the Moodle platform were analysed. The results are herein shown and discussed.

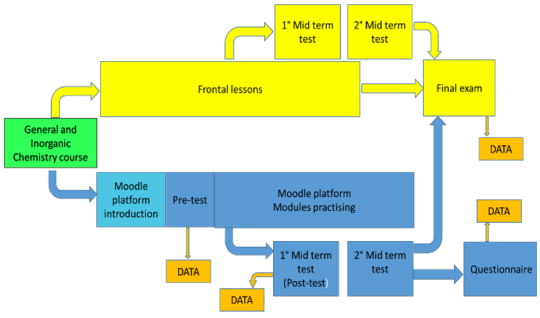

Figure 2 - Sketch of a horizontal structure of the course in the academic years taken in consideration in this study along the academic year. In yellow the learning's structure of academic year 2016/2017 and in blue that for the academic years 2017/2018 and 2018/2019. The orange arrows detail the didactics' step producing the data for the herein discussion.

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2. Materials and methods

The online tutoring course design has been preceded by an accurate identification of the first part course's topics and related stoichiometric problems that students found more difficult and/or for which poorer performances in the final exam were recorded. Within the course, seven study packs or modules are included, each one addressing one of the detected issues. Our goal was to promote deeper conceptual understanding by prompting students to connect quantitative calculations to chemical processes at the microscopic level (e.g., the level of atoms and molecules) and to outcome at the macroscopic level (e.g., final concentrations, colour, temperature) (Johnstone, 1997). The VLE used in this study is a Moodle, a web based Course Management System, that it is an open source software that can be freely downloaded from the web and allows the educator to develop a course with multiple functions, including file hosting, quizzes, assignments, chats, discussion forums, glossaries and questionnaires.
Our course includes the following sections:

1. An initial test of 30 multiple choice items, checking students' General and inorganic Chemistry basic knowledge;
2. Three Forums for student-teacher interaction: a "News Forum" for general notices, a "Technical Forum" for technical problems and an "Interaction Forum with the course tutor and the professor2, for more detailed explanations and scaffolding;
3. A "Prerequisites" section with some preparatory materials (significant figures, units of measure, etc);
4. Seven Modules, organized as described below, inserted simultaneously at the opening of the VLE;
5. A mid-term evaluation test of 24 multiple choice items, in six different equivalent versions, administered to all enrolled students;
6. A survey questionnaire, consisting of 43 questions aiming to acquire variables of interest to the study and to test students' perception and satisfaction.

All course materials are delivered in English. The initial and the mid-term test were performed by students in the classroom, with mobile devices (mobile, tablet, laptop).

2.1 Structure of the Modules

The seven modules were designed to allow students to rapidly interconnect the three levels of representation in Chemistry (macroscopic, sub microscopic and symbolic). After the title of the task, the macroscopic level is being introduced using short videoclips of the experiment related to the assignment. The sub microscopic level of the phenomena is being visualized via computer animations, found in Chemistry didactics' websites. To understand the symbolic level, a video tutorial guides the students, step-by-step, in solving the stoichiometry exercises, related to the investigated chemical phenomena.

Video tutorials are based on voice and handwriting, simulating teacher's exposition and addressing students with different backgrounds of knowledge and problem solving skills. Handwriting is accomplished by using a Wacom tablet. The videos have an average duration of 15 minutes and the file size is from 100 to 150 MB. In the video tutorials, detailed step-by-step explanations show the solution of the assigned problems or exercises, along with the principles and formulas of the symbolic level needed for the specific task. Key information about the followed method of analysis and solution, as well as theoretical references, are included in the videos, with the aim to make the student able to apply the method to similar cases, once mastered the required skills.
Within each module other sections have been added to complete the learning path:

- A "Background knowledge" section, which lists the knowledge and skills required to afford the study of the module, so that students can check and fill their gaps;
- An "Overview" section, which details the steps needed to solve the stoichiometric exercise illustrated in the video tutorial;
- An "Other material to support learning" section, in which more learning support materials (interactive guides, tutorials, tables, etc.) are added;
- A "Multiple choice exercises" section, with a multiple choice test of 10 randomly-selected questions on the topics of the module, to allow students' self-assessment.

2.2 Participants

In the first edition of the course (A.Y. 2017/18), 185 students of both degree courses (140 students of Biology and Biotechnology and 45 students of Geology and Natural Sciences) were enrolled on the platform and its use was highly encouraged, even not mandatory. In the second edition of the course (A.Y. 2018/19) 155 students of both degree courses (118 students of Biology and Biotechnology and 37 students of Geology and Natural Sciences) were enrolled on the platform. However, the data were analysed without distinguishing the frequency course. The percentage of enrolled females (2017/2018, 61.08%; 2018/2019, 57.42%) on the total number of students was higher than the males (2017/2018, 38.92%; 2018/2019, 42.58%) in both editions, but decreased from one edition to another, while that of males increased (+3.66%). Regarding their nationality, most of the students enrolled in the two degree courses were Italian in both editions (2017/2018, 62.70%; 2018/2019, 72.26%), followed by Non-European countries' students (2017/2018, 31.35%; 2018/2019 20.65%) and Other European's countries students (2017/2018, 5.95 %; 2018/2019, 7.10 %). The statistical analysis of the students' mid-term test evaluations also examined the results of the students enrolled in the 2016/17 academic year when the VLE

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Academic Year	Number of students	% M	% F	% Italian students	% European students	% Non-European students
2016-2017	186	54.06	45.94	60.5	4.37	35,13
2017-2018	185	38.92	61.08	62.70	5.95	31.35
2018-2019	155	42.58	57.42	72.26	7.10	20.65

Table 1 - Demographic characteristics of students enrolled in A.Y. 2016/17, 2017/18, 2018/2019.

was not yet present. The main characteristics of the students enrolled in the three academic years examined are described in the table below (Table 1).

2.3 Collection and Data Analysis methodology

The results of the study are based on the data extracted from the Moodle platform. The statistical analysis of the mid-term evaluation test administered to the students and the analysis of the results of a questionnaire on the students' subjective perception of the VLE learning activity, are all related to the second edition of the course (A. Y. 2018/19). As a matter of fact, the A.Y. 2017/18 edition was a pilot study whose results (Schettini et al., 2018) improved the next full scale implementation.
Specifically, we analysed:

(i) the students' pattern of usage of the platform, numbering the logging hits of the VLE different sections and of each section of the module;
(ii) the improvement of the results in the mid-term evaluation test for the students who used the e-Learning course (A.Y. 2018/2019);
(iii) The percentage of the students who passed the exam in the first three sessions during the three A.Y. 2016/2017; 2017/2018; 2018/2019;
(iv) The data collected through an online questionnaire on the students' experience and perception about the blended learning activity, proposed to the students at the end of the online activities.

As for (i), we also compared the number of accesses of the second edition with those of the pilot one, even relative to gender and nationality. We have analysed the learning analytics extracted from the Moodle platform after the practising of the course by the students and organized them in tables that represent the number of log to different resources and activities, in order to obtain the level of interaction that students have with each them. As for (ii), we compared the mid-term exam's results obtained from the students of the A.Y. 2018/2019, who had available the tutorial course on the Moodle platform, with the results obtained from the students of the A.Y. 2016/2017 that have not available the e-Learning course. To do that we compared the results of the two academic years by submitting them to the statistical analysis of ANOVA (Kozielska, 2004) and then, to the analysis test of Snedecor-Fisher, where the values of F-crit can demonstrate if exist a significant difference between the analyzed samples of students. As for (iii), we have considered for the three academic year under analysis the percentage of students passing the final exam within the first three exam sessions, comparing and discussing in both qualitative and quantitative way the obtained results. As for (iv), the questionnaire consisted of 43 questions and was divided into 4 sections: (a) Personal data; (b) Behaviours; (c) Intentions/Preferences/Opinions; (d) Open questions, comments. The first section (a) collects basic demographic information (age, gender, country of origin, degree course) and data regarding digital and English language skills. The second section (b) contains five questions to elicit qualitative data on students' previous e-Learning experience and mode of use of the current VLE. The third section (c) consists of 19 Likert-type statements and one closed question, regarding students' satisfaction and perception of the online course advantages and any difficulty related to materials' comprehension and usage. Finally, in the fourth section (d) we have asked to the students to give their general opinion on the platform through five open questions, while the last eight Likert-type statements investigate the preferred class modality of the students, and how the students use personal devices and social networks in the preparation for the exams. Only 50% of the active students of the A.Y. 2018/2019 answered the questionnaire (66 students). In this work we will discuss the results of the questionnaire about section (c).

3. Results and discussion

Do students use the online resources available through Moodle and, if so, how they used them?
In general, during the fully implemented Moodle platform year, that is 2018/2019, students used the platform in preparation for the mid-term test, but even more between it and the final examination (230% increase in the number of log hits after the mid-term test date). 52.90% of the students enrolled took the mid-term test (82 out of 155) and all were active students, constituting 62.12% (82 out of 132). The fact that 100% of active students took the mid-term test can mean either that the platform made them more self-confident or indeed that, being the most motivated and conscientious,

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they would still have addressed it, even without the online resources. In detail, in the first edition of the course, 110 students logged in to Moodle platform and accessed to its resources (hereinafter referred to as active students), whereas they were 132 in the second edition. Comparing the two editions, the number of active students on the platform increased (+25.70%), even if there was a decrease in the number of students enrolled (-16.22%). The percentage of active females (2017/2018, 57.27%; 2018/2019, 55.30%) on the total number of active students was slightly higher than the males (2017/2018, 42.73 %; 2018/2019, 44.70%) in the two editions and slightly decreased from one edition to another, while there was a small increase in the males' percentage (+1,97%). On the other hand, the percentage of active males in the total of males (2017/2018, 65.28%; 2018/2019, 89.39 %) was definitely greater than the percentage of active females versus the total of females (2017/2018, 55.72%; 2018/2019, 82.02%), and both increased from one edition to another (Males, +24.11%; Females, +26.27%), with greater participation of females who became more active in the second edition. In 2018 and in 2019 Italian students represented the largest proportion of active students (2017/2018, 62.70%; 2018/2019, 72.26%), compared to active students' total extent, followed by Non-European countries' students (2017/2018, 31.35 %; 2018/2019, 20.65%) and Other European countries' students (2017/2018, 5.95%; 2018/2019, 7.10%). On the other hand, in 2017/2018 the most active students on the platform, compared to same nationality students' total number, were other EU countries students (72.73%), followed by Italians (64.66%) and those coming from non-EU countries (46.55%). In 2018/2019, the most active students on the platform, compared to same nationality's total number, were still other EU countries' students (90.91%, with an increase of 18.18%), now followed by Non-European countries students (87.50%, with a significant increase of 40.95%) and by Italian students (83.93% with an increase of 19.27%).

3.1 Patterns of usage of the Moodle platform

In this study, we analysed only the data of the second edition of the online course (2018/2019). An indication of overall usage can be obtained from the log of hits, demonstrating the general level of interaction students had with each resource (Table 2), even if it is possible that a student can access to the same resource several times.

The ranking of the modules with the highest number of accesses reflects the order in which these are placed into the platform, except for Module 7. The fact that the latter modules have been less visited may be due to the insufficient time students had available for their study before the exam so, following the list, they failed to complete all the modules. Moreover, students didn't use the forums at all, preferring the traditional explanation face-to-face in the classroom.

Resources	Hits
Forum news	0
Technical forum	0
Forum for interaction	0
Module 1-Net Ionic Equation for an Acid-Base Reaction	1709
Module 2-Mass Relation in Chemical Reaction	1164
Module 3-Oxidation-Reduction Reaction	1001
Module 4-Writing the Equation for a Precipitation Reaction	879
Module 5-A reaction with a limiting reactant	746
Module 7-Recognizing the Common Types of Reactions	720
Module 6- Theoretical and Percentation Yield	678
Prerequisites	182

Table 2 - Total Moodle resource hits.

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Sections	Hits
Multiple choice exercises	5453
Other materials to support learning	632
Videotutorial	282
Background knowledge	200
Overview	151
Video experiment	101
Submicroscopic view	78

Table 3 - Total Module's sections hits.

Table 3 shows which modules' sections were the most accessed in total. "Multiple choice exercises" had the most number of hits, followed by "Other materials to support learning" and "Video tutorial". As shown in Table 3 "Module's sections hits", this ranking is the same within each module, as well as the number of students who accessed the single sections. The exercises were delivered on the platform at the same time as the other resources and for each of them students had an unlimited number of attempts. They were not used for formal assessment and students received solutions only after submitting their answers. Students' preference for multiple choice exercises revealed the need to assess their knowledge and to receive an immediate feedback that facilitates the understanding and learning process. Furthermore, the possibility of receiving systematic feedback gave the students the ability to complete their preparation before facing both the mid-term test and the final exam. Indeed, as these self-assessment activities are aimed to provide students information on the knowledge acquired, other authors have emphasized the use of self-assessment resources allowing the reorganization of students' self-learning strategy (Bell & Volckmann, 2007; Lovatt, 2007; Kennepohl & Guay, 2010; Lau Gonzalez et al., 2014).

Do students who access the online material have a better general performance and result in the mid-term evaluation test?

Combining a qualitative and a quantitative analysis on the data set, we observed a substantial difference in the skills acquired by students, with a clear improvement of the scores of the students when, during the second year considered (2018-19), the blended methodology has been adopted. In order to visualize the difference in scores among the two academic years, we clusterized the data in such a way to form four ranges of scores obtained by the students: 1-10 (strongly insufficient); 11-17 (insufficient); 18-23 (sufficient-good); 24-30 (very good-excellent). Comparing the two bar plots of Figure 3, we are able to conclude that the blended methodology was almost ineffective with the first and the second group of students having low (strongly insufficient) or very low scores (insufficient), except for few cases of improvements in the score from insufficient to sufficient, while there is a clear shift of a sizable number of students from the third group (sufficient-good) to the fourth group of top performing students (very good-excellent). Hence, empowering the classical teaching with online resources (the blended method) is not enough to solve the large ensemble of problems for the very outperforming students, in some way an expected result, while there is a very positive effect of the blended approach in the case of students who knows how to orient them self in the study of a discipline.

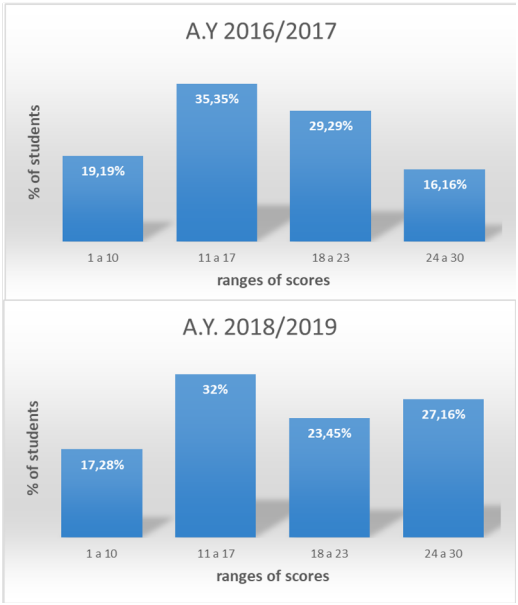

Figure 3 - The difference in scores among the two academic years 2016/2017 and 2018/2019.

The students need to have a minimal set of instruments and knowledge to benefit from a more reach teaching and learning approach. This qualitative picture coming out from a visual data analysis is then confirmed by a more rigorous statistical approach, as follows. In Table 4a and in Table 4b we reported the data obtained by applying the statistical method of Anova. The Anova is based on the Analysis of variance, a method of

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ONE FACTOR ANOVA SUMMARY

Groups	Number of students	SUM of normalized score	MEAN of normalized score	Variance
2018-2019	81	54.4250	0.6719	0.0332
2016-2017	99	55.7833	0.5634	0.0494

Table 4a - Number of students for each academic year, sum of the normalized score (0-1), average of the normalized score and variance.

ONE FACTOR ANOVA ANALYSIS

Origin of the Variations	SQ	DoF	MQ	F	Significance value	F crit
Between groups	0.5239	1	0.5239	**12.4345**	**0.0005**	**3.8942**
Within groups	7.5000	178	0.0421			
TOTAL	**8.02**	**179**				

Table 4b - Statistical test of Snedecor-Fisher: the values of F and F-crit (in bold) of the academic years 2016-2017 and 2018-2019 show that the differences in the averages of the scores acquired by the students in the two examined academic years are considerable from a statistical point of view.

inferential statistics which allows to compare two or more groups of data set by considering the variance of the data within each group and comparing it with the variance of the other groups. In this work, the Anova is applied to the mid-term scores of the students of the two academic years 2016-17 and 2018-19, that are the academic years in which the two methodologies (classic and blended) were performed in their complete form. In the statistical test of Snedecor-Fisher, which is a standard hypothesis test to compare in a quantitative way the variance of two data set, the values of F and F-crit of the academic years 2016-2017 and 2018-2019 show that the differences in the averages of the scores acquired by the students in the two examined academic years are substantial from a statistical point of view.

Which is the percentage of the students who passed the exam in the first three sessions?

Regarding students' performances at the final exam of general and inorganic chemistry, the percentage of first year students passing the exam within the first three sessions of exams in the three academic years taken in consideration was analysed. If we compare the data, we can observe that in the 2016/2017 A.Y., the percentage of students passing the exam was as low as 19%. Thanks to the additional support to help students in their study organization and to give further explication of the basic knowledge needed, this percentage was then increased in 2017-2018 A.Y, where the percentage of students passing the exam was 31%, while in 2018-2019 A.Y. the percentage was 30%, very similar to the previous year, showing a net increase of 11 % (Figure 4).

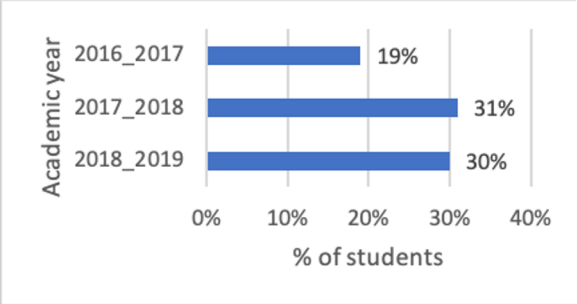

Figure 4 - Percentage of first year students passing the final exam of general and inorganic chemistry, within the first available three sessions of exams, in the three A.Y. taken in consideration.

How do students perceive the effect of online resources on their examination performance and chemical concepts' understanding?

In this section we report the results of the data extracted from the questionnaire proposed to the students of the A.Y. 2018/2019, the period during wich the online tutorial course was completely adopted. The 50% of the active students in the Moodle platform answered to the questionnaire (66 students).

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Students' perception and satisfaction

Students were asked to report on their perception of usefulness of the platform as a whole and of the different module's sections and results are showed in Table 5 (legend: SDA = strongly disagree; DA = disagree; NAND = neither agree nor disagree; A = agree; SA = strongly agree).

Most of the students considered useful for the mid-term test the platform as a whole (A + SA = 53.03%), also for the topics' deeper awareness (A + SA = 48.49%; NAND = 39.39%), according with other studies' results on Chemistry blended learning courses (Lovatt, Finlayson and James, 2007; Tekane, Pilcher and Potgieter, 2019).

The ranking of the perceived usefulness of the different modules' sections (A + SA: Multiple choice exercises 74.25%; Overview 69.69%; Video tutorials 56.06%; Other materials 51.52%; Videos of the experiment 37.88%; Sub microscopic views 22.73%) almost reflected the log hits' ranking (Table 3).

It is noticeable that students reported greater difficulties in understanding the sub microscopic level (SDA + DA = 22.73%), compared to video tutorials (SDA + DA = 10.61%) and videos of experiments (SDA + DA = 7.55%). This could explain the lower number of accesses and the lower perceived usefulness, possibly due to a lack of familiarity with this type of representation of chemical phenomena, with respect to the macro and symbolic level. Being first year and first-semester students, simultaneous shift between the three levels of chemistry represents a long-term educational goal, rather difficult to achieve in just over a month of study without an adequate background. Regarding the accessibility of materials, students mostly considered adequate their previous knowledge to understand the material (A + SA: 46.97%; NAND 25.76%; SDA + DA: 27.28%) and also to respond to the initial test (A + SA: 45.45%; NAND 31.82%; SDA + DA: 22.73%) and to the choice exercises (A + SA 53.03; NAND 25.76%; SDA + DA 21.22%).

Questions	SDA	DA	NA ND	A	SA
The platform has been useful for the test	0.00	9.09	37.88	30.30	22.73
The videos have been useful for the test	4.55	16.67	40.91	27.27	10.61
The submicroscopic views have been useful for the test	10.61	16.67	50.00	12.12	10.61
The overview of the resolution steps of the exercise has been useful for the test	0.00	6.06	24.24	27.27	42.42
The video tutorials have been useful for the test	1.52	13.64	28.79	21.21	34.85
The multiple choice exercises have been useful for the test	1.52	4.55	19.70	22.73	51.52
Other materials have been useful for the test	3.03	6.06	39.39	31.82	19.70
The platform has been useful for topics' deeper awareness	1.52	10.61	39.39	31.82	16.67
I had no difficulty in understanding videos	3.03	4.55	36.36	30.30	25.76
I had no difficulty in understanding the submicroscopic level	3.03	19.70	36.36	25.76	15.15
I had no difficulty in understanding video tutorials	3.03	7.58	31.82	28.79	28.79
My previous knowledge was adequate to understand platform materials	7.58	19.70	25.76	31.82	15.15
My previous knowledge was adequate to address the initial test	4.55	18.18	31.82	30.30	15.15
My preparation was adequate to address the multiple choice exercises	4.55	16.67	25.76	37.88	15.15
The difficulty of the final test was comparable to the level of the multiple choice exercises	4.55	9.09	30.30	43.94	12.12

Table 5. Students' perceptions on the usefulness and difficulty of the platform.

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Questions	SDA	DA	NA ND	A	SA
Online tutoring can replace traditional lectures	30,30	25,76	24,24	12,12	7,58
Online tutoring helps me better understand course materials	3,03	13,64	31,82	36,36	15,15
Online tutoring helps me better understand course requirements	0,00	12,12	30,30	39,39	18,18
I hope more course modules available on the platform	3,03	1,52	24,24	27,27	43,94
I hope more online tutoring courses available	1,52	3,03	30,30	28,79	36,36

Table 6. Student's perception on this online tutoring facility.
legend: SDA = strongly disagree; DA = disagree; NA/ND = neither agree nor disagree; A = agree; SA = strongly agree.

Finally, most of the students reported the same level of difficulty in the mid-term test and in multiple choice exercises (SA + A 56.06%), confirming their validity for an adequate preparation. As a matter of fact, the mid-term test was designed according to the structure of the modules and considering the three Johnstone's levels.

The overall difficulty of the mid-term test was weighted with tests administered in the past.

Five statements in the questionnaire explored the students' perceptions about online tutoring and their suggestions for future improvement. The results are shown in percentage in Table 6. Although the majority of students (SDA + DA = 56.06%) believed that online tutoring could not replace traditional lectures, most of them considered it useful for understanding both the course materials (A + SA = 51.51 %) that knowledge and skills' requirements (A + SA = 58.17%). With a high percentage (A + SA = 71.21%), students agreed with the need of more online modules covering the other topics of the course and, in general, with a higher number of online tutoring courses (A + SA = 65.15%). These first results underline as the students' perception on platform's use was absolutely the expected one (Vishnumolakala et al., 2017; Abrahim et al., 2019; Stowe, 2019).

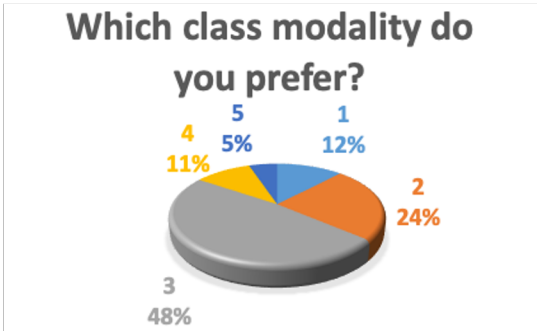

Figure 5 - Students' opinions on the didactics experience and their preferences. The number relative to the entries represent: 1 (pale blue): entirely face-to-face, 2 (red): minimal use of the web, mostly held in face-to-face format, 3 (grey): an equal mix of face-to-face and web content, 4 (orange): extensive use of the web, but still some face-to-face class time, 5 (dark blue): entirely online with no face-to-face time.

Freshmen students feel the need to be guided for very first approach to study chemistry, for their knowledge gap filling and to individuate a method of study to have success in chemistry exam. Furthermore, when asked about the preferred class modality mostly they chose frontal lessons blended with equal or minimal use of online facilities (Figure 5).

In detail, 48 % of students opted for a blended learning with equal distribution of online content and face-to-face lessons, while only 12 % indicated entirely face to face modality as the preferred one and 5 % would like only online contents.

4. Conclusions

The first year students in an academic course are obviously very different from each other with heterogeneous backgrounds both from a cultural and a scientific point of view. Generally, this is expressed with a plurality of approaches to the learning and difficulties in organizing the study. Moreover, in the first semester of the first year, students are distracted by many stimuli often concerning adaptation to a new lifestyle as well as to the reconstruction of a new social life. Furthermore, data extrapolated from input tests (pre-test) performed by freshmen on the basic knowledge in chemistry reveal a variable percentage of students who do not reach the minimum knowledge about chemistry and therefore they have the so-called additional educational objectives (OFA). For a teacher of the first semester of the first year the need to teach a proper approach to the study, for example, the use of modelling, the need to introduce a specific language, the implementation of problem solving, becomes therefore a priority.

Hence, any resource that remains available to students and that can be enjoyed at any free moment, becomes an opportunity to stimulate and motivate the study of needy students.

The preparation of tools and materials on virtual learning environment, as discussed in this work, responds to the aforementioned needs by providing tutorial support to all students regardless of their incoming situation, bringing in them a perception of utility and satisfaction although shared with the attribution of a fundamental value to the frontal lectures

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in teaching. However, from the data of this study, we can see some salient aspects.

For example, students like to study online, even though not exclusively, but, surely the most intriguing aspect for them is the possibility of having multiple access to a quick self-assessment. This leads us to think that freshmen may approach the first study quickly, perhaps roughly, to then study what they failed to answer in the self-assessment, but they correct their style upon practising the tutorials to get success in the mid-term exam. However, after passing the mid-term exam and having spent extra time following the tutorials, there is a certain loyalty to the subject so that a smaller percentage of students leave the chemistry course to devote themselves to something else. This is highlighted by the higher percentage of students (+11%) who pass the final exam in the first exam sessions once they have practiced the platform. Moreover, the statistical treatment of the exam score reveals as the students of the three years are significantly different in terms of outcomes. The positive correlation between the time spent on the platform and the outcome of the exam reveals how there is still a positive correlation between the use of the platform and the overall outcome in terms of score.

On conclusion of this work, we can assess that the Moodle platform facility is a useful device because makes available materials without any limit of time, leaving freshmen to consult it in a customizable fashion. Moreover, the teacher has ready feedbacks about the commitment, the perceive and the self-assessment outcomes of the students. In this work we implemented a Moodle platform with tutoring modules covering only initial topics, making easier for first year chemistry students, to get in a rigorous method of study to achieve a win-win output.

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A framework for assessing LMSs e-courses content type compatibility with learning styles dimensions

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Abstract

During the past few decades, it seems that personalizing and adjusting the e-courses' content based on individual learning styles is rather important. Indeed, several studies have been carried out throughout the years regarding the a priori personalization and adjustment of e-courses systems. This way modern LMSs (Learning Management Systems) could identify beforehand the learning styles of the e-course attendants and adjust the lesson content flow and type based on personal learning styles. Nevertheless, little bibliography exists on how to assess the compatibility level between educational content and learning styles dimensions of an LMS, in a real-life environment. With the above thoughts in mind, the current work attempts to introduce and verify an innovative framework for the students' learning styles and e-courses compatibility assessment, based on the content type and volume. The proposed framework is validated through its application at an LMS in a real-life academic environment. Such an approach could be very beneficial for already deployed e-courses on LMSs that aim to differentiate educational content provision based on users' profiles.

KEYWORDS: LMS, E-course, Learning Style, FSLS, Moodle

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1. Introduction

Since the 1970s, the individualisation of learning and teaching methods based on students' diverse learning styles or capabilities has drawn great attention (Coffield et al., 2004; DeJesus et al., 2004). According to Keefe (1988 cited in DeJesus et al., 2004), *learning styles are affective, cognitive and physiologic behaviours, which serve as relatively stable indicators of how students understand, interact and reply to the learning environment*. In practice, the research community developed several models that aim to categorise individuals according to their learning styles (Cassidy, 2004; Graf et al., 2007).

Although each model introduced different ways to show how learning styles can be defined and categorised, all of them conclude that each person follows a different learning approach (Willingham et al., 2015). It seems that the most widespread and easy to implement model is the Felder-Silverman Learning Style (Truong, 2016; Kumar et al., 2017).

Consequently, when it comes to students, it is apparent that their performance and achievement is directly related to the way they react to a learning situation (Cassidy, 2004). Hence, getting information about the students' learning styles is an essential prerequisite for an educational programme's adaptation to serve diverse individual needs. Several studies over the years have revealed that when adaptive tutoring systems, based on individual learning styles are employed (e.g. students with high preference for content with visual characteristics are benefited when they have access to video-based educational material), the students grow more productive, the learning curve and time involved to learn is more efficient and the academic achievements of the learner are improved (Kumar et al., 2017; Yang et al., 2013; Tseng et al., 2008; Adetunji & Ademola, 2014).

Additionally, the advancement of the Internet has allowed educators to embrace LMSs as an alternative teaching tool, available to the students synchronously or asynchronously. Admittedly, most of the universities, nowadays, provide their students with

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access to e-courses to support their educational processes. Amidst other functions, modern LMSs offer the ability to diversify the educational material per student, for the same e-course, with reference to personal learning styles. In addition, LMSs could offer personalised access to different types of learning activities and educational content, for the same topic, overcoming the limitations of traditional teaching. This way students benefit from engaging in a variety of learning activities and not just those targeted toward their learning styles (Hattie & Yates, 2014). With this in mind, some researchers have employed Moodle platforms and other LMSs to provide personalised learning courses content (or learning objects) for their students (Graf and Kinshuk, 2007; Despotović-Zrakić et al., 2012; Limongelli, Sciarrone and Vaste, 2011). Even the most advanced educational platforms, such as Massive Open Online Courses (MOOCs), focus on the creation of adaptive learning courses (Onah & Sinclair, 2015; Sein-Echaluce et al., 2017) that can support attendees' varying learning styles and needs.

Although several research studies have been done in previous years regarding the a priori personalisation and adjustment of e-courses systems based on the learners' learning styles, limited bibliography exists on how to assess the compatibility level between the educational content and learning styles dimensions of an LMS in a real-life environment. The LMSs content, meaning educational material format (e.g. video, audio, text etc.) and students learning styles compatibility evaluation should be an indispensable part of an academic department performance evaluation, as well as a tool for improving the teaching quality level.

Based on the aforementioned elements, the current work attempts to introduce and verify an innovative framework for the students' learning styles and e-courses compatibility assessment, based on the content type and volume that the latter provide to the students. The proposed framework is validated through its application at the LMS and the students of the Department of Archival, Library and Information Science at the University of West Attica. Such an evaluation process as the one proposed could also prove to be very beneficial as part of the content adaptation and validation process in modern LMSs, in the form of a stand-alone component or add-on.

2. Related work

Over the past decades, various studies regarding the identification of student learning styles for the creation of adaptive learning systems have been done. These studies can be categorized as theoretical and practical. The first category (theoretical studies) aimed mainly to introduce learning models and tools for the identification of individual learning styles. The practical studies concentrated their focus on designing and building adaptive learning systems to facilitate the learning process, based on individual learning styles. Our work is a practical study focusing on evaluating the compatibility of already existing LMSs content in relation to individual learning styles. It is remarkable that the review of all the practical studies carried out reveals that the most common approach for the identification of learning style is the use of the Felder-Silverman Learning Style Model - FSLSM (Silverman & Silverman,1988; Özyurt & Özyurt, 2015).

To start with, Cha et al. (2006) proposed a methodology to identify the learning style of the individual based on the FSLSM with the employment of an intelligent learning environment. The learning styles are identified through the interaction with the system and the intelligent learning environment customises the interfaces accordingly (e.g. text vs pictorial navigation buttons to the content). In a similar approach, Garcia et al. (2007) employed Bayesian networks (BN) precision to detect student learning styles. More specifically, they employed a BN where the input is the student's interactions with the web-based educational system. The BN results were evaluated through the comparison with the results of a corresponding questionnaire. The results were promising, but some mismatches occurred due to the fact that some students were not familiar enough with the system. Finally, Yang, Hwang and Yang (2013) developed an adaptive learning system by considering not only learning styles, but also cognitive styles. The evaluation showed that their adaptive learning system could improve the learning achievements of the students. Finally, Labib, Canós & Penades (2017) decided to adopt an ontology, based on the creation of interconnections between the different learning style model dimensions (such as Kolb and Felder-Silverman models) and learning styles with the relevant learner's characteristics. Their aim was to cover the heterogeneity that exists in different learning style model dimensions and to handle customization effectively.

The following three research efforts focus on implementing e-learning systems that diversify e-course content based on students' learning styles. More specifically, Radenkovic et al. (2009), Klašnja-Milićević et al. (2011) and Ocepek et al. (2013) distributed questionnaires in order to classify learners in specific learning styles, employing the FSLSM framework. Based on the results of the questionnaires, the authors proposed adaptive e-learning systems corresponding to the preferred learning style of each individual and the preferred types of multimedia materials.

On the contrary, Adetunji and Ademola (2014) propose an Automatic Adaptive E-Learning System (AAELS)

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that adapts to e-course participants' learning styles automatically. The system does not require the user/learner to perform any preliminary activity before it gets information about their adaptive needs; the system does this automatically when a user/learner navigates their way through the e-learning platform.

Finally, two recent studies show that the identification of the students' learning style is still in use in some disciplines and plays a crucial role at the educational environment. More specifically, Crockett et al. (2017) proposed a method for the prediction of learning style in conversational intelligent tutoring systems with the employment of fuzzy decision trees. The results showed that their approach augmented the prediction of the individual's learning style. In another study, McKenna et al. (2018) tried to identify the learning style of the post-graduate pre-registration nursing students using a very "traditional" research approach based on questionnaires.

The following works focus on Moodle as an LMS in order to provide to students e-courses content based on their individual learning style. More specifically, Graf and Kinshuk (2007) and Limongelli et al. (2011) proposed add-ons to Moodle that provide adaptation capabilities. They both identified the learning styles based on the FSLSM. The results proved that teaching is more effective and learning results are better when e-courses' content is fitted to the students' learning styles (e.g. adaptation features related to differentiation on content type / volume and/or content sequence).

Next, via a more generalised approach, Despotovi-Zraki et al. (2012) conducted a survey where they aimed to measure if the adapted e-courses can benefit the students. The described e-course adaptation method utilises data mining techniques to classify students into clusters with regards to FSLSM and activities in Moodle. Research results proved that teaching resources and activities adapted to learning styles led to significant improvement in learning results.

The following research works have a different approach in identifying the learning style of the individuals. Specifically, they do not use the "traditional" questionnaires proposed by many authors but they try to find the learning style by the employment of other activities. In particular, the studies focus on other activities, such as video-based multimedia material (Chen & Sun, 2012), literature-based methods (Ahmad et al., 2013), game-based problem-solving activities (Hung, Chang & Lin, 2016) and computational intelligence algorithms (Bernard et al., 2017). They all pinpoint the importance of the discovery of the individual's learning style and they all conclude that the students were greatly benefited when they were presented with material based on their specific learning style.

Considering the popularity of e-courses, especially with the advancement of Massive Open Online Courses; automated tools for content compatibility assessment, in conjunction with students' learning styles could be useful both for educators**,** as well as for quality evaluation purposes. The usefulness of such automated tools, that would provide the ability to continuously assess content compatibility level, in relation to students' needs, could prove significant for educators**,** as well as higher level decision makers. Consequently, the following sections present an innovative methodology and application of it in an actual academic department LMS.

3. Methodology

3.1 E-course content and learning style compatibility assessment framework

The need for introducing a framework for LMS content quality assessment is an essential part of the evaluation process of a higher education department. Since the Department of Archives, Library and Information Studies (University of West Attica, Greece) relies heavily on the use of an LMS (with more than 50 undergraduate and postgraduate e-courses) a formal evaluation was performed, and its results presented in Zervos et al. (2013). The results of the previously mentioned evaluation highlight mainly the students' favorite activities and behavior patterns when studying, in relation to LMS offered functions. Although useful remarks were obtained, there was no information about the e-courses content compatibility with the specific requirements of students' learning styles. In this sense, an easy to implement evaluation framework, comprising of five phases, which are briefly described below and depicted in Figure 1, was formulated for the department's e-courses content characteristics evaluation, as provided through its LMS.

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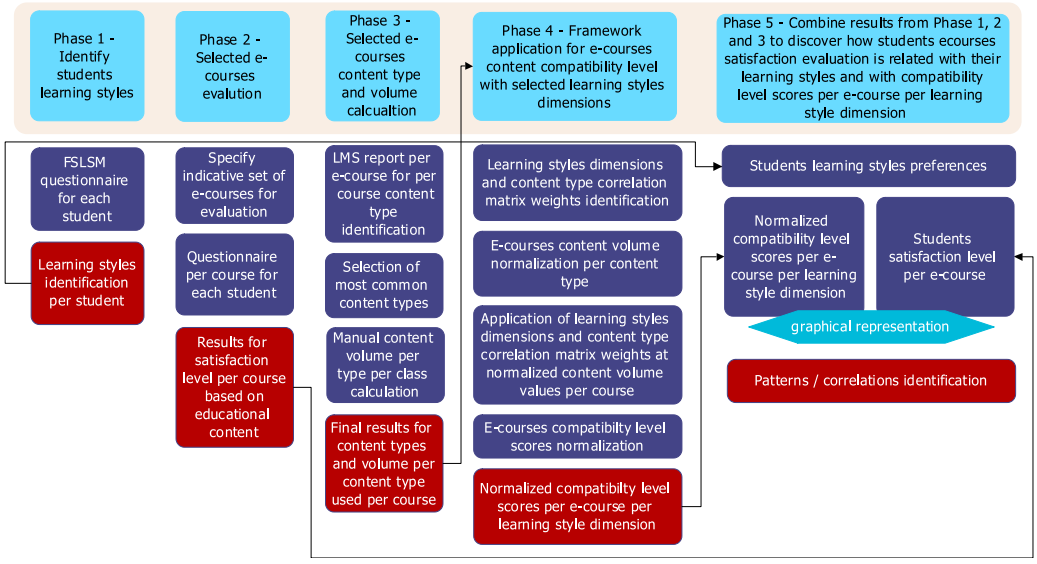

Figure 1 - Methodology phases overview

The first phase of the proposed evaluation framework concerns the identification of students' learning styles via the use of the FSLSM questionnaire. This phase aims to determine for each student, as well as at departmental level, the score for all FSLSM learning styles scales. In the second phase, students were asked to state their satisfaction level about the usefulness of the content, meaning comprehension support and achievement of pass mark during final exams, for a representative set of e-courses (per semester and per course type, e.g. lecture course only**,** or lecture and lab course). It is noted that the under-evaluation e-courses were part of the students' major degree program. Specifically, the questions asked concerned the degree to which the content promoted students' course learning outputs understanding, as well as if they achieved satisfactory marks during the exams. Their satisfaction level was measured via a four-level grading scheme. At the next phase (phase three), for each selected e-course the content types (e.g. text, presentations, assignments, quizzes etc.) and the volume per type (e.g. number of files, presentations etc.) were identified. The types of content per course and the volume were retrieved from LMS reporting system, while in some cases content volume was calculated manually (text pages, PowerPoint slides etc.). Content types selected (see Table 2) are corresponding only to those that used by the e-courses that participated in the evaluation. Next, at phase four, a correlation matrix which provided a mathematical tool for quantifying the e-course level of compatibility with the two (out of four) more appropriate FSLSM learning style scales, in conjunction with the volume per type content, was introduced. Before applying the weights depicted in the correlation matrix, the content volume values per course, were normalized using the min-max scaling. After, by multiplying the correlation matrix weights, with each e-course volume normalized value per content type data, the compatibility level score per learning style scale was calculated. Again, for allowing comparison between e-courses a normalization process was implemented. At the last phase (phase five), the results from the phase one, two and four were combined. Specifically, a graphical representation of normalized compatibility level scores per learning style and students' satisfaction level per e-course, participating in the sample, enables the identification of useful correlations and patterns. The results from phase 5 provides significant evidences about whether e-course compatibility levels, with specific learning style scales dimensions, are related to students' satisfaction levels and/or their learning styles.

3.2 Felder-Silverman Learning Style Model

The decision to select the FSLSM was based on the fact that it is the most wide-spread model for analyzing the individual's learning style (Graf, Kinshuk and Ives, 2010). FSLSM can describe the learning style in much detail compared to other methods (Graf et al., 2007). Additionally, the Felder model is more appropriate for e-learning and web-based learning systems (Kuljis and Liu, 2005). According to the FSLSM, the learners are divided into four two-dimensional scales, based on the Index of Learning Styles – ILS (Graf et al., 2007) as they are presented in detail in Table 1.

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Learners style scales and their dimensions	Description per dimension
Scale 1 *Active vs Reflective* (Act / Ref) Processing	Active learners tend to understand information better by doing something active with it. They prefer exercises and group participation. They learn by doing something. On the other hand, reflective learners prefer to take their time and think about it quietly. They prefer to study alone and to do individual exercises.
Scale 2 Sensing vs Intuitive (Sen / Int) Perception	Sensing learners prefer to learn through examples from the real world. They tend to be patient with details and good at memorizing facts. They are more practical and careful than intuitive learners. On the other hand, intuitive learners prefer innovation and they dislike repetition. They can better grasp new concepts and are more comfortable with abstractions and mathematical formulations in comparison to sensing learners.
Scale 3 Visual vs Verbal (Vis / Ver) Representation	Visual learners prefer to learn through pictures, diagrams, flowcharts, videos, etc. However, verbal learners prefer to learn from words, whether spoken or written. They tend to communicate and discuss with other people.
Scale 4 Sequential vs Global (Seq / Glo) Understanding	Sequential learners tend to learn gradually, step by step from the individual information give, to the general meaning. Whereas global learners tend to perceive the general meaning, understanding afterwards the specific details. They can solve complex problems quickly.

Table 1 - Felder-Silverman learners style scales and dimensions (Klašnja-Milićević et al., 2011; Adetunji and Ademola, 2014; Felder and Soloman, 2017)

The determination of the learning style score per scale is made through the employment of a questionnaire, which contains 44 questions with two available responses (a or b), which aims to detect the individuals' preferences through each scale's dimensions, as Felder and Silverman defined them. For each scale, 11 questions are posed. For example, assume that for the 11 questions of the "active" vs "reflective" scale, a learner scored 9 answers with the "a" and 2 with the "b". The score for this scale is calculated by subtracting the smaller number of answers (based on the letter) from the larger one and by adding the letter (a or b) for which the answers where the majority. For our example, the final score for the scale "active" vs "reflective" is 7a (9-2=7 plus the letter "a"). Figure 2 depicts how scores per scale are interpreted in relation to the dimensions of the FSLSM. More specifically, a score between 11 to 9 either for "a" or "b" expresses a very strong preference for one of the dimensions of the scale. Accordingly, scores between 7-5 indicate a moderate preference for a dimension, while the score from 3 to 1 expresses a rather well-balanced attitude to both scale dimensions.

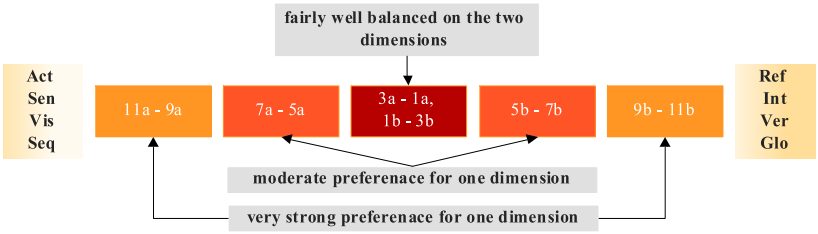

Figure 2 - FSLSM dimensions scoring interpretation

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3.3 Educational content according to learning styles – Correlation matrix

Based on the aforementioned types of learners, the teachers must create the corresponding content in the form of learning objects that reflects the learning style of each student. The LMSs such as Moodle provide a great variety of learning objects (Graf, Kinshuk and Ives, 2010; Zervos et al., 2013) such as content objects (e.g. text files, presentations, videos etc.) and interactive objects (e.g. tests, quizzes, assignments, forums, thesaurus, databases etc.).

Having the above thoughts in mind, Mendez, Morales and Vicari (2016) tried to relate learning objects to learning styles based on the FSLSM. Such a study facilitates and gives guidelines to the teachers to create the corresponding learning objects and materials by taking into consideration the individual's learning style. Following their example, the table below quantifies via a weighting vector for FSLSM scale 1 and 3 dimensions (Active vs. Reflective and Visual vs. Verbal), the relation to specific content types such as presentation files, text files (pdf, word etc.), assignment/projects activities, quizzes/interactive modules, video/audio files, external links to reference material and computer files (source code, XML files etc.). Weighting is useful because it presents the results as a single score and keeps the complexity of the evaluation framework low (for communication purposes). It is worth mentioning that the content types selection was based on their popularity among department teachers of the evaluated LMS. Also, only FSLSM scale 1 and 3 are related to content types as they are more affected by the content format and the presence of activity modules. Subsequently, scales 2 and 4 were not used for the proposed compatibility assessment framework as they are associated more with the content itself and the teaching model, followed by the instructor.

Content type and activity modules / weighting factor per dimension	Scale 1 – Processing		Scale 3 - Representation	
	Active	Reflective	Visual	Verbal
Presentation files	0	0.4	0.1	0.2
Text files	0	0.5	0	0.6
Assignments / projects	0.3	0	0.1	0.1
Quiz/Interactive modules	0.3	0	0.3	0
Video/Audio	0.2	0	0.3	0
External material (links to articles, books, reference material etc.)	0	0.1	0	0.1
Other computer files (source code, xml files, rdf examples, bibliographic records, etc.)	0.2	0	0.2	0
Total	1	1	1	1

Table 2 - FSLSM dimensions and e-courses content types correlation matrix

As reflected in the correlation matrix weighting values, dimensions such as "*active*" and "*visual*" are better served by content type such as video, audio clips, PowerPoint presentations (for the "*visual*" dimension) and activity modules such as assignments, quizzes and other computer-oriented files (source code, XML files, RDF examples, bibliographic records, etc.). However, text files, presentations and other types of reference material are more suitable for improving the educational process of students who prefer readings, narratives, diagrams and presentation (reflective and verbal). Moreover, the weighting values are considered balanced and aligned with the content types or activity modules with the most volume or population. In more detail, the weighting factors presented in Table 2 were obtained though testing, intending to give greater values to more "compatible" content type in relation to a certain learning style dimension and less value (or even zero) to types of content that are not relevant or don't fit to the educational process based on students' learning characteristics. The results and conclusions for the specific set of e-courses are not significantly influenced when weighting values with minor differences are used.

3.4 LMS e-courses compatibility level calculation

After presenting the correlation matrix, a set of 21 e-courses were selected to be assessed concerning their compatibility with 1 and 3 dimensions of the FSLSM scales and students' learning styles. The e-courses information and thus compatibility levels were normalized by applying the min-max normalization during the assessment process. This option was intentionally adopted as it allowed for the obtaining of

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comparative results about e-courses that could encourage the spirit of competition between faculty members.

Next, an example of how the compatibility level per e-course is calculated**,** is described. In the second column of Table 3, the volume of the most common types of content, as well as the number of activity modules used (following the correlation matrix types), were measured, per e-course. By taking into account content volume of educational resources (e.g. number of slides in presentation files, number of assignments etc.), that are included in the e-course material, a more precise indication of their gravity and importance, during the educational process, is obtained, compared to considering content type only. For better understanding, the chosen e-courses for evaluation, were ranked in descending order by content type, volume and number of activity modules (presented in the third column of Table 3). The e-course picked as an example, had the highest volume of text content with more than 2.700 pages. As stated in the methodology section, all content values per type and per e-course were normalized using min-max scaling (see the last column of Table 3).

Content types &activity modules	e-course material volume	e-courses order by volume per content type / module number	normalized values
Presentation files	342 slides	9th	0.36
Text files	**2736 pages**	**1st**	**1.0**
Assignments / projects	6	11th	0.20
Quiz/Interactive modules	0	-	0.00
Video/Audio	0	-	0.00
External material (links to articles, books, reference material etc.)	21	5th	0.68
Other computer files (source code, XML files, RDF examples, bibliographic records, etc)	1	6th	0.06

Table 3 - e-course example - normalised values based on content type – activity module /volume – number of instances

E-course score computation for FSLSM scales 1, and 3 dimensions entails multiplying the normalised values for each of the content type and activity modules with the weighting factors of the correlation matrix (see Table 4, row 1 for the example e-course). The weighted results that occur are again normalised using the min-max rescaling process (see Table 4, row 2) for the set of e-courses under assessment.

Dimensions	Active	Reflective	Visual	Verbal
e-course score per dimension	0.07	0.71	0.07	0.76
normalized score	0.13	1.00	0.10	1.00

Table 4 - Course example - Applying FSLSM dimensions weighting matrix on content normalised values

As expected, due to the excessive volume of text content for the e-course used as an example, the scores for dimensions such as reflective and verbal were the highest (equal to 1) among all other e-courses. However, the e-course in question scores low for dimensions "active" and "visual" due to the lack of compatible educational material. Concluding, it is evident that the e-course example would best support students with strong preference for reflective and verbal dimensions.

In more detail, the majority of the respondents (73%) were between 18 to 23 years old, while one out of ten was between 24 to 26 (students who had put their studies on hold in the past, or delayed their graduation). It is notable that 17% of the respondents were more than 27 years old, which may seem unusual for a 4-year study academic department.

4. Results and data analysis

As stated before, the framework was validated through its application in an academic department's LMS. The results included the responses collected from more than 150 students via an online questionnaire with two parts. Part 1: the Index of Learning Styles (ILS) test, developed by Richard M. Felder and Barbara A. Soloman (44 questions), and Part 2: the evaluation

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score for the 21 e-courses content (21 questions one per e-course that participated in the evaluation process). Before presenting the analytical results of the responses, the demographic and academic characteristics of the responders are presented (Figure 3), plus details on the e-course selection learning style profile, based on the FSLSM dimensions.

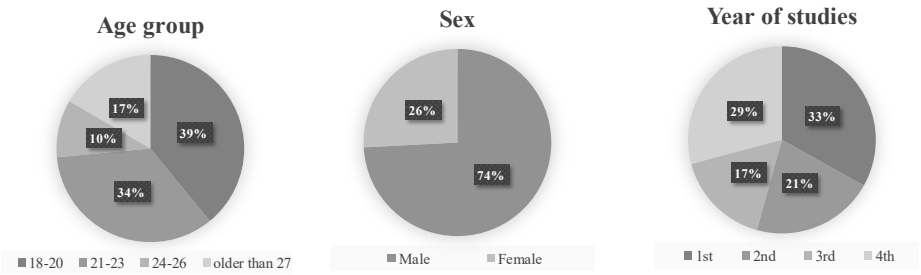

Figure 3 - Students demographic and academic characteristics

Those respondents are mainly school teachers, lawyers, computer scientists etc. working towards a career change or professional development, by obtaining a second degree. The majority of the respondents were female (74%) which was expected as this reflects the gender ratio of the department's students. Finally, the distribution of respondents among the year of studies was balanced (1st year 17%, 2nd year 21%, 3rd year 33% and 4th year 29%).

Also, the department's LMS (http://ecourses.alis.uniwa.gr) hosts more than 44 undergraduate e-courses, distributed in 7 semesters. As the ILS test comprised of 44 questions, it was decided to narrow the number of under evaluation e-courses per semester, to 3 in order to reduce "survey taking fatigue". In this way the entire number of e-courses selected was 21. It is noted here that 14 e-courses were linked to lecture and lab courses, while the remaining 7 e-courses related to lecture-only courses, while all of them belong to the "core courses category" (required courses), where students enrolment is obligatory.

4.1 Learning styles identification

The figures that follow (Figure 4a, b, c, and d) depict the aggregated ILS test scores from all the participants, in an attempt to determine the department's students learning style profile, based on the FSLSM dimensions.

The analysis of the results points out that the department's students have a strong/moderate preference for "*sensitive*" and "*visual*" learning style dimensions. In particular, 49% of the respondents' scores for scale 2 ("*sensitive*" vs "*intuitive*" dimensions, see Figure 4b) are between 11a and 5a, exhibiting a strong/moderate preference for the "*sensitive*" dimension. A well-balanced attitude for both dimensions of scale 2 shows that 45% of the respondents score from 3a to 3b and only the 6% of the students score between 5b and 11b, suggesting a strong/moderate preference for the "*intuitive*" dimension. Similar results apply to scale 3 ("*visual*" vs "*verbal*" dimensions, see Figure 4c). In detail, 38.4% of the respondents' scores are between 11a and 5a, suggesting a strong/moderate preference for the "*visual*" dimension, 53% of the responders present a well-balanced attitude for both dimensions (scores from 3a to 3b) and only 8.6% are in favour of "*verbal*" dimension. As far as concern**s** scale 1 ("*active*" vs "*reflective*" dimensions, see Figure 4a) and scale 4 ("*sequential*" vs "*global*" dimensions, see Figure 4d) students exhibit a rather well-balanced attitude for both dimensions with 62.9% and 71.5% of them scoring between 3a and 3b. It is notable that 1 out of 4 (25.8%) seem to have a moderate preference for the "*active*" dimension.

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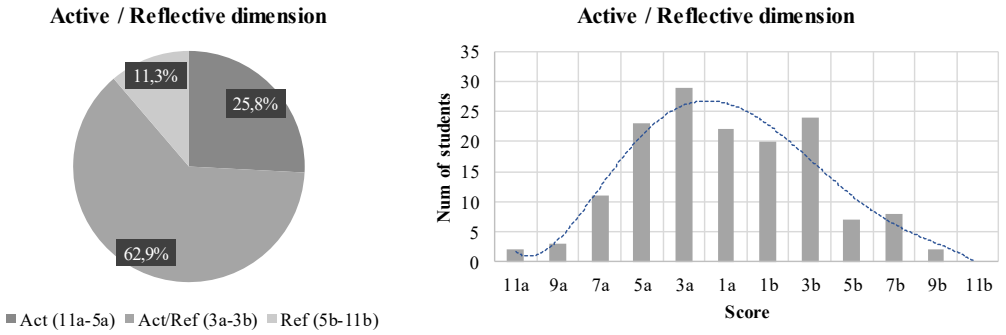
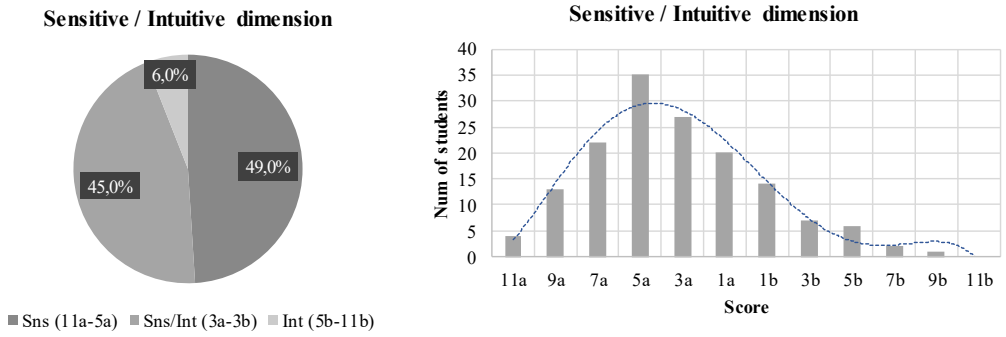


(a)



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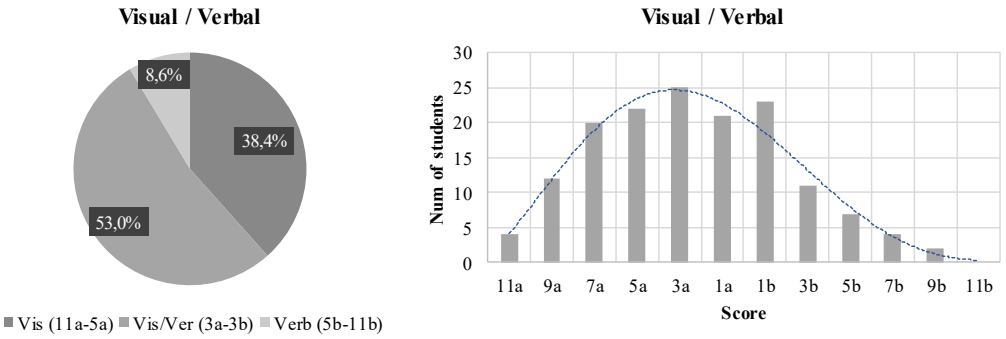

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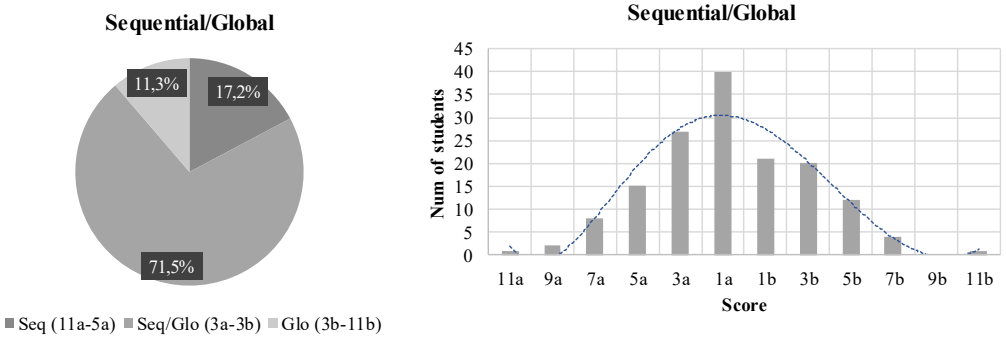

(d)

Figure 4 - FSLSM dimensions results per scale: (a) Scale 1 results – Act/Ref, (b) Scale 2 results – Sen/Int, (c) Scale 3 results – Vis/Ver, (d) Scale 4 results – Seq/Glo

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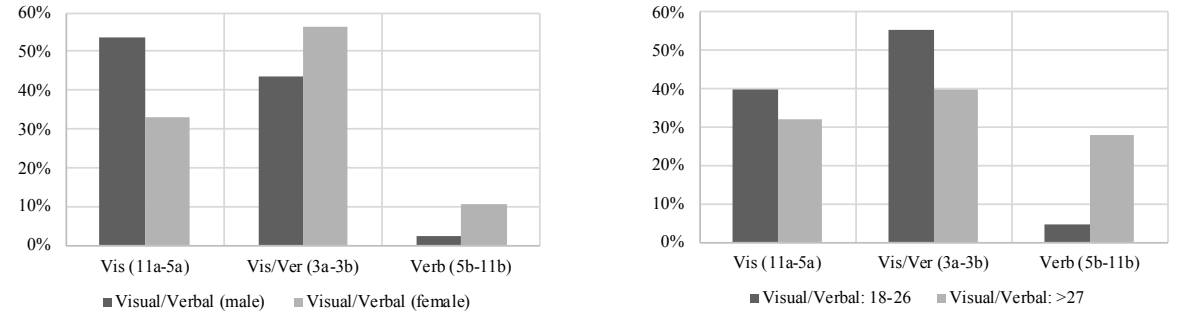
The learning styles results presented are aligned with the overall profile of the department's students and results from other similar research activities (Shuib and Azizan, 2015; Thomas et al., 2002; Murphy et al, 2004; D'Amore, James and Mitchell, 2012). The majority of the students that follow archival, library and information studies have a theoretical background, providing some justification for the "*sensing*" dimension**,** strong/moderate preference and the rather balanced attitude to both scales 1 and 4 of the FSLSM test. Also, after an in-depth analysis of the results, two more interesting findings were revealed about the "*visual* vs *verbal*" dimensions. Those findings are depicted in Figure 5a and b. As can be observed from this figure, there is a relationship between the "*visual*" and "*verbal*" learning style dimensions, with gender and age factors. 53.8% of the male students present a strong/moderate preference for the "*visual*" dimension (score 11a to 5a), while for females the percentage drops to 33%. It is also interesting that almost 28% of students with an age greater than 27 years old present a strong/moderate preference for the "*verbal*" dimension (score 5b to 11b), while for younger students the percentage drops to 4.8%.



(a) (b)

Figure 5 - FSLSM dimensions results deviations based on gender and age

4.2 Compatibility level scores per learning style dimension vs students' satisfaction levels per e-course

Figure 6 and figure 7 present the 21 e-courses FSLSM scales 1 and 3 scores as they derived from the computation procedure presented previously. The order of the e-courses is based on the results from the students' satisfaction survey (dotted line).

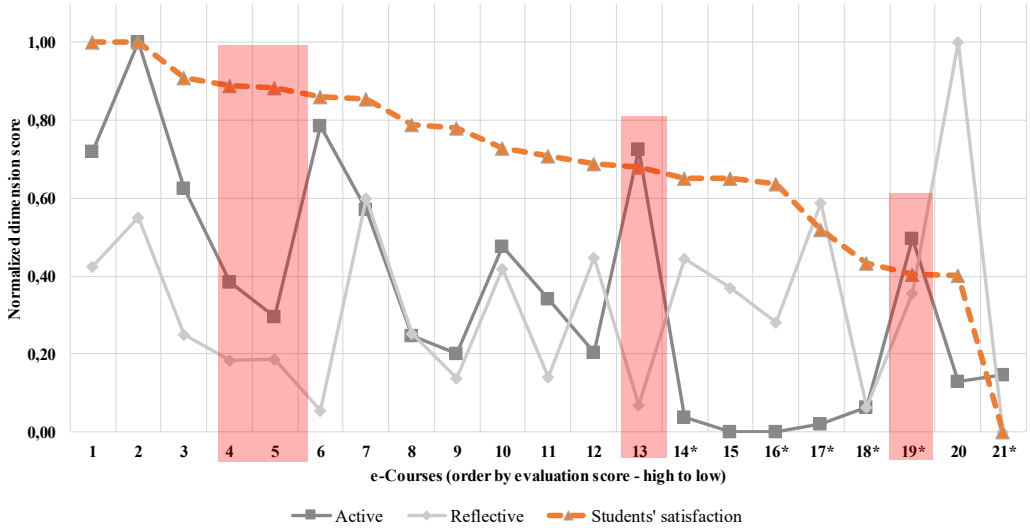


Figure 6 - E-courses compatibility levels for FSLSM scale 1 – Students' satisfaction level

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As depicted in Figure 6, it can be seen that in general, e-courses that their content present high compatibility levels with the "*active*" learning style dimension are also receiving high scores reference student satisfaction. Whereas, e-courses with the "*active*" learning style dimension show a low compatibility level and are receiving low student satisfaction scores. As can be seen in Figure 6 (see e-courses with id 4, 5, 13 and 19), there are some exceptions to the general trend. Specifically, e-courses with ids 4 and 5 present high student satisfaction scores, while the compatibility level indicator for the "*active*" dimension is considered low. On the other hand, the situation for e-courses with ids 13 and 19 is reversed, as they present low student satisfaction scores and a rather high compatibility level indicator for the "*active*" dimension.

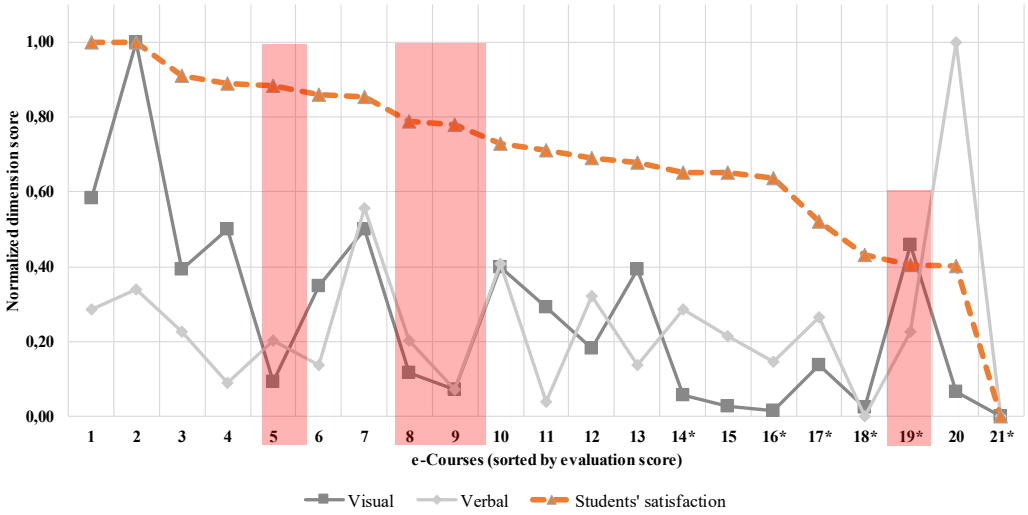

Figure 7 - E-courses compatibility levels for FSLSM scale 3 – Students' satisfaction level

The results for the "visual-verbal" dimensions are similar. As depicted in the figure above (Figure 7), it can be seen that e-courses that are scoring better on the "visual" learning style dimension are receiving high satisfaction grades. This conclusion is also supported by the fact that the specific group of students had a strong preference for visual dimension. On the contrary, e-courses that exhibit low compatibility level with "visual" dimension are graded with low scores from students. As expected, there are some deviations from the general trend. Specifically, e-courses with ids 5, 8 and 9 present high student satisfaction scores, while the compatibility level indicator for the "visual" dimension is considered low. Whereas the situation for e-course with id 19 is reversed, as it presents low student satisfaction scores and a rather high compatibility level indicator for "visual" dimension.

Another interesting finding is that e-courses which are linked to lecture only courses (see Figures 6 and 7, e-courses with ids 14, 16, 17, 18, 19 and 21) are getting the lowest scores on both dimensions "active" and "visual" as well as in the students' satisfaction rating. Although there was an expectation that students are more intrigued by courses comprised of lectures and lab exercises, the lack of interactive and visual/multimedia material seems to have a negative impact on the results of students' satisfaction scores.

5. Discussion

At this point it is important to address the criticism on the usefulness and the scientific coherence of learning styles application in relation to educational activities that has been raised lately by research community (Newton, 2015; Newton & Miah, 2017; Kirschner & van Merriënboer, 2013; Kirschner, 2017). More specific, Kirschner (2017) summarizes learning styles major drawbacks in the following: (1) There has been no proof or at least no proof that learners are benefited when they are given different instructions based on their learning styles, (2) the identification of learning style based on questionnaires suffers from fundamental problems. Although, this may be partially accurate for conventional teaching, there is still vigorous research interest for implementing adaptive e-learning environments by utilizing learning styles or cognitive styles models (Özyurt & Özyurt, 2015; Truong, 2016; Kumar, Singh & Jyothi-Ahuja, 2017, McKenna et al., 2018). The computer-based nature of adaptive e-learning environments allowed researchers to acquire

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empirical evidence of the merits that learning styles and educational content correlation presents (Radenkovic et al., 2009; Klašnja-Milićević et al., 2011; Chen & Sun, 2012; Ocepek et al., 2013; Yang, Hwang, & Yang, 2013; Adetunji & Ademola, 2014) in an attempt to address the first point of the criticism mentioned above. Also, the e-learning environments improved significantly the precision of automatic learning style identification based on students' behaviour in combination with self-report measures techniques (Bernard et al., 2017; Crockett, Latham & Whitton, 2017; García et al., 2007), addressing the second point of criticism. In this sense, learning styles application in relation to educational activities in LMSs, rather than traditional face-to-face teaching, is an important aspect that could support higher engagement thus better satisfaction levels for the students.

Moreover, based also on our findings, the individualisation of learning and teaching methods based on students' diverse learning styles or capabilities, although it is not a new concept, appears to be an attractive add-on feature for modern LMS environments. Usually, before attending an LMS e-course, students' learning styles are identified, so that they can access the most appropriate content. An alternative approach, such as the one presented in this paper, could be a framework for assessing the compatibility level between educational content and students learning styles dimensions per e-course. Educators and learning content creators could redesign the e-course workflows and provide multiple types of material and content according to the assessment results of each student. This alternative approach could be very beneficial for already deployed e-courses and traditional LMSs as they could provide personalised learning activities and educational content, extending the limits of traditional teaching in a classroom.

The sections above presented an innovative methodology for evaluating the compatibility between student learning styles and e-course material. The application of the assessment framework at an academic department was easy and straightforward leading to useful results for educators and the department's quality assurance committee. The results section provided sufficient evidence that an immediate connection between students' learning preferences, their degree of satisfaction and e-courses compatibility levels with particular learning styles dimensions, exists. More specifically, it has been seen that e-courses utilizing content types that better support the "*visual*" and "*active*" learning style dimensions are graded with the highest scores by the students. The same trend appears with the courses that have both theory and lab parts, as expected. Such a result may be attributed to the fact that the courses that have both theory and lab parts are more interactive**,** in contrast to the courses that have only the theory part and might be more difficult. In addition, the deviations observed between the satisfaction ratings of certain e-courses and the learning style dimensions scores are indications that students' responses are influenced not only by the content type**,** but also by factors such as the level of difficulty, the instructor's teaching methods, the topics presented etc. Moreover, the presentation of the compatibility assessment and evaluation results in a comparative way had an immediate impact on the department's faculty. Most of them started to reconsider their teaching approach, whilst a guide to good practices during e-course content development is being produced.

6. Conclusion and future developments

Our future work aims to further improve the proposed framework and explore the opportunities for implementing an add-on for Moodle LMS. Clearly it is essential to identify students' satisfaction levels in a multidimensional way, including quantitative and qualitative information about their performance results. Also, it is considered necessary to further automate the content type and volume calculation, as well as to add information referring to their utilization by the students, directly from LMS reporting system. Finally, further effort has to be put into computing different metrics per compatibility assessment case, e.g. for a unique e-course, or for a specific semester's e-courses, or for all e-courses in the LMS.

In conclusion, we believe that the proposed framework is sound, easy to apply and contributes to the improvement of e-courses content. The benefits from the application of the presented framework could be seen during the design and improvement of new and already existing e-courses. Finally, from a technical perspective**,** our work specifies most of the requirements, the workflows and the details necessary to design and implement an LMS add-on component in order to accommodate the compatibility assessment between students' learning styles and e-course material. Such a function is missing from modern LMSs and is expected to contribute positively to their operation and quality enhancement.

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Participatory video and digital citizenship: a case-study within an instructional technology course for social educators

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Abstract

Digital challenges tied to the multifaceted landscape of citizenship are the focus of a workshop developed within an instructional technology course that took place in the academic year 2019-2020 in the degree course in Education Science (curriculum socio-pedagogical professional educator) at University of Macerata (Italy). The experience is framed in a multiple-case study where the case here described is intended as the last unit of analysis. The aim of the qualitative study is to check how a hands-on workshop on digital citizenship, which involved students in a participatory video project, affected their reflection about (1) the theme and the effectiveness of media formats used for the educational design and communication; (2) the collaborative attitudes that were involved for the creation of a video artefact designed as an educational resource.

The data were collected through different tools (reflection papers, questionnaires and interviews) and were coded with a content analysis approach to be, then, triangulated with the artefacts created by the 31 students of the sample who worked in small groups.

KEYWORDS: Participatory video, social educators' training, digital citizenship.

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1. Introduction

The article focuses on a training experience within the instructional technology course that took place in the academic year 2019-2020 in the degree course in Education Science (curriculum socio-pedagogical professional educator) at University of Macerata (Italy). A hands-on workshop on digital citizenship involved students in the creation of a short video with a twofold objective: (1) making students reflect on the theme and the effectiveness of media formats used for the educational design and communication; (2) making students practice strategies of active learning where the creation of a video artefact, designed as an educational resources, is meant as a generative process for the educators' training.

Digital citizenship was chosen as the core theme for the training experience since it merges the attention of the educational contexts (formal, informal and no formal) on digital literacy and related competencies' areas (OECD, 2016; Tiven et al., 2018) and the need to face new challenging issues related to global and active citizenship which social educators need to manage in the contemporary professional contexts (Hoskins et al., 2008; Margiotta, 2017; Tramma, 2017).

The phrase "digital citizenship" refers to a broad area of interest and inquiry and includes concepts associated with ethics, safety, wellness, communality, and rights with the integration of the changes those concepts experienced with the advent of the digitalization and, most of all, of the social web.

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Among the others "engagement" is addressed as a key dimension connected to several visions of digital citizenship (Frau-Meigs et al., 2017) that are complementary to active citizenship defined as "participation in civil society, community and/or political life, characterised by mutual respect and non-violence and in accordance with human rights and democracy" (Hoskins et al., 2008, p. 389). Citizens' active participation in the digital environments by using online tools and products is considered of paramount importance and promoted by several organizations and institutions at national level (e.g. US NGO ikeepsafe.org; the project Safer Internet Centre – Generazioni Connesse coordinated by the Italian Ministry of Education and Research), European level (e.g. European Commission's Joint Research Centre and its DigCompEdu, Digital Competence Framework for Educators) and international level (e.g. ISTE, International Society for Technology Education).

The NGO Netsafe (2018) refers to the digital fluency as a needed background for digital citizenship where "fluency" embrace the "skills and strategies" to be able to wisely manage technology with "attitudes, underpinned by values" when activating social connections and deep "knowledge" of the environments born in the digital context. Nowadays our digital lifestyle is fully integrated with our offline lives so that a new 'interreality' living space (Riva, 2010) is marked by risky implications such as online challenges (Fedeli, 2019c) and addictions (Livingstone, & Palmer, 2012). In this framework digital citizenship is seen as "the ability to draw on this competency of 'digital fluency' to participate in life-enhancing opportunities (social, economic, cultural, civil) and achieve their goals in ways that make an important difference." (Netsafe, 2018, p. 5).

Educating kids and young adults to be digitally literate and savvy digital citizens implies a holistic effort and synergy among educators, parents and caregivers. The process involves an open dialogue among all actors and may find several barriers due to the reluctance to face sensitive issues, such as being the target of bullying for example. Priebe, Mitchell, & Finkelhor (2013, p.12) in their research data discussion refer to surprising results addressing the non-correspondence between the parents' and caregivers' active mediation expressed with talking about specific Internet risks and youth disclosure attitude about unwanted Internet experiences and they stress "the importance of talking with youth about these things in a non-evaluating way". How can educators touch those topics in an effective way without showing a judgment attitude? And how can student educators be trained to manage proper instructional strategies? In the present article an experimentation using participatory video approach was used to address the above mentioned questions.

2. Materials and Method

Participatory video (PV) approach has a long history whose origin can be traced back to the late 1960s with the "Fogo Process" when the National Film Board (NFB) of Canada promoted the "Challenge for Change" program. It was directed to residents of the Fogo Islands area of Newfoundland with the aim to empower the community by making them participate in a video project that could reflect the economic difficulties they were struggling with (Robertson, & Shaw, 1997).

The PV experienced several dimensions of use and contexts along the decades (Montero, & Moreno-Domínguez, 2015), but we can envision its cornerstones in the following aspects: a group-based collaborative effort to design and create a video product with a social intention; reflection and empowerment that are to be seen, at the same time, as outcomes and premises of the creative video production process.

PV can have a pre-determined theme to develop as a starting point. Participants as designers and producers of the video project can take advantage of different modes of communication and create powerful messages to be exploited in/by the community for social change.

The previous paragraph closed with a remark on the need to involve young audiences in an interactive open process where they can feel engaged and not under judgement. PV approach (Milne et al., 2012; White, 2003) can represent a successful strategy to: (1) overcome the top-down one-way communication; (2) support and encourage the learner to disclose his/her own viewpoints or experience of sensitive topics through a video project (3) activate a collaborative bottom-up decision-making effort through a process–oriented and product-oriented vision that brings to the creation of a final artefact that can be of social value.

PV, in fact, enables a so called "transactional communication" (White, 2003, p.68) where "communicating parties are tuning in to each other in an ongoing interaction", a process which contributes in reducing the imbalance between the educator and the student allowing the latter to develop empowerment. This does not mean that the two roles (educator-student) disappear to merge in the same profile, but instead that an educational relation based on reciprocity is being activated:

"Reciprocity can assume, in education, the meaning of equality of value among all involved actors: a due symmetry that coexists with the asymmetry of roles and the different authoritativeness (educator-learner); but such difference should not preclude the bidirectional trajectory of the educational relation" (Stramaglia et al., 2018, p.85)

Digital challenges within the multifaceted landscape of citizenship was the focus of the workshop and the pre-determined theme chosen by the instructional

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technology course teacher for the participatory video project which involved the class of 31 students who participated to the whole training experience (a total of 48 hours where 18 hours were dedicated exclusively to the hands-on workshop).

The initial section of the course introduced the instructional technology perspectives on design and implementation of educational actions with a focus on social media and digital storytelling while the hands-on workshop completed the theoretical part with a practical activity based on PV.

The workshop session was developed in the computer lab and students were encouraged to use the institutional e-portfolio system (Mahara) to collect their artefacts during the project. Students could also consult the teacher e-portfolio where course resources, instructions and guidelines were set to activate and support the hands-on activity.

Students divided into 9 small groups (2, 3 or 4 people) according to their preference with the only indication to work collaboratively with a maximum of 4 members per group.

Students were encouraged to analyse a problematic aspect connected to digital citizenship (e.g. the need to ensure different dimensions of wellbeing while using technology) and were provided with an initial set of resources (journal articles, case-studies reports, statistics, etc.) and guidelines to design and create a short video aimed at introducing the discussion over the theme for an educational purpose.

Guidelines included technical suggestions (software to use) and procedural inputs (the usefulness to design a storyboard before creating the video). Students could choose a specific problem-based theme situated in the disciplinary content (digital citizenship), the target audience and the context in which they would like to use the video and, finally, its style (interview-style, live action, animation, screencast, slideshow, etc.).

The final task included the presentation of the group work to the whole class using a digital tool they felt appropriate in order to explain the decisions made as student educators about the choice of the topic, the objective of the video and its potential use for the benefit of the community. PV approach was, in fact, also used to make students experience the role of change agents in a social context.

The workshop was used as a case –study to address the following questions: (1) how did PV affect the development of reflection and empowerment in relation to the disciplinary core topics? (2) How did PV influence the social change attitude?

The qualitative research used a multiple case-study approach (Baxter, & Jack, 2008; Yin, 2003) where the case here described (academic year 2019-2010) is intended as the last unit of analysis of three case-studies. The previous cases refer to workshops developed in the same course of the academic years 2017-2018 and 2018-2019 (Fedeli, 2019a; Fedeli, 2019b) where the approach of collaborative video design was investigated for its transformative dimension in different directions (empathetic value and service learning).

The current case is meant also to understand the similarities between the cases and check if the efficacy of group work highlighted in the previous analysis is confirmed and what connotations it takes when the focus is social change.

In order to be able to investigate the two research questions the following data gathering tools were used: an initial reflection paper; an online final open-ended questionnaire, a final semi-structured interview. Besides the individual data collected (written reflection papers, written questionnaires, audio interviews) group data sources were analysed: the three artefacts required as outcomes of the workshop (storyboard, video and presentation of the work) (Fig. 1).

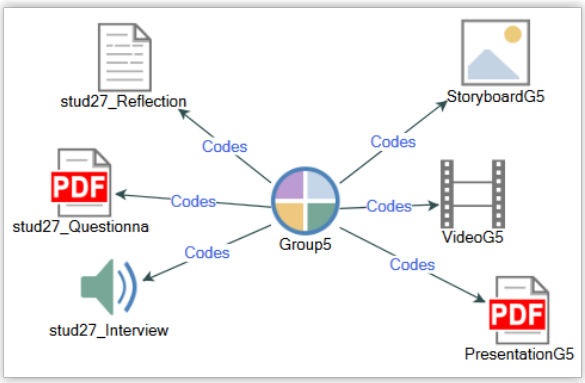

Fig. 1 - NVIVO map of the individual data sources related to one student of group 5 (stud27) and her group data source.

The data gathering process and tools were planned with the following time sequence:

- before the beginning of the workshop: students are requested to give their vision of digital citizenship and create a short reflection paper to be uploaded in their individual e-portfolio;
- during the last meeting of the workshop: students are asked to fill in the online questionnaire and upload in their e-portfolio all their group artefacts. In this last meeting each group presents its work to the class;
- after the conclusion of the workshop: students are interviewed once the teacher had analysed available sources and students had their presentations.

The reflection paper had the objective to collect data about the students' knowledge and understanding of the macro area of interest of digital citizenship addressed during the theoretical section of the course. Those

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reflections were, then, compared with the answer obtained through the open-ended questions asked with the online questionnaire and the oral interview and, finally, with the artefacts created during the workshop.

Specifically, the interviews had the advantage to let the teacher go deeper in the understanding of students' perceptions once they had time to make a collective reflection on their group work thanks to the presentation; the chance to show the videos and explain to the whole class the rationale behind the artefact was an opportunity for students to compare personal viewpoints, shared in the small group, with the enhanced audience of the class and the teacher following a transactional model (White, 2003).

The questionnaire and the interview covered directly four dimensions: (1) the students' perception of efficacy of the group work; (2) the role played by the three different artefacts to support the design and the production of the video; (3) the students' opinion about the PV approach for educational use; (4) the value of the connection between PV approach used in the workshop and the focus on digital citizenship.

The data were analysed with the support of the qualitative data analysis software NVIVO (version 11 plus) by using a content analysis approach for the textual data (Bardin, 1977). The interpretative categories used to code data were: "reflection"; "empowerment"; and "action" taking into account the PV characteristics and the research questions.

Images and videos, instead, were coded using descriptive categories. Videos were coded according to the chosen style (interview; creative artwork; short-story; video-report) and addressed problem-based theme (fake identities and information; harmful behaviours; risky challenges), while storyboards were coded according to their structure (sequential frames; unstructured mental map; table structure) (Fig. 2).

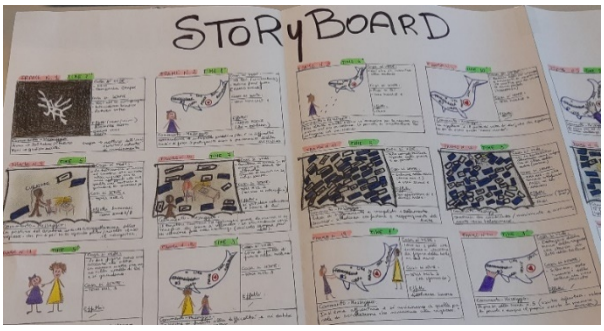

Fig. 2 - Photo of Group 5 paper-based and hand-drawn storyboard with sequential frames.

3. Results

As anticipated in the previous paragraph the analysis of data was developed by coding the textual sources in three different main categories namely "Reflection", "Empowerment", and "Action". As shown in the map (Fig. 3) each category (coloured nodes) has child nodes (subcategories), all nodes are located in a circular position just to mean the absence of a hierarchical value among categories and to highlight their strict connection.

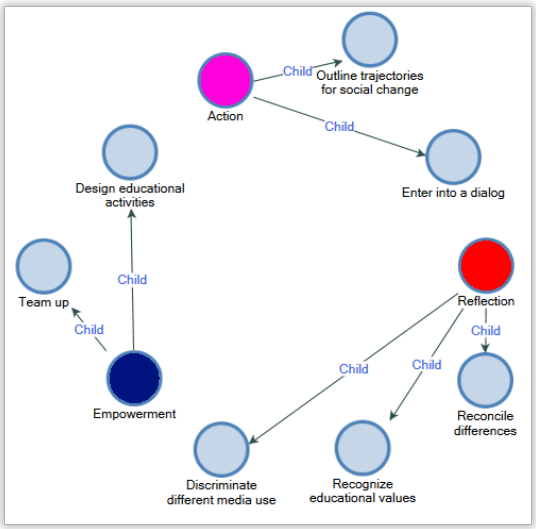

Fig 3 - Map of categories and subcategories.

The results of the analysis will be reported for each category and related subcategories with a short introductive description in order to better clarify the rationale of the interpretation process. Triangulation of data across categories will be, also, reported and meaningful results visualized with dedicated graph.

Reflection. This category includes three subcategories: "Recognize educational values"; "Reconcile differences", and "Discriminate different media use". PV aims at fostering reflection through a process-oriented approach and the research here described aimed at collecting students' inputs that can show their reasoning about how the PV process affected effective communication within the small group and what roles the different media used played for the students' understanding of the instructional design process they activated on digital citizenship.

Effective communication implies the activation of several skills such as listening, problem-solving, decision-making, negotiation (Lumsden et al., 2010) and "reconciling differences" was chosen as subcategory to collect students' references to a set of strategies they applied to reach an effective communication even if they experienced "differences". There are, in fact, several references to dissimilarities and the way students treated them to reach their common goal:

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Stud18: "The discussion in group showed two opposite viewpoints and we decided to represent both in the video giving them the same relevance, so that we could reflect on the topic and let other viewers reflect as well".

Stud20: "The final product [the video] is the concrete result of our different opinions, and it represents the decisions made and the management of those decisions by the group".

Stud21: "Communication exchange among us was fundamental for going deeper in the topic, since the perspectives and the experiences we had were the primary stimulus to progress with the work".

Stud27: "There was an in-depth and plural communication and discussion about the topic".

Stud5: "We were people with contrasting ideas, but we succeeded in finding a compatible way and a compromise for the group".

It is quite interesting that students' never referred to the communication flow bringing an "I" position; students, instead, referred to the group and mentioned a "we" perspective in every statement that show the process of negotiation, and this meaning is perfectly reported by stud5: "we were people with contrasting ideas….we succeeded in finding a compromise for the group". The peculiarity of each group member was not cancelled or ignored in the name of the final goal (the production of a video), but it was considered as a primary source to deepen the understanding of the topic and its dimensions; the communication was "plural" as stated by stud27 and as another student remarked, having different opinions means that the group need to make decisions, and that should be able to "manage" those decisions.

The management process appears very clearly described in the subcategory "Discriminate different media use"; students, in fact, demonstrated that a reflection on the functions of media (storyboard, video and presentation) have occurred and was of paramount importance for reaching their objectives:

Stud13: "The PPT presentation supported us in 'putting the words' and analyse in detail the video. The video lets you have a direct contact, the message is immediate".

Stud15: "The PPT presentation helped us identify the key words".

Stud16: "The PPT presentation supported the creation of a list of important aspects, the storyboard helped a lot in the production of the video since it let us gradually plan and visualize the video giving an idea of what the final product would be. The video was the final act where we created and practically put all ideas we had."

Stud 18: "The storyboard was useful to go step by step, the presentation to define the objectives and have a vision of the practical contexts in which the video could be used; the video was a very relevant step of reflection where the collaboration among the group member took place".

Stud19: "The storyboard was useful to make it concrete the ideas and let us keep a straight line during the video production. The PPT presentation, instead, let us reflect in a deeper way about the topic, the objectives of the project and the message we wanted to disseminate. The video is the concrete results of this process".

Stud22: "The storyboard was useful to design and have a framework. The PPT presentation can be used to introduce the video; the video is a fundamental connection to express the addressed topic".

Stud29: "The storyboard was very important to define a first draft of the video project, the video made it concrete the topic and the presentation was useful to draw conclusions and make it explicit the message."

Stud4: "The PPT presentation let us reorder the ideas, define the objectives and the possible applications of the topic in the educational context".

To summarize, the students' reflections find an agreement in the need to clearly express through "words" the objectives of the project in order to make a video useful in the educational contexts; they mostly identified that the PPT presentation could satisfy this need; a video is a powerful tool to disseminate with immediacy and attractiveness a message, but, according to students, it can rely on metaphors and, since in education it is important to offer a clear message, it would be good to associate a presentation to use a video for teaching/learning reasons. Videos are meant as creative products, but not just this, videos, as stud18 said, are where collaboration takes place, the reification of the group's effort. Storyboards were meant mainly as a support for the design of the video and it would be interesting in a future investigation to analyse in a more detailed way the connection between the storyboard style and the effectiveness of the video design process that did not emerge in the current research.

Design is at the base of the educational value and students' reflection on PV in such direction was twofold: students made references to PV usefulness as educational strategy whose benefit is seen for the video creators and made references, as well, to its educational potentialities for the benefit of the audience. Moreover three were the didactical/educational directions a PV approach can have when dealing with problem-based topics of digital citizenship: information, prevention,

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open discussion. Students' statements in this direction are:

Group5: "the video project can help providing information, it offers a vision of the problem that is not ordinary, prevents risks, offers an alternative way to involve youth".

Stud19: "It is important for an educator to use a video project to sensitize the audience and involve young students to create their own videos to make them reflect on the topic".

Stud20: "The efficacy of the video project is to be seen in its flexibility of use in the formal and informal contexts of education".

Stud27: "educators and students could create together a video so that students can "touch with their hands" the topic, understand from a first person point of view something they are used to watch in videos created by other people and published in the social networks and that are generally watched with superficiality and in a mechanical way".

Empowerment. This category includes two subcategories: "Design educational activities"; and "Team up". Both subcategories are meant to give an interpretative organization to students' references to their acquired self-confidence and expertise as future educators in action in terms of collaborative skills and design competences. Differently from the subcategory previously discussed, but in line with them, here students references are analysed in terms of not mere recognition of value of group work or educational application of PV, but in terms of parameters they demonstrate to take into account to plan an educational action.

The extracts here reported from groups presentations can summarize the impact PV had on their attitude as educators:

Group7: "the video created with a double interview style can be easily used in the educational settings, specifically in secondary schools (where those topics of digital citizenship appear to be more urgent), maybe they can be used as motivational and brainstorming tools in student assemblies to introduce and discuss the topic."

Group1: "Such videos can be useful in projects managed by territory institutions that deals with addictions and social-based problems in order to prevent harmful behaviour with real, concrete examples".

Group8: "The educational projects in which parents and sons are involved can be a good opportunity to use video projects like the one we did. In this context of applications video could promote an open exchange and discussion where parents and young kids compare their life styles with or without technologies."

Parameters such as "context" and "approach" appear in students' data when they refer to kind of educational institution (school/territorial body; formal/informal, etc.) and specific settings (student meeting/assembly; parent/son meeting, etc.) to apply a video project.

In the same way the subcategory "team up" was intended to collect references to group work that highlight an acquired awareness of skills needed to reach a successful collaboration and not merely the mention of satisfaction of working in groups. This subcategory appears to be strictly connected to the already discussed "Reconcile differences" and if we compare data of the two subcategories by group (Fig. 4) the matrix will show a consistency in the number of references. Data retrieved from students in groups 2, 3, 5, 7, in fact, had a major number of references coded in "team up" subcategory in respect to other groups and the same it can be said about the subcategory "Reconcile differences".

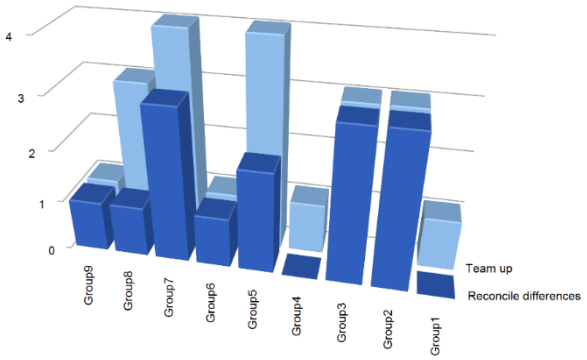

Fig 4 - Matrix coding: subcategories "Team up" and "Reconcile differences" are compared by Group.

Specifically students reported their vision of a good and balanced team work: almost all the groups identified first the individual preferences and skills of each member and, then, decided how to proceed with the work in terms of timing and roles. Stud17 says: "each of us contributed with the abilities and tools that could use at the best" and stud2 states: "the single tasks were divided equally so that along with the collaborative work each member had an individual responsibility". In those statements the value of being aware of basic principles in group work is clear: respect of individuality and the importance for everyone to feel protagonist of the work even when the group makes a decision in a different direction.

Action. This category includes two subcategories: "Enter into a dialogue", and "Outline trajectories for social change". Action is, here, meant in a social perspective when student educators can identify opportunities and modalities to open a dialogue with the territory and the community, and they are able to envision a project for social change.

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Student data, in some cases, highlight a perspective that goes beyond the personal experience and take into account a holistic approach to social issues.

In two cases digital citizenship and problems addressed in the students video (internet/smartphone addiction; inappropriate behaviours; risky challenges) were analysed and put into relation with possible causes such as a deprived family background. Students mentioned the relevance for social change to involve actors from different contexts in order to have a comprehensive landscape of the problem and better chances to realize a successful synergy (e.g. between the educator and the teacher at school) in the development of a social project. Entering a dialogue with external stakeholders or with direct beneficiaries, as told by stud31, "let you collect and address the different nuances of the topic". Group 5 refers to the net of the social relationships in a way different actors can accompany youngsters in their development, observing and opening a dialogue with them with delicacy and caution when entering their world. Social change was referred to as a path that starts with information and progress with a critical behaviour that can support the development of awareness.

To conclude PV was recognized as a precious opportunity for students to express what they really perceived about digital citizenship and what sources they could rely on to strengthen their knowledge and plan an educational use of the video. There was no significant difference among groups' data related to the video style chosen. The video development revealed as an emotional and rational process at the same time, since the most engaging languages of the video coupled with the descriptive written language of the presentation, as stud25 said "Video is a means that moves the souls and the minds".

4. Conclusion

The discussion of data appears to be consistent with results of the previous case studies (Fedeli, 2019a; Fedeli, 2019b) in terms of perceived efficacy of group-work and the engagement promoted by the collaborative video production in terms of social commitment. PV that was, here, analysed as an approach to train future social educators by involving students in a practical activity whose focus was digital citizenship shows successful results in the direction of an acquired self-reflection attitude by students not only about the relevance of the topic, but also in its contextualization and professional application. Students were able to perceive the advantages of active educational strategies specifically because the attention on the process (the group work) is joint to the motivation of reaching a common concrete goal, the video (Kiili et al., 2012). In the case of the workshop here described, differently from the previous case studies, digital citizenship was chosen as pre-determined theme for the video. The topic revealed its power for two main reasons: students realized that, even if digital life is familiar to them, this is not enough to be prepared to face the challenges and the risks associated to this dimension and that, in order to use a video for social change the educator needs to take into account different parameters (kind of contexts, audience, actors involved, etc.) and provide additional resource to enrich and valorize the message you want to disseminate through a short video. As future educators students of the sample reported that they would use the same approach of PV to engage their future learners/beneficiaries in the active production of a video as an educational strategy. When asked why they would use PV their feedback was mostly focussed on the opportunity to encourage dialogue and discussion through an "object" (the video) that is concrete and that can easily reify people's feelings and opinions, since it is created by the actor of the educational activity (the educator himself/herself or/and the students/beneficiaries).

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