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# THE ISSUE

## VOL. 13, N.3, 2017

by Nicola Villa

In this issue of Je-LKS we publish a selection of papers presented at the **Italian Conference on e-Learning , Media Education and MoodleMoot - EMEMITALIA**, which was held in Reggio Emilia from 7 to 9 September 2016.

EMEMITALIA is a multi-conference following the attempt to unify under a common hat the initiatives of the scientific societies and national communities active in the use of technology in training and educational processes.

***Design the future!*** was the theme of the multi-conference, that had involved schools, universities, Public Administration and companies during the three days in Reggio Emilia.

This plurality of the participants and research included in the conference is expressed in the published works, that you can find in the proceedings edited by Marina Rui, University of Genoa (*Design the Future!*, Genova University Press, ISBN: 978-88-97752-89-9).

In this number we host nine extended papers from the conference, after a new evaluation by our reviewers.

Maria Carmela Catone and Paolo Diana (***Social Research Methods 2.0: e-learning design***), starting from a reflection on the aims and learning outcomes of the undergraduate course on social research methods and an analysis of the entry level skills of students, especially related to the numerical reasoning, illustrate the design process of a course in a blended format. In particular they present the activities of translation, implementation and innovation of the logical and conceptual structure of quantitative empirical research in the e-learning environment.

Gianni Fenu, Mirko Marras and Massimiliano Meles (***A Learning Analytics Tool for Usability Assessment in Moodle Environments***) deepen the subject

of user experiences' evaluation, focusing on Moodle LMS.

Corrado Petrucco and Cinzia Ferranti in the article ***Developing Critical Thinking in online search***, illustrate a qualitative-quantitative survey conducted during a course in Educational Technologies within a five year Degree program. The outcomes of the survey reveal some interesting behaviors and perceptions of students when they are faced with the Web search process and the characteristics of their critical thinking processes.

Giovanna Berizzi, Eugenia Di Barbora and Maddalena Vulcani in their paper ***Metacognition in the e-learning environment: a successful proposition for Inclusive Education***, describe a research on Locus of Control mode, that shows that an attributive-metacognitive training can improve the attributional style of students with Special Educational Needs (SSEN).

Marina Marchisio *et al.* (***Advanced e-learning for IT-Army Officers through Virtual Learning Environments***) present and discuss the joint experience of the IT-Army Education and Training Command and School of Applied Military Studies of Turin and the University of Turin, that worked together to designed an advanced e-learning path.

The article ***Are Computer Adaptive Tests suitable for assessment in MOOCs?*** is written by Veronica Rossano, Enrica Pesare and Teresa Roselli. The paper, to understand if Computer Adaptive Testing (CAT) could be suitable for assessment in MOOCs, proposes a first algorithm to measure the acquired knowledge using a quiz-game and the pilot study attests the users' appreciation.

The article of Maria Cinque (***MOOCs and Soft skills: a comparison of different courses on Creativity***), reports the results of eLene4work project, carried out between 2014 and 2017 and focused on the selection and definition of soft skills, including digital soft skills, and in particular the selection and classification of MOOCs on creativity.

***MOOC Design and Heritage Education. Developing Soft and Work-based Skills in Higher Education Students*** is the paper by Antonella Poce, Francesco Agrusti and Maria Rosaria Re. They describe one of the pilot activities foreseen by the Erasmus+project DICHE (Digital Innovation in Cultural and Heritage Education in the light of 21st century learning). The pilot activity was carried out at the undergraduate course in Educational sciences – University Roma TRE, as an internal training module for the conception, implementation and

evaluation of MOOC courses in museum education.

Closed the EMEM 2016 section the article by Alice Barana *et al.* (***Open Platform of self-placed MOOCs for the continual improvement of Academic Guidance and Knowledge Strengthening in Tertiary Education***) describes the methodologies adopted in Orient@mente project, aimed to support students in the transition from high school to university, the obtained results and future developments.

Closes the issue two papers selected after the usual peer review procedure .

The work by Antonella Carbonaro and Mirko Ravaioli (***Peer assessment to promote Deep Learning and to reduce a Gender Gap in the Traditional Introductory Programming Course***), introduces a web-based system, which improved students' program skills by reviewing peers' source codes and delivering feedback to peers.

The paper by Ana Maria Ortiz Colon, Inés María Muñoz Galiano and Maria Jesús Colmenero-Ruiz (***Impact of the Flipped Classroom Model and Collaborative Learning in Childhood Teaching University Degree***) shows the applications of the fipped classroom model (JITT) as an emergent didactic strategy with two groups of students in Childhood Teaching Degree, using the methodology of collaborative learning, where the professor implemented the fipped classroom model in one of the group.

The next issue of Je-LKS (January 2018) will be dedicated to the theme ***New Trends, Challenges and Perspectives on Healthcare Cognitive Computing: from information extraction to healthcare analytics***. The call for paper, edited by Mauro Coccoli, Paolo Maresca and Gabriella Tognola, is currently open and the deadline for the final submission of papers is November 15th.

You can find all the information of the call and the free access to all the published paper on the journal's website **www.je-lks.org**.

**Nicola Villa**
*Managing Editor*
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# SOCIAL RESEARCH METHODS 2.0: E-LEARNING DESIGN

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**Keywords:** Blended learning, Quantitative social research, Social research methods, Numerical reasoning.

Starting from a reflection on the aims and learning outcomes of the undergraduate course on social research methods and an analysis of the entry level skills of students, especially related to the numerical reasoning, this article illustrates the design process of the course in a blended format. In particular, we present the activities of translation, implementation and innovation of the logical and conceptual structure of quantitative empirical research in the e-learning environment. From our point of view, the use of the e-learning platform allows the learner to overcome the difficulties that they usually have in the quantitative analysis of social phenomena.

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## 1 Introduction

The design and implementation of a university learning environment is a complex activity consisting of a reflection on different aspects, ranging from the pedagogical and disciplinary knowledge to the analysis of the characteristics of the learners (De Rossi, 2015). These issues have been considered for the design of social research methods course, planned in the second year of the bachelor degree in Sociology at the University of Salerno. In particular, since more than 10 years we have carried out many research on the teaching and learning processes of the discipline, on the different pedagogical strategies, also linked to the ICT innovations and to the use of e-learning, and finally on the socio-cultural profile of southern Italy and Campania region students (Diana & Catone, 2016; Catone & Diana, 2016; 2015). Starting from these analysis, since 2001 the social sciences methods course has been offered in both full distance and blended formats. The experience and the results obtained have led us to continue our reflection on the most appropriate teaching strategies able to facilitate the learning path of students and to foster the acquisition of their methodological expertise.

In this article we present the design activity of a blended social research method course by building an e-learning platform that reproduces the quantitative empirical research process, which is the main object and learning outcome of the course. More specifically, skills, motivations, and pre-knowledge of the student have been at the center of the platform design, in order to provide a learner centered approach, based on a socio-constructivist perspective (Scardamalia *et al.,* 2012; Calvani, 2005). These concepts are developed in the following three sections of this paper: section 1 deals with an analysis of the learning aims of the course and the outcomes of the student; in section 2 we illustrate the entry level skills of the students related to the numerical reasoning by presenting the results of an evaluation test; the last paragraph concerns the design activities of the e-learning platform as support of the frontal lectures in order to overcome the issues identified.

## 2 Teaching social research methods: aims and learning outcomes

Social research methods course is planned in the second year of the bachelor degree in Sociology at the University of Salerno: it has a duration of 60 hours for a total of 9 training credits and in last academic year has been attended by an average of 130 students. The course deals with the key problems, methods and techniques of social research to enable student to carry out sociological investigations of the social world. More specifically, the course introduces to the different stages that characterize the empirical research process of the

quantitative approach from the formulation of researchable questions, to the choice of appropriate research strategy and the use of data collection and analysis techniques. In other words, the course aims to provide student knowledge and skills of the theory and practice of social research methods needed to develop an adequate command of the methodological toolkit. In particular, the educational path encourages the acquisition of methodological competence which is mainly made up of two aspects: the abilities to do research and to evaluate the work of others (Ricolfi, 1997). According to this perspective, the course takes account of the double nature of methodology, which is characterized by the operative dimension of research and the normative one that provides its abstract re-elaboration (*Ibidem*). The presence of these elements implies the need to offer students both the formal and procedural methodological aspects as well as the operational and technical ones that characterize the "concrete" research situations (Meraviglia, 2004).

At the end of the course, student should be able to develop the conceptual structure of a quantitative empirical investigation, to choose and use the most appropriate research techniques needed to answer the research question. Moreover, being the course focused on quantitative methods, student should acquire the skills and capabilities for reasoning with number, i.e. a capacity that is not simply based on counting, measuring and calculating but combine number with argumentation and exposition (Payne & Williams, 2011). For example, student should learn: to collect primary data by constructing a survey or secondary data, browsing on specific social sciences databanks; next, to select and use appropriate data analysis techniques through specific social sciences software (e.g. Excel and SPSS); to write a research report; to proficiency use specific tools for data visualization; to critically read, understand and evaluate the results of a social research; to acquire an appropriate linguistic register that makes sociology as a scientific discipline. This knowledge enables the student to adopt a sociological perspective based on methodological rigor that is needed to understand the social world in everyday life as well as in the world of employment, business and management. In this sense, it allows the learner to discern common sense - the knowledge based on prejudices, and value judgments - from scientific reasoning - the knowledge instead characterized by method.

As developed in the following sections, to respond to these goals we have chosen to adopt a learning by doing approach (Schön, 1987), which can favour fieldwork activities and the practical dimension of discipline to give a deeper understanding of the key concepts of the subject.

During the frontal lectures the practical tasks are usually neglected for a different types of reasons: for example, the teacher usually spends more time on the theoretical aspects than the empirical research applications and meets

difficulty to manage and supervise the activities of a large audience of students. The importance of linking methodological theory to the practice of research to foster the methodological expertise of student and encourage his critical thinking is part of wider reflection developed in emerging studies and research on the pedagogy of social research methods (Lewthwaite & Nind, 2016).

## 3 Reasoning with number: the bias of students

During the quantitative social research methods course students usually encounter typical difficulties, mainly related to the performance of quantification tasks needed to understand the empirical research process (Diana & Catone, 2016; Catone & Diana, 2015; Payne & Williams, 2011). The bias that students of social sciences have in the numerical and statistical-mathematical reasoning and calculation, according to our teaching experience, are a combination of the following aspects:

- the prejudice toward the "world of number": learners are often worried about the technical aspects, as they believe to not possess the quantitative expertise required by the discipline;
- a wrong conception of the sociology course degree: according to Williams and Sutton « because the social sciences are not usually seen as numeric disciplines and because what numerically-inclined people gravitate towards are science and technology, social science subject intakes in universities are primarily non-numerically inclined students» (2011, p. 67);
- the numeracy lack of students linked to their possible bad experience in secondary education that can determines an aversion toward quantitative skills.

These aspects contribute to generate a sense of anxiety that many undergraduates usually feel when they face with numbers and statistical argumentation. The role of the methodology is to link the statistical concepts with logic and reasoning. This is a crucial factor for a sociology student, who deals with the study and understanding of a plethora of social phenomena. As stated by Payne and Williams «without resorting with numbers – sizes of groups, frequencies of occurrences, rates of change, distributions across locations – these cannot be fully comprehended» (2011, p.3). According to this perspective, it is fundamental that sociology students will acquire quantitative methods skills, considered as form of a logical system of reasoning and not as a simply technical ability. These capacity to proficiency develop a numerical reasoning also contributes to recognize common sense from scientific reasoning. To enhance the acquisition of these abilities, we have carried out an evaluation

test on the entry level skills of students, attending the course in social research methods, and in particular on the level of numerical reasoning. This choice seemed to us appropriate to adopt a student centred pedagogical approach that allows to adapt the content and teaching strategies to educational needs and knowledge of the students (Mannay & Wilcock, 2014).

The test has been designed to investigate three main dimensions in which the cognitive quantification process could be articulated: the first dimension aims at identifying the quantitative knowledge of some of the main demographic, social and cultural aspects of Italian phenomena and its geopolitical levels (1- 13 items, Tab. 1); the second dimension concerns the quantitative aspects that affects the sphere of everyday life - especially related to the university context - of the students (14-18 items, Tab. 1); the last dimension relates to the ability of quantification of the phenomena concerning the cultural and media consumption (19-22 items, Tab. 1). The assessment of student quantification skills on these dimensions, from our point of view, allows us to understand the level of knowledge of the social world in which sociology student is embedded, that also represents his object of study and investigation.

The test was comprised of 22 closed-ended questions; each item has four possible answers: only one is the correct answer; another is similar to the correct one, while the other two are completely improbably compared to the asked phenomena. The test was administered to 120 students during the first day of lecture of social research methods course, which was offered in the second semester of the 2016/2017 academic year.

The results of the first 13 questions suggest deep gaps that students have in quantitative skills related on the knowledge of demographic and socio-cultural phenomena in Italy and in the Southern Italy: for example, only the 56.7% of students knows the amount of the Campania region population and only about 30% the amount of foreign people living in Italy and in Campania Region.

Moreover, the results of unemployment rate show that the percentage of corrected answers increases when the phenomenon affects the student's social proximity, i.e. his life and behaviours: 20% of students exactly answers the question on Italian unemployment rate in contrast with 51.7% obtained on the youth unemployment rate. A significant factor concerns the lack of knowledge of the results of the Italian referendum, held on 4$^{th}$ December of 2016 on the constitutional law; although it has been an important topic debated for many months on the Italian political and media agenda, only 56.7% of students correctly answered to the related question; moreover, about one third of the students has even reversed the result, showing a deep knowledge lack on this phenomenon. These are important deficiencies that need to be overcome not only to be caring citizen, but mainly for the a sociology student who should

be sensitive, curious and adequately informed to what happens around him. Moreover, this data suggests the emerging estrangement of young people from the traditional forms of political participation (Istituto Toniolo, 2017).

Table 1
QUANTIFICATION ENTRY LEVEL SKILLS OF STUDENTS

| Questions | % of correct answers for each item |
|---|---|
| 1. How many people is the Italian population? | 73.3 |
| 2. How many people is the Campania region population? | 56.7 |
| 3. How many regions are there in Italy? | 73.3 |
| 4. How many provinces are there in Italy? | 60.0 |
| 5. How many foreigners live in Italy? | 31.7 |
| 6. How many foreigners live in Campania region? | 33.3 |
| 7. How many NEET are there in Italy? | 25.0 |
| 8. How much the unemployment rate in Italy is? | 20.0 |
| 9. How much the unemployment rate in the South of Italy is? | 28.3 |
| 10. How much the youth unemployment rate in Italy is? | 51.7 |
| 11. How many elderly people are there in Campania? | 11.2 |
| 12. Considering the Italian population aged 30-34 years with tertiary education which is the position of Italy in the European ranking? | 18.3 |
| 13. Which were the results of the Italian referendum on constitutional law? | 56.7 |
| 14. How many students are enrolled at the University of Salerno? | 58.3 |
| 15. How far (in Km ) is the city of Salerno from Salerno university campus in Fisciano? | 56.7 |
| 16. In which of the following countries (Spain, Portugal, Germany, Finland) would you buy less stuff with only 1 euro? | 35.0 |
| 17. Which is the position of province of Salerno in the Sole 24 Ore quality of life ranking,? | 8.3 |
| 18. Which is position of the University of Salerno in the ranking of the best Italian universities? | 36.7 |
| 19. In average how many users connect to facebook in a month? | 45.0 |
| 20. How many YouTube views has Occidentali's Karma - the winning song of the 2017 San Remo festival - registered? | 48.3 |
| 21. In average, how many newspapers does La Repubblica sell each month? | 36.7 |
| 22. How many viewers have followed the last edition of San Remo Festival? | 55.0 |

Other lacks relate the quantitative aspects that affect the sphere of everyday life of students who seem to not have an adequate awareness of the context they live: only almost 8.3% knows the position of the province of Salerno in the Sole 24ore quality of life ranking, underling that students have significant difficulties to reflect to the living conditions that contribute to the levels of life quality. Another important result relates the wrong perception of the life cost and of the

purchasing power, as only 35% answered that Finland, compared to the other 3 countries indicated in the answer (Spain, Germany and Portugal), is the most expensive. This difficulty of quantification in a comparative perspective also indicates a distorted knowledge and understanding of the student living area.

Last questions deal with the cultural and media consumption: although this generation of students is part of millennial and digital natives, they show gaps related to quantitative data that can be easily extracted from the traditional and digital media: for example, only about 50% had an idea of the number of YouTube viewers registered by the winning song of the last San Remo music festival. According to these results, we have tried to imagine a study path that makes the student closer to the quantitative knowledge of social phenomena. In the next section, we will illustrate the e-learning platform design, that can enhance the cognitive process of numerical reasoning with the performance of specific activities and the use of user-friendly online resources.

## 4 E-learning design

The issues above identified related to the learning aims of the course, the entry level skills of the students as well as the need to balance the theoretical and the practical dimensions of the discipline have led us to rethink the way to offer the quantitative social research methods course. More specifically, the analysis on these aspects has suggest us to design and implement a blended course as the most appropriate educational strategy (Capogna, 2014; Garrison, 2011; Andrews & Haythornthwaite, 2007). This choice is suggested by our long experience developed since 2001, when social sciences research course was offered both in blended and full distance formats (Diana & Catone, 2016). Moreover, the use of blended learning is firstly an attempt to promote a learning by doing approach, often neglected during the frontal lectures (Debbagh, 2005): the theoretical aspects of the discipline acquired during the frontal lectures will be applied through the performance of specific activities, provided by the e-learning platform (Bruschi & Ercole, 2005). Secondly, the platform, if carefully designed, could became a direct channel to bring the student closer to the study of social phenomena according to a quantitative approach, trying to overcome the numerical reasoning bias.

Related to the pedagogical choices, the social research methods blended course will be carried out using a constructivist pedagogical perspective that places the student at the center of the knowledge production process, through collaborative activities between peers and the performance of authentic and contextualized tasks (Jonassen, 1994).

The platform will be built in a Moodle environment in order to encourage problem solving skills, collaborative learning (Messina *et al*., 2015; Ghislandi

*et al*., 2008) and the creation of a learning space, able to foster interest and curiosity of the learner towards discipline (Fig. 1). The contents of the course will be structured in units that that will be released by the teacher.


Fig. 1 - Structure of the e-learning unit

Each unit will include: a section related to the synthesis of the topics, firstly explained during the frontal lectures, developed by using multimedia and interactive resources; a section with activities such as exercises and simulations; a section including the working material like datasets, research reports, questionnaires, bibliographic resources, with a special focus on the online social research tools (online databanks, web-surveys, online data visualizations tools). The platform will also host synchronous (chat) and asynchronous (discussion forums) tools to promote both the communication among students and with the lecturer and the tutor.

The structure on which we will design the e-learning course reproduces the five stages that, according to methodological literature, characterize the empirical research process: research design, construction of the empirical basis, data organization, data analysis and presentation of results (Ricolfi, 1997). Each stage will correspond to a unit of the course.

This choice offers the student to be involved (Fedeli, 2016) into the quantitative research process as a workplace that makes him aware of the activities to perform and able to ask the right questions needed to answer the cognitive aims. The five phases of the research represent an ideal path that goes from theory to the empirical control and must be considered as logical activities and not as «a simple one-dimensional sequence of steps» (Marradi, 1996, p.76): in other words, the student will follow the main process provided

by the e-learning environment but, at the same time, he/she will choice the different paths, through the use of the different resources, activities and in depth areas characterizing the platform.

The opportunity to follow the five stages of the quantitative empirical research developed in the platform will allow the student to understand the difference between the scientific and common sense reasoning: he/she will be guided to face with specific questions on social phenomena of everyday life contexts and to answer with rigor and argumentation; moreover, he/she will socialize to the use of numbers in a scientific perspective, trying to overcome bias related to the number reasoning. In this sense, the platform will play as a fundamental guide for the learner who can improve his quantification skills with specific activities, such as the opportunity to explore, collect, analyze and interpreter the large mine of online data needed to answer specific cognitive questions.

We now present the design of the five stages of quantitative social research and the correspondent e-learning activities (Tab. 2).

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Table 2
QUANTITATIVE SOCIAL RESEARCH PROCESS AND E-LEARNING ACTIVITIES

| Stages | Learning aims | E-learning activities |
|---|---|---|
| Research design | Identification of the cognitive aim, literary review and methodological choices | - Use of online bibliographic archive: Sociological Abstract, Social Sciences Citation Index, Scopus, Google scholar<br>- Gamification activities |
| Building of the empirical bases | Collection of primary or secondary data | - Interactive exercises<br>- Use of web data collection resources: Google Docs e Survey Monkey<br>- Use of Istat (Demo: demografia in cifre; Noi Italia; Italia in cifre), Eurostat, OECD, World Bank, UNESCO, Open Coesione, Dati.gov databases |
| Data organization | CxV matrix building | Building of a matrix, data coding and data input |
| Data analysis | Univariate and bivariate data analysis | - Interactive activities<br>- SPSS and Excel exercises |
| Result presentation | Communication of the results | - Development of a research report<br>- Use of presentation tools (e.g. Prezi, Power Point, Tableau)<br>- Development of info graphics with online tools |

The first phase is the research design, characterized by the choice of the

cognitive aim of the social investigation and the definition of the sociological concepts to empirically translate. The e-learning platform will support the student in the performance of different activities such as the literature review, through the use of specific online bibliographic archives such as Scopus, Google Scholar Sociological Abstracts and Social Sciences Citation Index (Corbetta, 2003)

In this stage it could be useful, in our opinion, to carry out gamification activities that encourage the ability of learner to take specific choices according the typical issues that may occur during the empirical research process.

Also interactive exercises (e.g. drag and drop) will be realized to support the learner in the selection of the social indicators that better empirically measure complex and theoretical sociological concepts (Fig. 2).


Fig. 2 - Selection of social indicators – drag and drop exercise

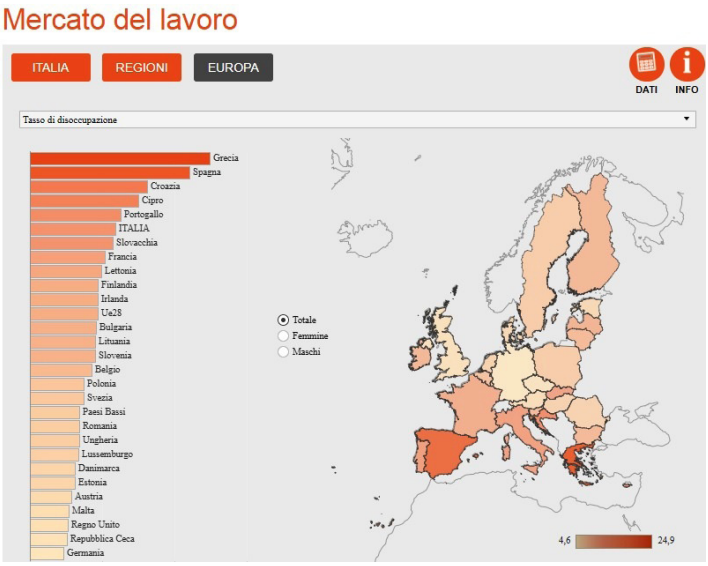
The next phase is the construction of the empirical basis consisting of a data collection activity.

In case of primary data, the platform will guide the student to build a structured questionnaire that represents one of the most used data collection techniques in the social sciences. To make the student familiar with the use of the technique, the platform will include tasks on the structure of a questionnaire as well as a wide library of surveys. For example, student will be led to the knowledge and analysis of the "Aspetti della vita quotidiana" Istat (Istituto Nazionale di Statistica) questionnaires and, through self-evaluation exercises, he/she will identify the correspondent type of variable for each question. Moreover, also new forms of data collection, with a focus on web surveys, will be

presented: for instance, some activities to promote the use of the main tools for the implementation of online questionnaires, such as Google Docs and Survey Monkey.

In the case of a secondary data research, student will be supported in the knowledge ad use of the online resources that represent the new frontiers of social research: online national database such as Istat data warehouse and its specific sections (e.g. Demo: demografia in cifre; Sistema informativo sulle professioni; Scuola, università e mondo del lavoro; Noi Italia); the international databanks such as Eurostat (Ufficio Statistico dell'Unione Europea), OECD ( Organisation for Economic Co-operation and Development), UNESCO (United Nations Educational, Scientific and Cultural Organization) and the open data platforms like Open Coesione and Dati.gov.it. An informed knowledge of these resources became crucial to bring the sociology student closer to the understanding of real world phenomena dealt with scientific rigor. In particular, some activities will concern the use of these platforms to make the learner able to collect and interpreter the data and to answer to specific question on social issues such as immigration, education, unemployment, etc. For example, as shown in Fig. 3, student will be asked to browse on "Noi Italia" Istat platform to know the European unemployment rates and download the correspondent data matrixes.

Once the data have been gathered, the next step of the quantitative research process relates the data organization: during this stage the data is organized in a CxV (cases x variables) data matrix. The e-learning platform will provide exercises related to the data input of structured questionnaires included in the working material section and specific tutorial needed to correctly extract secondary data. Next, the learner will be supported in the data analysis that is usually considered as the most complex stage of the whole research path, because it deals with the statistical and numerical concepts. According to us, in this unit it is necessary that the learner could carry out activities that promote both reflection on the choice of the techniques that best answer the cognitive aim of the research and experience in data analysis itself.




Source: http://noi-italia.istat.it/

Fig. 3 - ISTAT data collection activities

For this reason, the platform will include research situations in which the student will have the opportunity to choose the type of analysis that could respond to the objective cognitive as well as a wide library of data analysis activities; these tasks will be done using the most used data analysis software in social sciences such as SPSS and Excel; moreover, scientific articles, research reports, surveys (for instance, "La situazione del Paese" and "Italia in cifre" Istat annual reports) will be inserted in the platform working material in order to develop methodological expertise, such as the ability to read and to critically interpret tables and graphs. These activities allow the learner to perform the numerical activities with exposition, reasoning and argumentation.

The last phase of the empirical research process is the presentation of the results; student will learn: to communicate the most interesting results by linking them to initial hypothesis and the theoretical framework of the research design; to prepare a final report and presentation using both traditional (e.g. Power Point) and innovative data visualization resources (e.g. Prezi and info graphics online tools such as Tableau). At the end of this process, the student, through the performance of real and contextual tasks, will be able to understand the different stages of a quantitative social research and, in general, to give an answer to the social research question with scientific exposition.

## Conclusions

The vast and increasingly amount of information, arguments, research finding and data offered by Internet represent a valuable opportunity to foster social research methods learning and to overcome students bias mainly linked to numerical reasoning. In this article we have shown how the blended course and in particular the support of the e-learning platform to the frontal lectures can guide the student in the use of many digital resources, that represent the new frontiers of social research. From our point of view, the use of the platform can also arouse the curiosity and interest of the student, making him motivated and closer to the knowledge and understanding of social world phenomena using a scientific method.

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# A LEARNING ANALYTICS TOOL FOR USABILITY ASSESSMENT IN MOODLE ENVIRONMENTS

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**Keywords:** Learning Analytics, Usability Evaluation, Learning Management Systems, Moodle.

Evaluating user experience is a challenging task, particularly in e-learning. Existing e-learning systems are limited in their ability of being evaluated based on the user interfaces because current evaluation approaches are usually expensive in time and organization and require active users' participation. Moreover, a usability assessment is needed whenever a new version of the "user interface tailored for a given type of device (e.g. laptop, tablet, smartphone) is developed". In this paper, we get around the problem leveraging on the increasing adoption of analytics tools in e-learning and on logs transparently tracked by e-learning platforms. We introduce an automated analytics approach aiming at assessing the usability of both desktop and mobile user interfaces of a Learning Management System through specific native indicators (e.g. efficiency and satisfaction). They are defined as comparable scores and calculated automatically based on the tracked log files. In order to put the proposed approach into practice,

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we implemented it on the Moodle LMS. Our contribution promises to reduce both time and cost for usability assessment of user interfaces in e-learning, while ensuring adaptability to different devices and systems.

## 1 Introduction

Emerging technologies are greatly influencing how people approach daily educational experiences in both formal and informal contexts. The concept of e-learning is gaining increasing popularity since it promotes the adoption of multimedia technologies to improve education, including online and onlife access to content and services. This success has led to a wide range of Learning Management Systems (LMSs), each one of them with different features and learning approaches (Thakkar & Joshi, 2015). Some LMSs are able to improve learning capabilities via social and gaming tools; others have custom services developed to support adaptive mobile learning and ensure online exams integrity (Fenu *et al.*, 2017). Moreover, new data-mining methods embedded into LMSs extract information about the learning processes from raw data to allow teachers and content makers to improve their courses (Conde *et al.*, 2015). The good usability of LMS user interfaces used to provide such features is crucial to ensure positive learners' perception of material and services. Evaluating LMS user interfaces and improving the usability of their design is as essential as challenging.

Since the purpose of e-learning systems is not only to interact, but also to support knowledge dissemination and acquisition, traditional usability design guidelines and usability evaluation methods are not sufficient in e-learning. In general, traditional methods are categorized in analytical and empirical. The first ones are used for interface inspection by usability experts and perceived as a quick and low-cost alternative to the second ones, where testing with final users is performed. However, they require active users participation (e.g. experts or learners) which is usually expensive in cost and time. Moreover, LMS interfaces are firstly designed to allow access from web browsers in desktop devices. Styles and layouts are often responsive. Later, full support for mobile device access (i.e. hybrid or native applications) is provided. This design process has great impact on testing. Every time a new interface is designed or the support for a new type of device is added, a usability evaluation is needed.

In this paper, we get around the problem leveraging on the increasing adoption of analytics tools in e-learning and on logs transparently tracked by e-learning platforms. We introduce an automated analytics approach aiming at assessing the usability of both desktop and mobile user interfaces of a Learning Management System through native indicators (e.g. efficiency and satisfaction). They are defined as comparable scores and calculated based on

the log-files tracked during normal learners' activities. It results in an efficient and transparent usability evaluation method. To put into practice the proposed approach, a Moodle LMS plugin was developed to compute and display the indicators. Our contribution can represent a quick and low-cost alternative for usability assessment of LMS interfaces, applied either in cooperation with the traditional usability evaluation methods or as an independent method.

The paper is organized as follows. Section 2 analyzes the existing usability evaluation methods and analytics tools in e-learning. Section 3 presents the proposed approach, including the description of the required log data and how such data are combined to compute and compare the indicators we defined. Section 4 describes the analytic tool developed into Moodle LMS as practical application. Finally, Section 5 draws analysis and outlines future research.

## 2 Background

In this section, we first provide an overview of how traditional usability evaluation methods play a significant role in external software quality. Then, we describe relevant analytics tools in e-learning and their contribution to acquire information from learners' data. Finally, we focus on works bridging analytics and usability, highlighting similarities and differences with our approach.

### *2.1 External Software Quality Evaluation*

At the basis of software development, particularly of e-learning platforms, there is the engineering aspect. The aim is to create software which does what it is expected to do and does that in the right way. To achieve this challenging goal, software engineering includes tasks such as software quality validation and verification (Vasanthapriyan *et al.*, 2015). The term software quality generally refers to a measure of correctness of a software system, but there are several definitions of software quality and parameters used to model it.

One of the most popular classification is defined in ISO/IEC 9126 standard published by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). This includes six quality features: efficiency, functionality, maintainability, portability, reliability and usability. In contrast, ISO/IEC25010 distinguishes internal (i.e. structural) and external (i.e. functional) quality features. The first ones refer to the perception that the user has of the system in terms of utility. On the other hand, the second ones refer to the development of the software product. In this paper, we consider the external ones. The main properties are: efficiency as the amount of resources expended in relation to the accuracy and completeness with which the users' achieve their goals; satisfaction as the degree to which users are satisfied with

the experience of using a product in a specified context of use; learnability as a measure of how easy is for a user to learn to use a system; memorability as a measure of how a a user easily memorizes the way a task should be performed. The external quality classification proposed in (Rogers *et al.*, 2011) includes the parameters defined into the two standards and we use it to identify our indicators. Such indicators describe the quality of the user experience and greatly influence the success of LMSs.

Evaluation methods for external software quality are used for identifying problems and improving an interface design. In general, analytical methods are used for interface inspection by some usability experts and perceived as quick and low-cost alternative to the empirical methods where testing with final users is performed. Mainly, two analytical methods and two empirical methods exist: heuristic evaluation is a cheap and quick method where a small group of evaluators inspects a user interface to find problems using a set of usability principles; cognitive walkthrough requires that evaluators analyze a user interface by simulating step-by-step user behavior; thinking-aloud asks users to verbalize thoughts while interacting with the interface; questionnaires statistically measure opinions, preferences and satisfaction of users with the interface. The analytical methods identify interface problems cheaply and sooner than empirical one, which identifies more issues, but at a higher cost. The usability inspection should be accompanied by user testing for more reliable results. However, when only one method should be selected, cost-effective and easy-to-conduct analytical evaluation seems to have an advantage. Other researchers emphasize another aspect in the e-learning context, namely pedagogical usability. While general usability is concerned with usability of online environments, i.e. the user interface of the LMS, pedagogical usability is concerned with the tools, content, interface and tasks of learners to learn in various learning contexts according to the selected pedagogical objectives. The main assumption that lies behind pedagogical usability is how the functions of the system facilitate the learning of the material. Evaluating the usability of LMSs includes the e-learning platform and the provided educational content, but the latter is non-frequently studied.

### *2.2 Analytics Tools in E-Learning*

E-learning has led to the increasing availability of data about learners. In this direction, analytics and data mining techniques analyze such data to improve and refine learning through LMSs (Nespereira *et al.*, 2015). We consider analytics techniques for the measurement, collection, analysis and reporting of data about learners to optimize learning and where it occurs.

The goals of analytics in e-learning (i.e. descriptive, diagnostic, predictive,

prescriptive) have been largely analyzed. More precisely, descriptive ones provide information about the current state of the learning environment, then diagnostic ones process values to identify reasons. In addition, if pre-defined patterns are available, future trends can be forecasted with predictive techniques. Furthermore, prescriptive ones can be used to set action plans. These analytics goals are still under research. In (Tempelaara *et al.*, 2015), between the main objectives, the follows are mentioned: predict students' performance; model learning styles; suggest learning material; enhance learning environments. These objectives are achieved through activities and computations which allow to capture students' interactions with resources and other students, providing different overviews and peer comparison (Lukarov *et al.*, 2015).

Multiple learning analytics tools and plugins driven by reference models, data sources and indicators have been developed. In (Del Blanco *et al.*, 2013), the authors underline how the use of standard formats for learning material provides greater support for analytics. Moving the focus to standards suitable for track and store users' interaction, different sources of users' data and correlated type of data exist: demographic data (sign-in on platform), previous knowledge data (entry tests), academic performance data (historical records), learning disposition data (questionnaires) and platform utilization data (system logs). In our approach, we integrate the latter ones.

### *2.3 Analytics Tools in External Software Quality Evaluation*

The increasing adoption of analytics in e-learning has led to several tools defined to evaluate the external LMS quality. In (Nanduri *et al.*, 2012), the authors proposed an analytical framework to evaluate the effectiveness of LMSs. It considers quality characteristics such as accessibility, reusability, performance, security, usability. The focus in (Rohini & Chabbra, 2014) is on the quality component related to navigation and tracking. Using analytical methodologies, the authors created the user interaction pattern and checked parameters on navigation, orientation and learning tracking. The process consists of four steps: prediction (selection of the parameters to be evaluated), monitoring (data patterns are stored during fixed periods), analysis (score computation from raw data) and reporting (visualization of results in a clear way). In (Scheffel *et al.*, 2015), an evaluation framework based on a set of quality indicators (i.e. learning support, learning measures, data aspects, and organizational aspects) is proposed and compared with other frameworks to check correctness and applicability. The results highlight that the framework has issues on concept definition, differentiation, and questionnaire adaption.

In LMS development, its evaluation is essential since the main objective is the good interaction between the users and the offered services. During

the development of platforms intended for desktop usage, effective evaluation methods are usually those in which active intervention of users or experts is required. Although the evaluation results are highly accurate, this evaluation requires a large amount of resources and staff. In addition, managing test users and users' collaboration is not always guaranteed. In (Liaw *et al.*, 2008), they investigated the reasons why users' satisfaction in LMSs was influenced by users' collaboration. In the case of a LMS in which a web portal already exists, at a later stage, developers often provide a responsive version for mobile devices, or even a native application supported by the same backend, but with an entirely-new interface. In such case, performing again an evaluation step is expensive. This is the reason behind our approach, which compares the quality of a desktop interface and a mobile interface to verify that the latter is equally solid from the usability viewpoint.

## 3 The Proposed Approach

In this section, we describe the proposed approach designed for automated interface evaluation, including the description of the required log data tracked by the LMS, how such data are combined to compute the indicators we define, and the comparison process between desktop and mobile interfaces (Fig. 1).

### *3.1 Environment Setup*

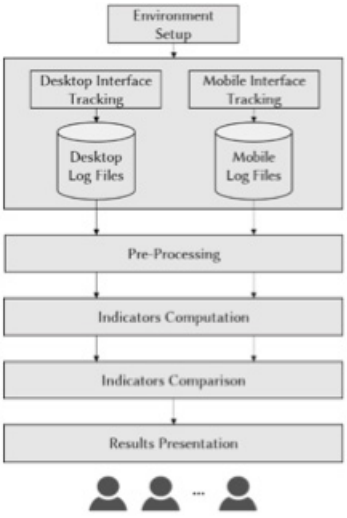


Fig. 1 - The proposed approach

The main goal is to compute a relevant set of usability indicators modelled

as numerical scores to make possible the evaluation and the comparison of desktop and mobile user interfaces for the same LMS. For that purpose, it is required a set of test users (e.g. learners) and a time length for the test period. The number of test users can largely range; a value around 30 can usually ensure statistical validity (Sauro & Lewis, 2012). All the users should use both desktop and mobile interfaces based on their learning context during the test period. Consequently, the comparison will be within-subjects (i.e. all the users use both the interfaces). This setting has been selected since it reduces the variability on how users interact, making the scores comparable. The test period should be long enough to track a relevant amount of data.

During the test period, the LMS tracks the data needed to compute the usability indicators. Section 3.2 describes the format of the tracked data and how the data coming from users' interactions on desktop and mobile interfaces is pre-processed and partitioned. Section 3.3 details how the scores associated to the proposed indicators are computed and Section 3.4 discusses how the scores for both interfaces are compared and presented to human evaluators.

### *3.2 Data Tracking and Pre-Processing*

In the proposed approach, the LMS is instructed to track temporal records related with the time a user performed an interaction on the interface. Each record is associated to an individual interaction and a single type of device. More precisely, the LMS captures the following temporal data for each user:

- **Session Starting Time (SST)** is the time when a new session between the user and the LMS starts, i.e. the timestamp related to the login action.
- **Session Ending Time (SET)** is the time when the current session between the user and the LMS ends, i.e. the timestamp related to the logout action.
- **Activity Starting Time (AST)** is the time when the user opens a resource. The resource is considered consulted if the user spends a minimum amount of time on it. This verification is done through the comparison between the timestamp of access to that resource and the timestamp of exit from it.
- **Activity Ending Time (AET)** is the time when the user closes a resource. If it has been occurred that the user has opened a resource at the time AST, the timestamp of the exit action from such resource represents the AET and it is associated to the last AST for that resource.

Timestamps are formatted in ISO8601, have millisecond resolution, and are partitioned in two sets based on their source device (i.e. desktop or mobile).

### 3.3 Indicators Computation

The approach defines a list of quality parameters and how the associated scores are computed. These scores do not represent an absolute evaluation of the quality, but allow to quantitatively compare two interfaces. Four quality indicators are included: efficiency, satisfaction, learnability, memorability.

**Efficiency**. It aims to evaluate the navigation to the desired resource and the navigation among pages (e.g. statistics, syllabuses). It includes the *Navigation Time* (NT) defined as the amount of time needed to reach and open a page or a learning resource and the *Utilization Time* (UT) defined as the time needed to consult the content of the desired resource. The first one is represented by the difference between AST and SST, while the second one by the difference between AET and AST. Then, the resulting efficiency scores are computed: *Score of Efficiency for Resources* (SER) is defined as the average of all NTs referred to a specific type of interaction in the case the task requires only navigation activity, while *Score of Efficiency for Information* (SEI) as the average of the sums between NTs and UTs for a specific interaction type and a task consisting of navigation and fruition (e.g. watching a video-lesson).

**Satisfaction**. It is an indicator of the amount of time the user spends on the LMS. The parameter is certainly affected by the quality of learning material, but it can be assumed that users do not spend a lot of time on a LMS if they are not satisfied from the user interface. The *Single Session Duration* (SSU) for a given user is defined as the amount of time spent by the user on the LMS during a single session and computed as difference between two consecutive SET and SST. The *Total Session Time* (TSD) for a user is the total amount of time that the user has spent on the LMS and is calculated by adding all the SSU for that user. The *Average Time per Session* (ATS) for a user is obtained by dividing TSD by the number of sessions for that user. Finally, the *Score of Satisfaction* (SS) is the average of the ATS values for all the test users.

**Learnability**. It measures how easy is for the user to execute a task for the first time. The timestamp when the task is executed for the first time and the timestamps of subsequent interactions are compared. If the learnability is low, it will be a significant NT change between the first interaction and subsequent ones; contrary, if the learnability is high, the first interaction is executed in a time near to that of subsequent ones. Low values of the difference between NT of first interaction and NT of *n-th* interaction (*n* is a free parameter) reflect a high learnability. User Learnability Time (ULT) is defined as the difference between NT of the first interaction and NT of *n-th* interaction. *Score of Learnability* (SL)

is defined as an inversely-proportional function associating increasing values to decreasing values of the average of ULTs for all users.

**Memorability**. It is assumed that a user interface is easy to be memorized if an interaction happened after a period of inactivity is similar to the one happened before the period. Low values of the difference between NT of last interaction before the inactivity period and the NT of the first interaction after that correspond to a high memorability. The User Memorability Time (UMT) is defined as the difference between the NT of last interaction before the inactivity period and the NT of the first interaction after that period. The *Score of Memorability* (SM) is calculated with an inversely-proportional function which associates increasing values to decreasing values of the average of all the UMT for all the users, considering the UMTs for a given interaction type.

### *3.4 Indicators Comparison and Results Presentation*

The five mentioned scores are computed for each couple of user interface and interaction type. For instance, if N user interfaces and M interaction types are evaluated, then N*M scores will be calculated. For instance, to compare two interfaces on a specific interaction type considering a given indicator, the desktop interface score and the mobile interface score associated to that indicator are evaluated. However, observing which score is greater than the other is not sufficient since the difference between such scores could not be statistically significant. Therefore, the approach requires to run a statistical test (e.g. Paired t-Test) for each couple of indicators scores and compute the confidence intervals related to the difference. For instance, we consider the couple of scores associated to the SL for the interaction of accessing a video lesson in both a desktop interface and a mobile interface, supposing that the first score is greater than the second one. To establish whether the SL is statistically better for the desktop interface rather than the mobile interface, the statistical test is run to obtain a confidence interval. Considering such interval, it is possible to confirm or discard the initial hypothesis. The scores and the statistical analysis are presented to human evaluators to be evaluated.

## 4 Practical Application

In this section, we describe the analytics tool, underlining the transition from the theoretical approach to the Moodle LMS plugin. This tool puts the approach into practice, providing insights about users' interactions and information on usability comparison between desktop and mobile interfaces.


Fig. 2 - Temporal data bar chart

One of the main Moodle characteristics is the modular structure which allows developers to extend the LMS with new features and functionalities. The proposed tool is developed as a report plugin which provides useful views of data in a Moodle site, using several web technologies: HTML and CSS for structure and styling, PHP as server-side language, JavaScript as client-side language, Chart.js as JavaScript library for graph drawing, JQuery as JavaScript library for ensuring cross-browser compatibility, and AJAX as asynchronous method to exchange data between server and clients.

Each step of our approach is associated to a software module in the Moodle plugin. In back-end, the Data Tracking software module exploits the standard log generation in Moodle. Each interaction with an LMS interface component throws an event notification when a user performs an action for which that component has an event observer. Using Moodle APIs, the module filters the events to be directly read from the logging subsystem, avoiding import/export operations. Then, the Data Pre-Processing, the Indicators Computation and the Indicators Comparison software modules implement the operations and calculations defined by our approach. In front-end, the tool is available on the Moodle main menu with the following pages and functionalities:

- **Usability Score Visualization**. The user can select a reference interaction type and a time period. Based on them, it is displayed a table containing scores for the indicators we proposed. More than one type of interface can be selected and they can be compared considering such scores.
- **Graph Visualization**. Three graph types are available for visualization of aggregated data: a bar chart showing values for the selected indicator for each type of device during a selected period, providing information about the usability changes on the LMS; a pie chart comparing the

number of users' interaction on each type of device; a bar chart displaying data for each user and type of device during a given period (Fig. 2).

- **Temporal Data Visualization**. The user can select a reference interaction type and a period for monitoring the given interaction type. Based on them, it is shown a table with a row for each LMS user. The table contains the average navigation time, the average execution time and the number of interactions on the LMS for each user interface (e.g. desktop or mobile).

Human evaluators firstly setup the test environment, selecting the test users and the test period. Then, they continuously compare the user interfaces under evaluation through the analytics tool available into the Moodle main menu.

## Conclusion

In this paper, we proposed a novel approach based on the use of analytics tools for the evaluation of interface usability using specific native indicators. A proof-of-concept plugin is implemented on Moodle LMS. The proposed approach has several positive aspects. In fact, standard usability evaluation needs active users' collaboration, while our approach transparently collects data during normal learning activities. It promises to reduce time and cost for usability evaluation in e-learning, ensuring adaptability to devices and LMSs.

In future research, we plan to apply the approach in real learning contexts and compare subsequent versions of the same interface or different versions of the same interface for different devices. Moreover, the approach will be tested in other contexts outside e-learning (e.g. e-commerce).

The proposed approach can be an alternative for user interface evaluation in e-learning when it is preferable to avoid no cost-efficient standard methods.

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# DEVELOPING CRITICAL THINKING IN ONLINE SEARCH

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**Keywords:** Information Literacy, Critical thinking, Digital competences.

Digital skills especially those related to Information Literacy, are today considered fundamental to the education of students, both at school and at university. Searching and evaluating information found on the Internet is surely an important competency. An effective way to develop this competency is to educate students about the development of critical thinking. The article presents a qualitative-quantitative survey conducted during a course in Educational Technologies within a five year Degree program. The outcomes of the survey reveal some interesting behaviors and perceptions of students when they are faced with the Web search process and the characteristics of their critical thinking processes: some aspects of critical thinking are generally wellsupported, but others are acquired only after specific training. Experience shows that if properly motivated by metacognitive reflections and a clear method, students can actually critically evaluate the information presented online, the sources, and the sustainability

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of the arguments found. Positive results also occurred when the evaluation process was done in a collaborative modality.

## 1 Introduction

The theme of the development of digital literacy is becoming increasingly important both in the field of education and at the national and international levels. Within the broad conceptual framework that defines "digital competences" lies the area of Information Literacy: this concerns that set of technical and methodological skills that enable a person to know where and how to search for information, to filter it effectively and above all to evaluate it appropriately (Eisenberg *et al.*, 2010). That this is a crucial issue is confirmed by the extensive literature on the subject: students have difficulty not in using the search engines from the technical point of view, but to manage the quantity and quality of the flow of information to which they are subjected to daily and so are often victims of "information overload" at the cognitive level and even of emotional "information anxiety" (Bawden & Robinson, 2009). This occurs both in the educational field as well as in daily life (Catalano, 2013; Eisenberg 2014;). It is therefore important to foster the development of Gardner's "critical intelligence," and critical thinking (Reichenbach, 2001; Cottrell, 2011) in training and educational settings. In order to develop these skills, during a Technology course of a Master's Degree program, we wanted to create a laboratory to improve information literacy skills and to experiment with targeted activities, both offline and online, to improve the research, selection, evaluation and production of information. At the beginning and at the end of the experience students were administered a questionnaire that provided significant results both on their technical skills of Information Literacy as well as on the development of their critical thinking processes.

## 2 Digital skills and source assessment

Digital competence is one of the eight key skills for lifelong learning. In its broader sense, it is defined as the ability to use with confidence and a critical spirit social information technologies. From an institutional point of view, the reference concerns the European Commission's Digital Competence Framework (Ferrari *et al.*, 2013): in particular, the first analytical competence is the one that emphasizes the importance of knowing how to access online information, search, locate relevant information, effectively select resources, navigate between different sources, and finally create personal information strategies. The research literature on the subject in fact tends to distinguish between the single research activities, selection / evaluation and information

disclosure (Calvani *et al.*, 2014; Aesaert *et al.*, 2014), while considering them as part of a single process and notes that students often fail to achieve the appropriate levels of mastery in these last ones, while having no problems in using the tools from a technical and operational point of view. It emerges that, among all the skills involved, those of the metacognitive type are the least developed (Calvani *et al.*, 2014; Kong, 2014). To hypothesize that students because they are "digital natives" already have some or all of these skills is risky (Boyd, 2014) because it assumes a strong interpretative imbalance of digital skills more towards the technological-operational component overlooking the metacognitive process-related components and critical thinking. (Reichenbach, 2001) which then effectively guide the activities of selection and evaluation of the sources (Mason & Boldrin, 2008; Tsai & Tsai, 2003; Parmigiani *et al.*, 2016). For this, it is important to encourage the creation of a genuine research method (Garvoille & Buckner, 2009) to promote the development of critical thinking that will enable students to decide, for example, whether the sources from which the online info comes from are valid or reliable, or whether the content being consider is actually supported by objective data. Typically the literature proposes methods that consist of a series of steps that students should follow to make their information search effective and efficient and consists of activities of verifying the authority of the sources and a comparison with other sources at various levels of depth. This implies the re-elaboration of semantic-level information, for example using different keywords that however belong to the same domain of knowledge (Julien & Williamson, 2010). Students actually find the procedure for choosing keywords and redefining their research one of the most critical elements of the whole process (Hoffman *et al.*, 2008).

However, the metacognitive processes that stem from the activity of information research are not uniform: each student uses his / her own research style (Tseng *et al.*, 2014) and as a consequence obtains a different outcome (Wu & Tsai, 2007). For this reason, rather than imposing a rigid methodology, in our experiments we preferred to propose a strategic approach initially based on the analysis and discussion of specific case studies and subsequently on authentic, situational and problem-based tasks: which also involved the ability to adequately summarize the terms of a problem and to set forth their own opinion in a clear and arguable manner. In fact, the latest models for the development of Information Literacy skills consider research activities not as the sole objective but as complementary to the productive-communicative ones (McNicol & Shields, 2014, p. 23). During the experiment we also adopted a collaborative approach with students to reduce the complexity of metacognitive processes involved in information research and information problem solving activities (Raes *et al.*, 2016). In fact, lots of research on metacognition emphasize the value of collaborative work (Greene & Azevedo, 2010; Panadero & Jarvela,

2015): when students deal with a problem in a group, not only do they benefit by the numerous critical perspectives and multiple informational resources provided by others, but they also better manage their own metacognitive processes (OECD, 2015).

## 3 Methodology and research tools

Forty-eight students enrolled in the second year of a five year degree program with an average age of 29 years participated. The activities were carried out in four successive phases: at the start, a broad spectrum 50 item questionnaire was submitted to broadly test their perceptions and attitudes towards the web, the devices used and the digital skills that they considered necessary for their work and study environment. Afterwards, students participated in an information literacy lab where, besides learning technical skills (advanced search engine research, online data bases, etc.), they learned how to effectively evaluate the quality of documents and Information sources on the web. Students were then asked to take part in activities where they needed to search for information on the Web and to produce a short report to express a personal opinion about three current issues of different emotional depth: 1) the decline in sales of newspapers; 2) The TTIP, 3) the decline in the birth rate and the possible role of immigration in Italy. Students were free to choose the topic to deal with and it's noteworthy to point out how the percentages of the choices reflected the emotional impact expressed by the topic itself, in this case, the topic of immigration. This aspect is particularly relevant as some degree of emotionality is always linked to the development of intrinsic motivation that improves commitment (Vauras *et al.*, 2003). The exploratory investigation also sought to investigate whether the emotional factor affects or not the students' critical thinking performance, and therefore the effectiveness and efficiency of an online search. The various reports produced were then shared online on Moodle and discussed together face-to-face in a dedicated meeting. At the end of the activities, a new questionnaire was submitted to check for any changes in their perceptions and attitudes regarding digital skills and their critical approach to information found online. Other data was derived from an analysis of the textual discussion on the forum. To guide the information and source assessment phases, the students had to verify each time: 1) the correctness of the content also understood as the presence of references to reliable sources, 2) completeness, understood as the degree of coverage of the topic, 3) source update, and lastly 4) comprehensibility, or readability of the information.

The models of reference that were presented to students are those of the "Big 6" Information Literacy Process (Eisenberg *et al.*, 2010) and the one from the

Berkeley Library (Berkeley Library, 2012) "Web page evaluation checklist". The first presents a series of 6 steps ranging from defining the information problem, searching and selecting sources, to synthesizing and self-evaluating the results; the second covers some specific aspects including: verifying the purpose and the functions of the website that is hosting the information (informational, commercial, educational, etc.), it's possible affiliation to some organization to discover the presence of any specific interests or biases and finally the presence of clear references to the author of the information. Attempts were made so that students had to pay more attention especially in the initial stages of the information research, inviting them to clarify what exactly they were looking for, what level of depth of info and what specific support they wanted (text, video, images, data, etc.). In fact, cognitive research seems to demonstrate that a clear representation of the problem in the early stages contributes to its effective resolution (Blessing & Ross, 1996; Chi, 2006). In our case the problem was almost always informative-lexical because search engines like Google anticipate the insertion of keywords that the algorithm then uses to retrieve the Web pages: the more the key words are semantically coherent and specific with respect to the domain of knowledge investigated, the more the results will be consistent and precise by limiting the effects of information overload. It is no surprise to find that experts in a particular domain of knowledge are able to retrieve information more effectively and efficiently precisely because they have a specific lexical vocabulary (Petrucco, 2002).

## 4 Results

The initial questionnaire reveals that 80% of students are employed and have an average age of 29 years; they are mainly employed as educators in educational services and contexts of pre-school and primary school, services connected to secondary school and working with adults and the elderly. All participants have a computer, 90% a smartphone, 42% a tablet; 91% use Social Networks and still 90% have at least one mobile device. The data is interesting when compared to Istat data (ISTAT, 2014) where it emerges that 44% of males and 42% of 25-34 year olds use the Net from a portable or mobile device and in the age bracket of 25 to 34, 80% have an internet connection and 70% use social networks. We are therefore dealing with a group of very connected students in possession of tech tools above the average of their Italian peers. Over 90% conduct online searches, 80% participate in online discussions, but few (15%) use cloud-based tools (such as Google Drive) as a collaborative tool to work with others as active producers of content. Prior to attending the lab sessions, 70% say they feel confident enough with their research skills and only about 20% feel not very confident; at the end of this intervention,

perceptions remain largely unchanged. However, they are more cautious with regard to their perception of search engine results: 72% believe them to be reliable in part or only partially. From a comparison of the data provided in the inbound and outbound questionnaire with respect to the relationship with sources and information, it emerges that, after the experience gained, the degree of importance attributed respectively to the following significantly increases 1) the authority of the sources; 2) completeness; 3) accuracy and 4) the update of information.

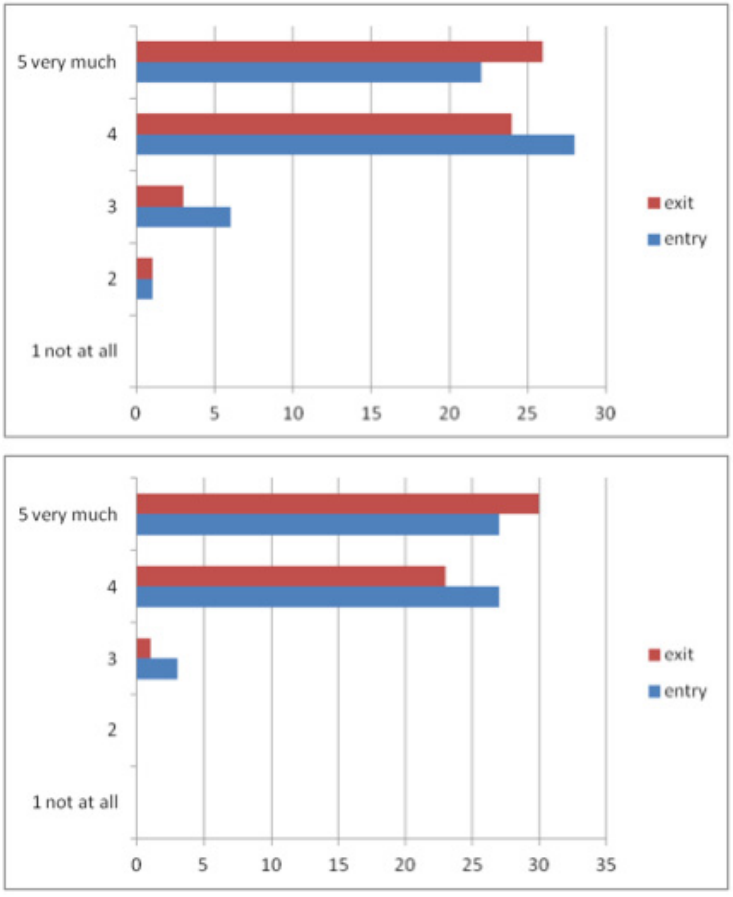


Fig. 1 – Authoritativeness and accuracy of information: comparison of inbound and outbound responses "How important is it to evaluate the authority of the source?" and "How important it is to evaluate the accuracy of information?"

From the analysis of the texts developed in the group, most students (80%) reach a "discreet" level on average, based on a 5-point scale (1 poor, 2 sufficient, 3 discreet, 4 good / and 5 excellent) but very few people reach a "good" or "excellent" level. The overall judgment was drawn on the basis of different weighing criteria: 1) exhibit clarity, 2) logical structuring of contents, 3) quality of argument 4) support of statistical data, 5) contextualization of the problem, 6) completeness of the vision of the problem 7) dialogic explanation of doubts, 8) critical attitude, 9) number of sources. In addition the best performance came from students who chose an emotionally more engaging theme (immigration) than those who chose the other topics. Overall, observing student practices and their discussions in the forum, the criticalities that emerged from their process of acquiring and processing information can be summarized as follows:

- Difficulty initiating an initial reflection on the most relevant keywords and managing the semantic restructuring processes related to the topic to be searched on the search engines, often detecting an insufficient specific strategy based on the investigated domain of inquiry;
- difficulty in applying explicit evaluation criteria in selecting information
- difficulty in integrating in a fluid and logically sustainable manner the information found;
- lack of a choice regarding a preferential format for information use

With regard to the first point, almost all students admit that their search process starts from the Google page and from some keywords entered without much reflection on the terms inserted and without using advanced search options, like OPAC or special and sector specific engines related to the topic to be investigated. From a strategic point of view, they stop at the first pages found by the engines confirming some previous research (Lau & Coiera, 2009), that found that during the navigation and web search process one tends to select the information that confirms what we already know or our opinions and only to memorize the last contents found (the so-called "last click"). Experience shows that, in addition to purely technical aspects, students need to test their critical abilities and that these will be used by them to make decisions (purchasing, health, professional, and political, etc.) and to achieve a certain degree of autonomy in the overall process of building their own knowledge and evaluating the knowledge published on the net. It should also be pointed out that the first approach to the information sought is a delicate orientation phase where the chaotic nature of information and the unstructured form, at least in the dispersion of sources, makes reaching a satisfactory level of clarity and understanding or to know what aspects need further investigation complex.

It was also found that students don't know much or anything at all about

the Creative Commons licenses and how to appropriately deal with content protected by copyright. They also declare that they do not use specific strategies related to the type of information they seek and the most appropriate context (institutional, international and sector type literature, or informal contexts such as blogs or forums, specific databases) and the type of support desired (differentiating the types of files in text, image, audio, video, graphics, and their possible extensions). In fact, one of the most common problems that emerged is that in most cases the strategies are not explicitly disclosed and are not treated as a process where one applies critical thinking. Often they juxtapose the information found to get an answer to the proposed problem, but they do not explicitly use reasoning to falsify the information found. This type of use, that is referred by Popper (1963), provides a scientific attitude to information processing, whereby the student, when evaluating the source and contents found, raises questions that try to refute the information obtained by searching and evaluating the arguments present on the Web, which support the inherent allegations contained in the refutation. In this sense, Information Literacy becomes an area of experience and competence that is not separated from critical thinking or the associated metacognitive processes, so critical thinking is closely related to the process of knowledge initiated by the research. It is not an innate ability, but involves the application of a well-defined critical method. During the information problem solving activity, we also found some difficulties related to the ability to carry out actions to integrate information in order to create a coherent and sustained body of content. The processing of information necessarily involves continually referring to one's domain of reference which, if perceived as a defect, needs to be thoroughly studied.

## Conclusion

The development of critical thinking has certainly always been an ever present objective in teaching and education (Maccario, 1999). Today, due to the numerous information we have access to online, the processes of research and evaluation of documents become important contexts where to apply it. The emphasis of our experimentation was aimed at transforming students' information research processes into real pathways of meaningful learning, in which they are able to develop a metacognitive and critical disposition towards the documents found and above all in their subsequent reworking of an argument in their interactions with other people. We have verified that it is important to stimulate collaborative processes between students precisely in order to be able to use the reciprocal dialogue interactions as a stimulus towards critical thinking. The focus of educational actions should therefore be based above all on the stimulation of the formulation of questions that are able to strategically

guide the research process by verifying the reliability, accuracy / completeness and possible bias of the sources and the authors examined. With regard to this last factor, we have verified that it was often present in the students themselves, and not just in the documents, in the form of true confirmation biases (Jonas *et al.*, 2001) or in the tendency to seek confirmation of their beliefs and refuse evidence which contradicts them. An effective antidote to this bias was when there was the possibility of discussing and comparing their opinions with others in the workgroup, although the members of the group were not always able to reach an agreement. In this sense, at the end of the experiment we proposed a reflection with a question that put more than one student in a panic: "Am I actually able to change my opinion if I find evidence that contradicts my deep convictions on a subject I believe is important?

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# METACOGNITION IN THE E-LEARNING ENVIRONMENT: A SUCCESSFUL PROPOSITION FOR INCLUSIVE EDUCATION

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**Keywords:** Metacognition, e-learning environment, Inclusive education, Special educational needs, Moodle.

The Locus of Control is a specific mode that allows each individual to identify the causes that determine a given event and therefore their own successes and failures. The internal attribution style is based on the subject's ability, commitment, and intelligence. It strengthens self-esteem and sense of personal self-efficacy and is crucial to fostering school success. This research shows that an attributive-metacognitive training can improve the attributional style of students with Special Educational Needs (SEN). Such training offers the students the opportunity to reflect on their skills and strategies by expanding motivation through Information and Communication Technologies (ICT). This perspective and longitudinal study, measured the attribution style of attendees (30 subjects attending the first grade of secondary school in northeast Italy) before and after a metacognitive and attributive program. The training, carried out on-line and in attendance, lasted FOR about 8 months (from April 2015 to November 2015). The article

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presents the positive outcomes of the training, obtained by comparing the data emerging from the Attribution Questionnaire and regularized and standardized values (De Beni & Moè, 1995). The study extends knowledge on approaches and programs aimed at improving the attributional style in children with SEN. A progress of the internal attributional style is conducive to improving academic success in these subjects.

## 1 Introduction

Within the Italian framework on school inclusion, the entry into effect of the Ministerial Directive of 27 December 2012, introduced the concept of "Special Educational Needs" (SEN). The term refers to a very wide area of disadvantage, much broader than the one explicitly referred to in the case of a deficit. Pupils with Special Educational Needs experience a particular organic, biological or otherwise family, social, environmental or contextual related situation that hinders them in development and learning: the difficulties can be global and pervasive or more specific, serious or light, permanent or transitory. To the usual educational needs that all pupils have (need to develop skills, need for belonging, identity, valorisation, acceptance...) something different, "special" is added; to work best with these pupils, therefore, we will need "special" and more effective skills and resources (Ianes & Cramerotti, 2005). During their school career, in most cases pupils with SEN develop a low self-esteem, poor perception of self-efficacy and feelings of depression, in addition to presenting particular issues caused by difficulties of attention, poor motivation and inadequate strategic and organizational skills. The school environment is trying to give concrete answers to the individual needs of these students, with the goal of creating personalized learning paths and providing students with ad hoc tools to learn better.

De Beni e Moe's (1996) studies have found that metacognitive interventions focused on strategies allow to improve the relationship of subjects with the study process, as it recognizes the value of engagement especially in case of failure. Strengthening commitment to engagement and skill is crucial to forming subjects that, effectively utilizing the most appropriate meta-cognitive strategies, successfully deal with school assignments.

Considering also that children are familiar with electronic devices, they know the dynamics of electronic interaction and are highly motivated by the use of ICT), the possibilities offered by technological innovation are fully integrated into the process of building an inclusive, personalized education. Technologies facilitate a multichannel approach serving the different learning styles, allowing active engagement and high attention from students, spontaneously triggering cooperative dynamics and allowing transferability of content and school/home materials. In particular, distance learning via learning

platforms promotes a collaborative, reflective and metacognitive approach to study, as well as allowing the building of learning communities and co-building knowledge (Cacciamani & Giannadrea, 2004; Scardamalia & Bereiter, 2004; Sthal *et al.*, 2006; Trentin, 2001; Varisco, 2008; De Marco & Albanese, 2009; Berizzi, 2016).

Indeed, e-learning produces substantial enrichment in communication, organized in pair and group mode, and in educational co-operation, which is also managed at a distance. ICT tools such as e-mail, Skype network conversations, videoconferencing, e-learning platforms (such as Moodle, Edmodo, and others) have a unifying power because they reduce space-time barriers, allow to create a support network and to enjoy independently and at any time the materials (cards, slides, questionnaires, videos, etc.) made available on the online platform. Participation in remote activities, such as on-line forum discussions, based on the principles of collaborative learning, implies a certain autonomy from the students. Such autonomy, is strengthened by continuous confrontation and support of Tutors and peers, and reflection on what has been done, the goals to be achieved, and ultimately the strategies to be adopted. Thus, the ability to self-regulate the study process is stimulated and participation in collaborative activities is stressed and supported (Lynch & Dembo, 2004, Nevgi *et al.*, 2006, De Marco & Albanese, 2009).

## 2 State of the art

During the school year 2014/15, within the project "Listening to each other to Listen" (Special Tender for the Friuli Venezia Giulia Region, Italy and the Inclusion Network of the Comprehensive School Institute of the Province of Trieste), the activation of a metacognitive e-learning training platform was decided for first-grade secondary school children, belonging to three Comprehensive Schools in Trieste. The experience was addressed to SEN boys with specific diagnosis of SLD and ADHD. SLD refers to Specific Learning Disorders (315 in DSM-5, APA 2013; F81 in ICD-10, 1992) the most commonly OF WHICH are dyslexia, dysgraphia, spelling disorder, and dyscalculia. ADHD, acronym for Attention Deficit Hyperactivity Disorder, refers to the evolutionary disturbance of self-control characterized by lack of attention, impulsivity and motor hyperactivity (314 in DSM-5, 2013; F90 in ICD-10, 1992). The SEN youth training was borrowed from the successful research conducted in the school year 2013/2014 with a group of oncological males at risk of school failure due to disease problems and with a double incidence compared to healthy peers (Shiu, 2001). To help these students succeed in academic achievement, they were offered an attribute training on a Moodle platform that led to a significant enhancement of attribution and changed the attributive style of these oncologic

subjects from external to internal (pre-post internal comparison: Internal_pre 19.69 vs interna_post 26.54: Wilcoxon test: p = 0.0000). In light of the positive experience with the boys in the hospital, the project and the training were transferred to the school. The aim of the school institutions involved in the project was to offer SEN students an opportunity to face more serenely their school career by offering them methodological and didactic approaches to address and overcome difficult conditions. The training offered within a Moodle platform (online computing environment, which involves the creation of virtual classes that enable effective and motivating network learning experiences) is therefore an added value to the metacognitive course, enabling students to identify and develop their potential and capabilities at best, through an innovative and motivating approach. In addition, the on-line platform stimulates students at home, increases their interest and gives them an opportunity to practice independently for self-sufficient control in execution.

## 3 Methodology

Subjects: 30 children with special educational needs (SEN) attending 1st grade secondary school of three school institutes in Trieste were recruited. The subjects of the clinical group who participated and completed the entire metacognitive training course as well as the test/retest phases were 21 (M 66.7%, F 33.3%). They are between the ages of 11 and 15 (average age = 12.4) and have already received a specific diagnosis (DSA 80%, ADHD 20%). Participants' families were given an information letter explaining the project objectives, the steps and the tools used. After obtaining informed consent from parents, the assignment questionnaire (De Beni & Moè, 1995) was given to students for the first time (April 2015). At this point, the first stage (reception) of the attributional training started, as described in Table 1. At the end of the training (end of November 2015), which was done in blended form (partly in presence - eight meetings - and partly on-line), the questionnaire for the 21 subjects who completed all the stages of the program was re-administered (retest). At the end of the training, each participant and their respective parents were asked to fill in a feedback questionnaire in order to gauge interest, satisfaction and usefulness of the training.

Table 1
OVERVIEW OF THE ATTRIBUTIVE AND METACOGNITIVE PROGRAMME

| Main aim |
| --- |
| Enhance children with Special Educational Needs to a positive self-attribution. The positive self-attribution facilitates a better quality of life and success in the field of education. |

| Objectives |
|---|
| Develop motivation, interest, willingness, self-esteemand in the children who enrolled the training, in order to strengthen their self-esteem and their self-efficacy. |
| **Materials** |
| The resources and activities enabled on the platform were: slides (to present the topics of the modules activated), questionnaires (to help the students to reflect on motivation, method and study skills, learning styles, self-control of anxiety, attribution), cards (to reinforce what they have learned and to practice, using new strategies, how to learn effectively), a glossary (where to insert new terms), a forum (with news, welcome discussions on various topics), doors (to send individual homework).<br>The materials (slides, forms, questionnaires, quizzes ...) were designed by the AUTHORS or have been selected from the successive programs: "Imparare a studiare 2" (C. Cornoldi, R. De Beni & Gruppo MT), "Empowerment cognitivo e prevenzione all'insuccesso" (F. Pazzaglia, A. Moè, G. Friso & R. Rizzato), "Percorsi verso il SUCCESSO" (P.R. Ferrari, M. Vassallo e M.A. Zanetti), AMOS, AMOS 8-15 (Cornoldi, De Beni, Moè, Zamperlin & Meneghetti). The materials were adapted to the specific context of the study and to the e-learning modality. |
| **Course structure** |
| There were three phases in the e-learning training program (reception, exploratory phase and reinforcement phase) and these ones were divided in modules. Each participant was given the opportunity to discuss individually the topics debated on the platform.<br>• Phase 1<br>April 2015: initial evaluation of the metacognitive and attributive style of the participants (2 hours).<br>The first phase of reception intended to put each participant of the new learning environment in a state of psychosocial well-being in which they can better understand their needs and their potentiality, start relationships, find the motivation to take up a training path.<br>• Phase 2<br>The second phase of exploration intended to make each participant aware of their limitations and of their potentiality in order to promote the investment of resources on those topics that require more intervention and also to reinforce skills that the students already had, so to strengthen their self-esteem and their self-efficacy. In this second phase issues such as motivation (module 1), method and study skills (module 2), learning style (module 3), anxiety and stress for examination (module 4), attribution and perception of the self (module 5), were discussed.<br>• Phase 3<br>In the third and last phase of reinforcement the efficacy of the method of study was strengthened. Various activities were suggested: detailed reading of slides, forms to complete, discussion forum where to ask questions in order to develop learning strategies that will help the student to memorize a text, make connections and comparisons between items of knowledge, learning to summarize, schematize with concept maps, understand how to take notes, learn techniques to follow the lessons, improve the organization of time, strengthen the motivation, focus on the commitment.<br>Operationally, the participants in the platform had the opportunity to:<br>• access materials to examine in depth the topics;<br>• fill in questionnaires the tutor created for the students; they would then sent them back, completed on-line to the tutor;<br>• complete operating cards that were delivered to the tutor, through a door "delivery tasks";<br>• access a forum where the participants opened discussion threads for dialogue and reflection together on the debated issues.<br>November 2015: final re-evaluation of the metacognitive and attributive style of the participants (2 hours). |
| **Evaluation tools** |
| No evaluation was planned, but frequent feedback was offered on the activities performed by each participant, in order to stimulate commitment and motivation. |

## 4 Results and discussion

The Attribution Questionnaire (*Ibidem*) was proposed in the first phase of research (April 2015) to all subjects in the clinical group and subsequently represented to them (November 2015) at the end of the metacognitive training to verify the changes that have occurred in relation to attribution styles. The scores obtained in the 10 success/failures rates scales (SC, FC success/failure commitment; SS, FS success/failure skills; ST, FT success/failure task; SH, FH success/failure help; SL, FL success/failure luck) by each child were compared to the normality limits for their level of schooling (the normality limit is given by the mean ± standard deviation, ascribed to the average Italian reference sample of 1280 students as indicated by the standardized and validated instrument used). The following are the averages that the clinical group has expressed in each of the 10 attribution scales. The averages obtained in the first test phase were then compared with the averages that emerged in the retest phase.

The data collected in the first phase of the test show a clinical group that presents overall average values, but with very high indices and very close to the high reference values of normality for success rates/failure connected to luck (SL, FL) and help (SH, FH). This indicates that in the first test analysis the attributional system of these children is within the norm but more projected towards external attributes.

Table 2
AVERAGE SUCCESS/FAILURE RATE DUE TO LUCK AND HELP OF THE CLINICAL GROUP WITH REFERENCE TO THE MINIMUM AND MAXIMUM NORMALITY LIMITS OF THE STANDARD ITALIAN SAMPLE.

| Average Success/Luck | | | Average Failure/Luck | | | Average Success/Help | | | Average Failure/Help | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Clin. Gr. | SL ref- | FL ref + | Clin. Gr. | FL ref- | UF ref + | Clin. Gr. | SH ref- | SH ref + | Clin. | FH ref- | FH ref + |
| 10.71 | 3.00 | 13.52 | 9.05 | 3.00 | 12.52 | 8.24 | 2.52 | 12.00 | 6.57 | 1.48 | 10.52 |

The data emerged in the retest show a clinical group that presents overall values within normal limits, but with very high indices and very close to the high reference values of normality for success rates/failure connected to commitment (SC, FC) and skill (SS, FS). In the retest, therefore, an attribute profile of the clinical group more fully oriented towards internal attributes emerges.

Table 3
AVERAGE SUCCESS/FAILURE RATE SCALE DUE TO COMMITMENT AND SKILLS OF THE CLINICAL GROUP WITH REFERENCE TO THE MINIMUM AND MAXIMUM NORMALITY LIMITS OF THE STANDARD ITALIAN SAMPLE.

| Average Success/ Commitment | | | Average Failure / Commitment | | | Average Success/Ability | | | Average Failure /Ability | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Clin. Gr. | SC rif- | SC rif + | Clin. Gr. | FC rif- | FC rif + | Clin. Gr. | SS rif- | SS rif + | Clin. Gr. | FS rif- | FS rif + |
| 28.05 | 20.38 | 31.37 | 28.43 | 18.14 | 29.33 | 19.90 | 8.48 | 21.76 | 15.95 | 7.05 | 18.71 |

In detail, the comparison between the averages of the values expressed by the children in the test/retest, i.e. before/after training, offers promising results. It should first be noted that all values expressed in the 5 successive scales and in the 5 scales related to the failure have undergone modifications. Specifically, the averages referring to internal attributes show implementation of values regarding the commitment and skill scales (SC, IC, SS). This is particularly relevant because commitment, which is "an internal, unstable and controllable attribution, is the most important attribution type to be considered "first" to interpret the score and delineate the attribute profiles (De Beni & Moé, 1995, p. 26).

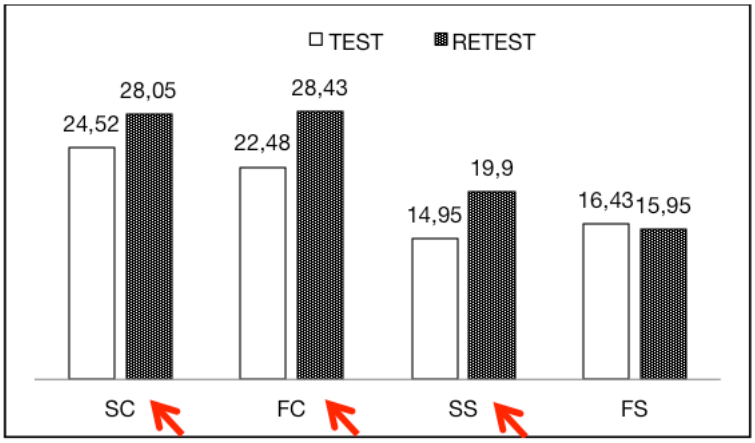


Fig. 1 - Internal attribution (commitment, skills) of the clinical group in the pre-post training comparison

Conversely, the averages related to external attribution, or causes of success/failure attributed to task, help, or luck, indicate a decrease in values expressed in all scales of the retest (ST, FT, SH, FH, SL, FL), thus showing a reduction

of the external attributional locus.

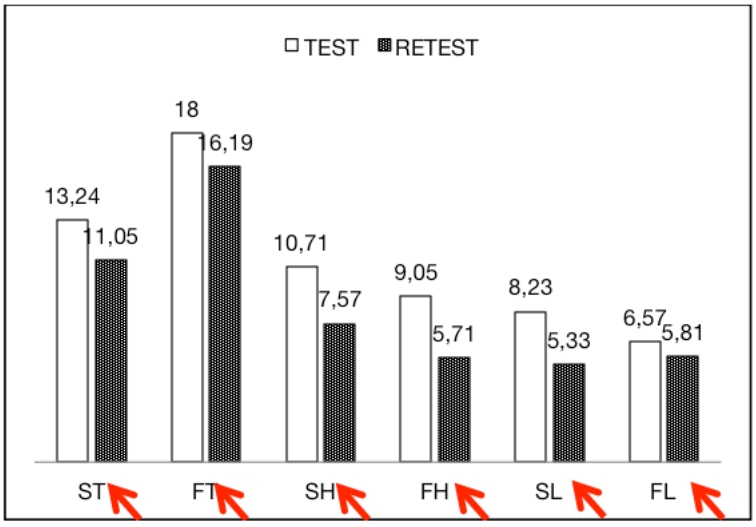


Fig.2 - External attribution (task, help, luck) in test/retest comparison

In summary, the comparison between the averages expressed in the first test phase and the averages shown by the retest indicate a modification of the attribution style of the subjects. This means that the proposed training was effective in changing the profile of attributive styles of the clinical sample. Subjects who have benefited from the training have decreased scores in external attribution and increased scores in internal attribution, especially those related to engagement, steadily orienting their profile towards GSU: good strategy user (Borkowski & Muthukrishna, 1994). This is particularly relevant in this study with children with SEN, as "particular categories of subjects, such as hyperactive children or learning disabilities, do not understand the relationship between commitment, strategic behaviour and effective performance, relationship that must be taught to them." (Borkowski *et al.*, 1986).

To complete the positive scientific outcomes shown by THE data analysis, it is interesting to provide some qualitative evidence emerging from the questionnaires offered to the children (100% of responses) and parents (57%) at the end of the proposed training course. As regards the interest in the course, positive feedback was given by both children (quite a lot 32%, a lot 48%, very much 20%) and parents (quite a lot 50%, a lot 33.3%, very much 16.7%). With regard to the metacognitive teaching that leads the student to reflect on his/her own abilities, his/her method of study, the strategies used, the parents expressed themselves positively (quite a lot 25%, a lot 58.3%, very much 16.7

%). And their responses have been even more impressive to the question "Do you feel that learning to study is important?", as the answers focused on a lot, 25% and a very much, 75%. The children who were asked if the training carried out has allowed their attributional style to be improved, so as to always aim on commitment to succeed in school activities in the future, responded with a 44% quite a lot, 40% a lot and 16% very much. The same question submitted to parents has provided the following evidence: 33% quite a lot, 58.3% a lot and 8.3% very much. The children and parents questioned about the possibility of recommending the course to other students, responded in both cases with 100% yes.

## Conclusions

In the complex SEN universe, intervention modes, approaches, methodologies, contexts and lines of action are very diverse: vision, however, must be systemic and must take into account the totality and complexity of the interconnected variables which manifest themselves. The heterogeneity of the students, characterized by diverse diagnostic situations, diversity and originality from the point of view of styles and learning strategies, emotional-affective needs, relational attitudes, and specific family and environmental situations, is now closely linked to an increasingly open school environment for exchange and participation. Metacognitive intervention and ICT can contribute effectively to the definition of learning paths that meet student needs (Berizzi, 2016) and provide more opportunities to discover special skills and talents (Veronico, 2014).

The results of the research, albeit limited to a limited sample, offer positive results on the success of an attributional-metacognitive training in e-learning in favour of children with special educational needs. The attributional style of the children has shifted from an external orientation to an inner locus, implementing the role of commitment as the main vector in defining their own successes/failures and in enhancing the active role of the subject that has the ability to control success and failure. The proposed intervention owes its success to the merging of two fundamental elements, the metacognitive approach (Borkowski & Muthukrishna, 1994; 2011) - attributional (De Beni & Moè, *op.cit.*) and the methodology used through ICT (Cacciamani & Giannadrea, 2004; Scardamalia & Bereiter, 2004; Sthal *et al.*, 2006; Trentin, 2001; Varisco, 2008).

The evidence emerged from the qualitative survey demonstrated the favourable acceptance of the training by both the children and the reference adults involved. They were both, convinced that an enhancement of the attributional style can produce positive impacts on academic success. The path to be undertaken or to be carried forth must be based on the notion that traditional didactics may be good for everyone but not for children with SEN, while a SEN didactics

could be good for everyone and must be seriously considered as a training for all the students in the classrooms which include children with SEN, modifying learning environments and integrating information and communication technology (ICT) in education, particularly e-learning.

The current Research has shown that attributional-metacognitive training jointly with ICT is a frontier that deserves further insights. It is desirable to be able to conduct studies with larger clinical groups in the future and to carry out follow-up analysis of the interventions already carried out. In the future, further research that includes training specifically targeted at homogeneous groups according to disorder (DSA only or ADHD only) will need to be done to verify whether the metacognitive-attributional training in the e-learning environment, as it is structured now, provides different benefits or needs more targeted differentiation according to subjects.

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# ADVANCED E-LEARNING FOR IT-ARMY OFFICERS THROUGH VIRTUAL LEARNING ENVIRONMENTS

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In this work we will present and discuss the joint experience of the IT-Army Education and Training Command and School of Applied Military Studies of Turin and the University of Turin, that worked together to designed an advanced e-learning path. This was made possible by the use of digital methodologies and integrated virtual learning environments, with the aim of supporting in the best possible way the military officers training, which has to be continuous, highly specialized, multidisciplinary, flexible, and strongly internationalized.

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## 1 Introduction

The training for the Army officers, and for the Armed Forces in general, is by its very nature very peculiar as, due to the assignments that will be appointed during their career, it has to be continuous, highly specialized, multidisciplinary, flexible, and strongly internationalized. The training should be both theoretical and practical, by increasing the knowledge and practicing on field, following a lifelong learning strategy.

Since 1998, the military officers have attended a five years training course composed of a three years Bachelor Degree in Strategic Sciences course and a two years Master Degree in Strategic and Military Sciences course. The first two years are organized by the Military Academy in Modena in cooperation with the University of Modena and Reggio Emilia while the third year of Bachelor and the Master degree are implemented by the Education and Training Command and School of Applied Military Studies in Turin in cooperation with the University of Torino.

After this initial training the officers continue, in different moments of their careers, to investigate some specific topics through post-degree courses, intensive seminars, practical activities or even theoretical exercises.

In the last years the e-learning (Clark & Mayer, 2008), understood as the introduction of multimedia technology and the internet to simplify the access to the resources, to distance collaboration or even to remote exchanges, has changed to the basis the way of teaching and learning, and has opened brand new and challenging scenarios which have to be taken into account by every training institution.

Following these new directions, the Education and Training Command and School of Applied Military Studies of Turin (SCAPPLI) and the University of Turin designed an e-learning training course which uses digital technologies and virtual learning environments to support the education of the military officers and the Strategic Sciences students. The extension of the University metropolitan area network to the SCAPPLI, and the activation of the Wi-Fi service to all the classrooms, were preparatory and integral parts of this project. In this cooperation the two institutions shared experiences and competences useful to design and develop innovative solutions for a modern and complete training, opening to a mutual collaboration which lead them to be recognized as reference and cohesion poles in technologic and education areas.

## 2 State of the art

Deep transformations have occurred and keep occurring in the Armed Forces, where they are asked to operate in different ways, both in the homeland

security and in international operations and missions.

These new operating modes need a continuous training of the personnel involved in this area, where they have to manage new challenges in all possible environments, such as sea, air and land. In addition to these, the cybernetic dimension opens new threats that need innovative defense solutions. In such a complex environment the Armed Forces started to experiment new effective teaching solutions (Lunardi, 2010) for their officers, reducing the associated management costs, which often are the goal of cost reduction in the annual budget.

The turning point dates back ten years ago, when the Armed Forces started to use the best distant educational solutions, acquiring e-learning platforms for teaching to internal personnel.

The first goal was the start-up of an e-learning platform for these main purposes:

- *investing* in new skills of military personnel, and increasing the technical and military knowledge of the staff through the use of state-of-the-art IT tools to achieve lasting and measurable results;
- *creating* an effective learning tool that can involve the individual learner (learner centric) in a continuous self-updating process aimed at achieving and maintaining a high and recognized professionalism;
- *reducing* the duration of some residential courses, particularly those with more theoretical topics and updating the Doctrine of Armed Forces, expanding the distance phase and introducing tools for evaluating acquired skills through e-learning;
- *increasing* staff "confidence" with computer based tools. The role of Informatics and new technologies has been growing in every new military operation. On the battlefield, an efficient and secure management of communications and IT tools enables, first of all, to provide the necessary information at the right time to people in charge of making a strategic decision and subsequently to complete successfully a complex military operation.

The Navy and Air Force started immediately e-learning training projects by adopting open source solutions, activating a Moodle platform as an end-to-end solution in remote distance learning and collaborative e-learning with Dione Navy Projects and the Aerospace pilot project AGP. Since 2008, the Guardia di Finanza has started its own distance learning with a series of Moodle-based courses that have been successful, particularly for the social aspects of that learning tool.

Since 2010 SCAPPLI decided to converge to the Moodle platform, now

consolidated from the software point of view and very popular in public administrations. After an appropriate period of testing, they began to use it for internal teaching needs, with excellent results. The use of Open Source system had already been adopted by the Army Foreign Language School, the only Armed Forces entity which immediately adopted the "ILIAS" solution, the most suited platform for language teaching. The recent change of Army direction towards the Moodle platform led all departments, including the aforementioned School, to a migration process towards Moodle, because it was considered more adhering to training needs. In-fact, Moodle is meant both for e-learning training and for direct teaching support. In particular, the use of the platform has been largely devoted to Education Quality Control Courses, through the provision of tests and questionnaires in the classroom and at distance. In 2013, the SCAPPLI and the University of Turin held the first meetings with the opening of technical tables to design together common educational solutions within the framework agreement that governs the Bachelor's Degree in Strategic Sciences and the Interdepartmental University School in Strategic Science (SUISS).

## 3 Methodology

The SCAPPLI and SUISS E-learning Project consists of three separate phases, which took about 1 year for their implementation. In the first step, the network infrastructure within SCAPPLI has been created to deliver the UNITO network; a new WLAN was installed in all the classrooms where the lessons are held. This connection was made by linking, through the UNITO fiber optic network, to the SCAPPLI didactic LAN, also through works on public areas. Following the connection and configuration of active network devices, the SCAPPLI Moodle Server and other didactic servers necessary to support Moodle service (such as Virtual Class VTCs, a streaming server as a basis of a multimedia portal, etc.) were made accessible through the UNITO network, always in compliance with the regulations of the two entities involved. Lastly, the Moodle of SUISS and the Moodle of SCAPPLI were enabled to share their users by using the well-known Moodle Network-MNet feature (Figure 1). This interconnection is critical and allows users to access seamlessly the two platforms, so depending on where the training activities take place, each user can follow them using always the same credentials. MNet's capabilities are also crucial to automate the enrollment in the various courses of military and civilian students. As it is well known, this cross-platform authentication method enables subscribers to a Moodle "A" platform to access completely the Moodle "B" platform and vice versa, therefore benefitting from all the resources and activities of the two platforms. The possibility to navigate from one platform to another has greatly simplified the management and delivery of

those courses involving mixed civil-military enrollment, such as the Military Erasmus. The SCAPPLI platform maintains the accreditation of users without University credentials, where the responsiveness ensures a quick and fast response, especially for teaching activities involving students from other Italian and foreign universities and academies. Numerous collaborations with various training institutes from EU Member States have been facilitated by providing these virtual environments. Splitting the management and the support tasks on the installed hardware, Help Desk tools and content production guarantees the functionality of both Moodle instances and the correct relationship with the different users ( Phase 2).


Fig. 1 - A screenshot of the two moodle platforms

After the first two phases, the training of the faculty members formed by university professors and military teachers (both Italians and foreigners) has begun via courses in attendance and personalized counseling in order to respond to the different needs of the individual subjects belonging to very different areas. The first level Help Desk was offered by the e-learning section of SCAPPLI, while the second level was guaranteed by the ICT Services at the UNITO Computer Science Department to ensure the functionality and technical updating of the software used. It was thus possible to design and build an innovative training offer with the support of Moodle of SUISS and SCAPPLI. Both Moodle platforms are integrated with tools that respond to the needs of multidisciplinary teaching. The SCAPPLI, through the Open Source Xerte authoring tool, enables the creation, updating and publishing of multimedia content in a fast and secure way, making it possible to create a collaborative environment for individual projects and ensuring teachers the opportunity to " Self-publish" their works on the Moodle site itself. Thanks to Xerte, each teacher can prepare the contents of the course in a PowerPoint-like environment using tools that allow all those effects that are typically used in

a multimedia presentation. Once the multi-media content is ready, the teacher can alternatively create a SCORM compliant content, which will be uploaded into his course, or directly link the content of the product made with XERTE. Displaying XERTE content can be done using Flash Player technology or, even better, in Html5, an important standard to make it easier to use on mobile devices. This feature is undoubtedly a remarkable opportunity, as updating the lesson can be done uniquely and easily by using web-based tools; by using this integration, the lesson can be updated without having to upload it again, being updated in all courses where the lesson is referenced.

The SUISS platform, thanks to the great experience acquired in the field of e-learning (Baldoni *et al.*, 2011), is integrated with an Enhanced Calculus Environment based on Maple, an automated evaluation system called MapleTA and MapleSim, a simulation system. These integrations allow teachers, especially those who teach scientific subjects, to adopt innovative, highly interactive and personalized didactics, thus enabling students to include complex answers such as formulas or equations that can be written in infinite equivalent forms, to verify their preparation through automatic tests, and to be guided by feedback according to an adaptive logic. MapleTA software also allows to prepare questions that include responses with graphics, or with elements such as vectors or even selecting parts of an image to build the answer. The SUISS platform is also integrated with a web conferencing system that allows, in addition to the asynchronous tutorial implemented with the forums, a synchronous distance mentor, where students can talk to the teacher by sharing microphone and a screen that turns into a blackboard where they can share formulas or draw figures.

Currently, Moodle platforms are used for the following types of courses:

1. Officers attending the University:
    - Bachelor and Master Degree in Strategic Sciences;
    - International Erasmus Military Courses;
    - Intensive English Language Enhancement Program Modules;
2. Post-graduated:
    - Stabilization and Reconstruction Courses;
    - Army Staff Course (200 captains each year)

for a total of 128 courses and 4.919 users. They are also used to deliver Courses for the Special Reserve (50 professionals directly selected from the civilian to become officer), for courses on working environment security for executives and workers of SCAPPLI, for a total of 400 more people, as well as providing support for quality control.

Some university courses are held in English within the TeachMob Program by Visiting Professor of unquestionable fame from all over the world. In the academic year 2015/16, some officers, graduates of the Master's Degree in

Strategic Science, attended a Game Theory course by Prof. Simon Salamon, together with their colleagues, civilians and students from the University of Turin School of Higher Education "Ferdinando Rossi". As the teacher's stay in Italy is limited, especially for the mentorship and for any additional examinations, the platform availability makes it an indispensable tool for maintaining distance relationship with the teacher. Thanks to the solutions adopted, the training of officers in recent years has taken on a highly international connotation; this in response to the increasingly strong and current task oriented needs of confrontation and collaboration with foreign partners. All international courses involving many participants from abroad can include remote phases using the virtual classroom before the residential phase.

"The European Initiative for the Exchange of Young Officers, inspired by ERASMUS", the so-called Military Erasmus, (Spinello, 2013) is an European Union program set up to promote the exchange among the various European training institutes of students/military officers during the initial training period. The initiative launched in 2008 under the aegis of the European Security and Defense College (ESDC) in Brussels (a network college that uses the institutes responsible for the training of the military and civilian personnel of the UE Member States) with the creation of a configuration of the Executive Academic Board (EAB), the Implementation Group (IG), develops joint training proposals and promotes European Union knowledge. In particular, the IT-Army has been participating in the program since 2010. The adhesion to the initiative is realized by sending the Officers to attend the initiatives proposed by the Member States and to organize, starting a.y. 2013-14, some Common Modules (academic or vocational training activity, which will be delivered in English language with a residential phase of 1-3 weeks preceded by an e-learning phase with admission test) per year. These courses are open to foreign personnel. In relation to the topics discussed, the same Common Modules are also offered to civilians of the Degree Programs in Strategic Sciences, which are an enrichment and a specificity in the national university scenario. The common modules are studied by a group of experts who periodically gather to elaborate new ones and update those already approved on topics of common interest for training and it helps the recognition of the European Credit Transfer and Accumulation System (ECTS).

For this type of modules, the possibility of accessing a common platform fulfills many functionalities, including the ones typical of Distance Learning (providing pre-didactic knowledge, reference texts, curriculum of the course, etc.) and those typical of the Support Learning (the pre-reading material prepared by each teacher, the course information, syllabus and curriculum vitae of the lecturer, slides of presentations as well as logistic info, especially useful for those who come from other countries before the residential phase) and

auxiliary functions such as the delivery of the final test and the final feedback. The common modules proposed in academic year 2015-16 were the following:

1. Common Security and Defense Policy (CSDP). For this course the distance phase was hosted on the ESDC site with two mandatory autonomous knowledge units (AKUs) and an optional third one. Distance phase test is required for admission to the residential phase. For other functions, the Moodle platform has been used. The module was attended by 8 IT-Army Officers, 4 IT-Air Force, 15 EU Member States (1 Bulgaria, 2 Croatia, 1 Cyprus, 2 Finland, 2 France, 2 Greece, 3 Romania, 2 Poland) and 14 Civilian students.
2. Law of Armed Conflict (LOAC). Fully organized on the Moodle platform. The module was attended by 12 IT-Army Officers, 5 IT-Air Force, 3 EU countries (2 Estonia and 1 Greece), 12 civilian students.

The English Language Enhancement Modules Program, within the broader internationalization program of SCAPPLI, has the purpose of preparing students to the modules delivered in English and especially in an international operation perspective. They are organized in one-week seminars.

Experienced teachers and native speakers have designed Note-taking and Active Listening activities, a deepening unit on the jargon, and the correct collocation of the verbs inherent to the discipline. In this way students, even the poorer in linguistic skills, prepare themselves both through lectures in the language labs, and autonomously by having a computer that, for example, does not stop repeating the pronunciation of a term. The program, developed in a.y. 2015-16, was composed of 2 modules attended by all the Officers of the 4th year of the course.

The Stabilization and Reconstruction Senior Management Course and Stabilization and Reconstruction Orientation Course are organized byand conducted at the Italian Post-Conflict Operations Study Center and intended for its personnel. These courses are entirely delivered in English with lessons held by military and university teachers as well as international experts in the field and/or areas of interest. Just in line with the comprehensive approach, typical of modern peace keeping operations, courses are also open to foreign personnel and civilians. The first type of courses is reserved for Military executives (Generals and Colonels) and civilians while the second one is open to civilian and military officers in the rank of Lieutenant Colonel and Major. Fundamental to their implementation is the use of a virtual learning environment, where leaders and officers become peer to peer communities while making, sharing and exchanging ideas, strategies and experiences.

## 4 Results and discussion

The adoption of the e-learning solution has radically changed the training of military officers. Figures 2 and 3 show activity statistics on the two platforms in the last solar year. The two teaching periods can be easily recognized the two teaching periods from the chart crests.

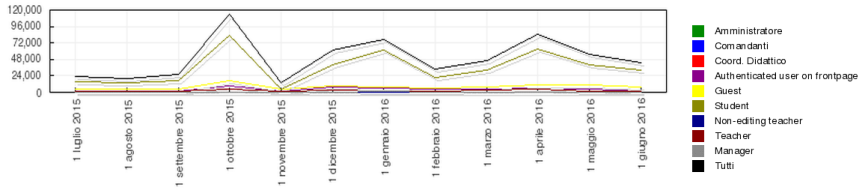


Fig. 2 - Activities on UNITO platform in 12 months (01-06-2015 – 01-06-2016).

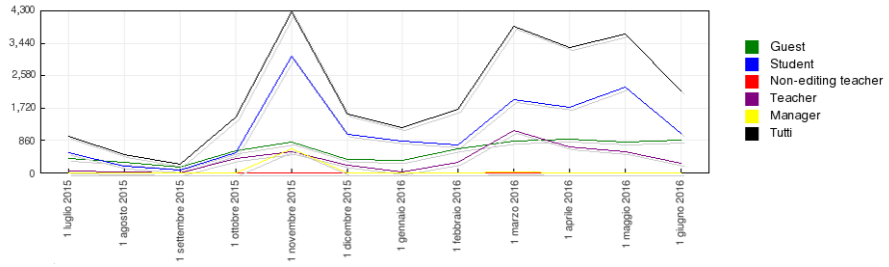


Fig. 3 - Teaching activities on SCAPPLI platform in 12 months (01-06-2015 – 01-06-2016).

Civil and military teachers, practitioners, coordinators, commanders, tutors have reorganized their teaching activities by questioning and rethinking their contents and presentations. Junior and senior students of the international online courses demonstrated their satisfaction about the distance learning opportunities as in Tables 1, 2, 3. The feedback were evaluated by using the Kirkpatrick method, used in ESDC with a gradation of results from 0 to 6. As for the e-learning use see following data:

Table 1
TESTS S&R MANAGEMENT SENIOR COURSE NOVEMBER 2015.

| Materials (Welcome package, documentation for studies, learning support) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | n/a | Answers | Avg |
| Materials/Relevance | 0 | 0 | 0 | 4 | 8 | 10 | 0 | 22 | 5,3 |
| General Average | | | | | | | | | 5,3 |
| Internet Distance Learning (IDL) Preparation | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | n/a | Answers | Avg |
| IDL Preparation - Relevance | 3 | 2 | 3 | 7 | 3 | 2 | 0 | 20 | 3,6 |
| IDL Preparation - Utility | 3 | 1 | 4 | 7 | 2 | 3 | 0 | 20 | 3,7 |
| General Average | | | | | | | | | 3,6 |

Table 2
TESTS CSDP MARCH 2016.

| Materials (Welcome package, documentation for studies, learning support) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | n/a | Answers | Avg |
| Materials/Relevance | 0 | 0 | 0 | 6 | 21 | 14 | 0 | 41 | 5,2 |
| General Average | | | | | | | | | 5,2 |
| Internet Distance Learning (IDL) Preparation | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | n/a | Answers | Avg |
| IDL Preparation - Relevance | 0 | 2 | 2 | 10 | 17 | 10 | 0 | 41 | 4,8 |
| IDL Preparation - Utility | 0 | 0 | 2 | 14 | 16 | 9 | 0 | 41 | 4,8 |
| General Average | | | | | | | | | 4,8 |

Table 3
LOAC TESTS, OCTOBER 2015.

| Materials (Welcome package, documentation for studies, learning support) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | n/a | Answers | Avg |
| Materials/Relevance | 0 | 0 | 0 | 4 | 16 | 11 | 0 | 31 | 5,2 |
| General Average | | | | | | | | | 5,2 |
| Internet Distance Learning (IDL) Preparation | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | n/a | Answers | Avg |
| IDL Preparation - Relevance | 1 | 0 | 3 | 3 | 15 | 9 | 0 | 31 | 4,9 |
| IDL Preparation - Utility | 1 | 0 | 1 | 4 | 14 | 11 | 0 | 31 | 5,0 |
| General Average | | | | | | | | | 5,0 |

The lowest rating, in the case of S&R course, can be interpreted either by the minor confidence with new technologies and by the lesser use of them, or by the

lower availability in terms of time of that particular type of students. Notable were the improvements in the results especially in Math disciplines attended followed by technical army students. Testing and verifying their knowledge with automatic correction enabled them to better calibrate their preparation. Aside from learning, there are other advantages to be considered, such as the economic benefits derived from a cost reduction that allow investing more in other activities. In the distance learning, there is a reduction in the costs of the military officers' relocation; with the dematerialization of training resources you can save paper, speeding up the administrative processes of certification of activities and the registration of examinations. On Moodle the teacher has an integrated registry with Maple TA where he records all the evaluations, ensuring a better tracking of students' progress which can, in turn, be consulted when needed in compliance with transparency. Teachers, saving time for evaluation, can focus on preparing up-to-date content and more suited material for formal and informal learning. The sharing of materials readily upgradable, accessible, with interactive formats between teachers and students, both civilian and military, allows the implementation of innovative pathways that exploit the potential of new technologies available today.

## Conclusion

The e-learning training of military officers may be refined in the next years by following different ways: reception and re-alignment programs for students can be envisaged after selection, so they can make an easy start with university studies. A bigger number of university courses may be provided in blended mode, where the teacher can give more attention to discussion and reasoning opposed to the traditional didactic. The provision of shared courses with other foreign training institutions allows the optimization of the resources and the wider range of training opportunities. The e-learning training of Army Officers in the next years is going to increase both to allow for up-to-date international training and to have a more thorough and highly specialized technical-scientific preparation, especially in the paths of Degree in Strategic Sciences related to Combat Engineer, Signal Corps and Logistics. The adoption of the most advanced digital technologies will be a winning choice to maintain high quality standards in the training of officers called to face complex situations. The sensitivity to these themes demonstrated by the Army's leaderships and the investment in their research by the University that collaborates with it will ensure the achievement of top levels of teaching and learning.

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# ARE COMPUTER ADAPTIVE TESTS SUITABLE FOR ASSESSMENT IN MOOCS?

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**Keywords**: MOOCs, CAT, Assessment, e-learning

Assessment is one of the basic issues in both formal and informal educational contexts. Current online courses are massive and online, thus it is important to find new strategies to improve the effectiveness of evaluation. In MOOCs (Massive Open Online Courses), indeed, there is also the certification of knowledge and skills acquisition that requires more formal and trustworthy methods. Researchers should work to combine pedagogical and technological solutions to guarantee the effectiveness of learning measures. In this context, the Computer Adaptive Testing (CAT) could be useful to better measure the knowledge acquisition using a quiz, as usually happens in MOOCs. These are the premises of this research work that, to understand if CAT could be suitable for assessment in MOOCs, proposes a first algorithm to measure the acquired knowledge using a quiz-game. The pilot study attests the users' appreciation.

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## 1 Introduction

In education, the assessment of learning is important as well as the instructional process, since it should help both students and teachers in improving the learning-teaching process and, thus, to improve learning effectiveness. The spread of Information and Communication Technologies pushes through different and more innovative assessment procedures that could be helpful in reaching this objective. In this view, it is necessary that also the assessment procedures evolve themselves to respond better to the new needs and features of the users but also of the technologies available, in terms of hardware and software.

Moreover, the spread of new models for online education require as well new learning assessment models. In particular, the assessment process in MOOCs (Massive Open Online Courses) (Kennedy 2014; Liyanagunawardena *et al.*, 2013), that are didactic contents for higher education characterized by unlimited participation and open access, need some revisions. The size of the audience, in fact, requires more specific processes or tools to assure the effectiveness and high quality of learning assessment.

The digital assessment in MOOCs is an emerging challenge. As stated in (Bayne & Ross, 2013) the assessment in MOOCs is an area of great interest and active experimentation. The issues are several, the most important in our view are related to the user's authentication during the assessment and the way useful to effective learning assessment. The first issue has been efficiently resolved in the Eduopen platform[1], that is a network of several Italian Universities that offers free MOOCs. The students can acquire the certification in three different ways. The first one is an attendance certificate, that does not require any payment, the second is a verified certificate, that requires that the final exam should be done in a NICE (Italian Exams Center Network) center where there are examiners that can certify the student's identity; the last is the traditional (i.e. in presence) examination at a University of the network and allows the attribution of ECTS (*European Credit Transfer System*).

As regards the assessment issue, there is a lively discussion. Different solutions have been studied from both pedagogical (self-assessment, peer assessment, co-assessment) and technological points of views.

In this context, the objective of the research herein presented try to address this issue investigating about a new approach to digital assessment. The Computer Adaptive Tests (Sands, 1997) are a methodological and technological solution that could improve the effectiveness of evaluation processes when they involve a wide range of subjects that cannot be classified a priori. To become familiar with the CAT, the researchers have defined a first approach of this new

[1] https://learn.eduopen.org

methodology in a quiz-game. The paper presents the algorithm defined and a first pilot test of the implemented quiz-game.

## 2 Learning Assessment: technological solutions overview

The learning assessment in online courses is always one of the hot topics in educational research field. In the context of MOOCs, the learning assessment is a thorny issue, since a certification could be acquired by the student (Clements & Cord, 2013). So, it is important that the procedure adopted in the evaluation should be trustworthy to certificate the knowledge and skills acquisition.

In the literature, solutions have been proposed in several directions. (Admiraal *et al.*, 2015; Muñoz-Merino *et al.*, 2015), for example, consider the integration of the qualitative measures that allow the teacher to have more complete feedbacks to certify the knowledge and skills acquisition. The proposed measures include the interaction with didactic resources and activities. Other researches use the Learning Analytics and Learning Dashboard (Pesare *et al.*, 2015; Siemens, 2012; Knight *et al.*, 2014) that allow users to better visualize the monitoring data of virtual learning environments and to infer informative results about the learning process. Some other solutions are focused on designing and implementing tools able to simulate the presence of the teacher or tutor to provide personalized feedbacks to students (Huertas, 2011).

Moreover, the trend is to design e-assessment systems that allow to have different tools and data useful to improve the quality of certification of skill and knowledge acquisition (Crisp, 2007). Sitthiworachart et al. (2008), in this view, propose a novel framework for e-assessment which captures the essential success factors. Another useful strategy could be the Computerized Adaptive Testing (CAT) (van der Linden & Glas, 2000; Wainer *et al.*, 2000). The adaptive tests can adapt the difficulty level of the questions to the student's ability level.

In this view, the authors research aims at evaluating this technological approach in order to adopt it as one possible solution in the context of MOOCs. For this reason, a first study has been conducted to better understand the technique and a quiz-game has been developed.

## 3 Computer Adaptive Test

The Computer Adaptive Test is a computer-based test that adapts the type and sequence of the questions to the examinee's ability level. In other words, a CAT is a dynamic test that is built by selecting the question to be posed from a set of possible questions (item bank) according to the answers provided by the student during the evaluation process as well as a human teacher does. In

this view, the CAT allow more effective quantitative tests to be implemented than those created with the Classical Test Theory (CTT). Standard fixed tests pose the same number of questions to all users and measure the knowledge acquisition by means of the transformation of the number of correct responses in a score. In this case, the assessment is related to the sample of questions and, for these reasons, they could be less informative in context in which the population is wide and not classifiable a priori, as the MOOCs users are. Moreover, in a traditional test not all questions are necessary to assess student's learning; the questions may be too easy or, on the contrary, too hard and so the test result may provide poor information about the student's actual learning gain. The adaptive tests, instead, build the questionnaire during the test session picking only those questions that are necessary to assess the specific student. Usually, the first question has a medium level of difficulty, the level of difficulty of the next is defined on the basis of the student's answer. The examinee's ability level and the level of difficulty of the questions are defined dynamically during the interaction and it stops when the obtained value is recognized as the best result. This process allows to build tests with different length. Indeed, one of the main objectives of the CAT is to measure the knowledge acquisition level using the minimum number of questions. Thanks to the use of CATs it is possible both to reduce the time required to answer the test, by dynamically selecting the question to be posed, and to maximize the precision of the learner' s evaluation. Thus, a CAT poses easier questions to low ability learners and harder questions to high ability learners. The scoring is calculated on the basis of the learner's ability and the item difficulty. For example, if two students answer the same number of questions, the one who answered the hardest questions will have the highest score. For these reasons a CAT could be less boring for students, because high ability learners do not have to answer useless questions (too easy for her/his ability) and, on the contrary, low ability learners do not have to try to answer too difficult ones.

### *3.1 Item Response Theory (IRT)*

As already mentioned, the main objective of a CAT is to define dynamically the composition of a test by adapting the type and the sequence of questions to the user's capabilities. In this process, it is clear that to build a CAT a prior classification of the items and the learner abilities is needed. The psychometric literature proposes different approaches, the most widely used of which is the Item Response Theory (IRT) (Baker, 2001; Hambleton & Swaminathan, 1985). The Item Response Theory, also known as latent trait theory, is a statistical approach used to define the probability that a user can answer correctly to a specific item. The probability is calculated using the user's ability level and

some item parameters. In other words, the IRT is based on the relationship between individuals' performances and the ability that item was designed to measure (Baker, 2001; Hambleton & Swaminathan, 1985). The user's ability level, or *latent trait* generally denoted using θ, represents the latent variable, a variable not directly observed but inferred through a mathematical model from other variables. The latent trait has impact on the subject's performance. Moreover, the subject's performance is influenced also by some psychometric features of each item: the item *discrimination* parameter (a), the item *difficulty* parameter (b), and the *guessing* (c).

In the literature, there are different IRT models that could be classified on the basis of the number of abilities measured by the test (unidimensional or multidimensional), and on the basis of the number of considered parameters (1, 2 or 3 PL). The 3 PL uses all three parameters, the 2PL assumes that no guessing influences data, and the 1PL assumes that guessing is embedded in the ability and all the items have the same discrimination, thus the P(θ) is calculated using only the difficulty as parameter. For the purpose of this study that is aimed at evaluating the applicability of the adaptive testing theory to the MOOCs context, we choose to apply the 3PL model to calibrate the item bank.

### 3.2 The Three-Parameter Logistic Model

The calibration is the basic process needed to define an item bank in which each question is useful to measure the subject's ability. In the calibration process one of the above-mentioned models (1, 2, or 3 PL) could be used. In this context, a Three-Parameter Logistic Model (3PLM) was preferred in which the probability that the item *i* could measure the latent trait $\theta$ is defined as in (1).

$$P_i(\theta) = c_i + (1 - c_i)\frac{e^{a_i(\theta - b_i)}}{1 + e^{a_i(\theta - b_i)}} \qquad i = 1,2, \ldots k \quad (1)$$

For each item *i* the Item Characteristic Curve (ICC) can be defined. It represents the relationship between the probability of correct response to an item and the ability scale. The P(θ) will be small for examinee of low ability and large for examinee of high ability (Baker, 1985). Then, in order to allow the algorithm to select the right item to submit, the Item Information Function (IFF) represents the range of subject ability that the item *i* is able to measure. The analysis of IIF is important to choose the most informative item for a specific range of subject ability. For example, an item is informative for a subject with ability level between 1.0 and 3.0 if the maximum of IFF is reached in θ = 2. To define a high-quality test, each item should be submitted to several processes

of elaboration, revision, experimentation and validation. Because of this, in our research we applied the CAT approach to a quiz-game to evaluate the feasibility.

## 4 A quiz-game using CAT

To figure out if the CATs could be useful in MOOC assessment, we have applied the adaptive testing approach in two quiz games. The first one (non-adaptive) was aimed at calibrating the bank items, the second was aimed at define an algorithmic strategy to create an adaptive test. Moreover, the second test was used to evaluate the users perceived usefulness. The questions are related to general knowledge, such as history, geography, literature, and science. The games are addressed to subjects of 15 years or more.

### *4.1 The non-adaptive quiz-game*

To define a CAT a first edition of a non-adaptive quiz-game was defined. It aimed at gathering and preprocessing data about the item bank. In other words, this first edition was launched online to collect answers from about 200 subjects to 30 questions. The game simulates a competition between the computer and the user. The idea to implement the game-quiz as a competition was only to make the quiz fun for the users. The final goal of this game was to submit the questions and collect the answers. The competition against the system was only used in order to push the users to play at least twice. At each step the user can choose the subject and the difficulty of the question to be posed to the antagonist. At the end the scoring is calculated as described in the following sections and the winner is celebrated.

### 4.2 Data processing

The non-adaptive quiz game allows answers of the 30 questions to be gathered. For each item, about 150 answers were collected. The data was used in the calibration process using the 3PL described in section 3.3. The first step is to define the parameters (discrimination, difficulty and guessing) of each item. There are several software tools that allow to define these parameters starting from the subjects' answers. We used Param3PL[2], that is a public domain, freeware tool for calibrating items and individuals using the 1 and 3 parameter logistic item response theory models. As an example, table 1 shows the results of the calibration process of the first 4 items.

[2] http://echo.edres.org:8080/irt/param/

Table 1
OUTCOME OF PARAM3PL SOFTWARE

| Item | Parameter a (Discrimination) | Parameter b (Difficulty) | Parameter c (Guessing) |
|---|---|---|---|
| 1 | 0.376 | -1.829 | 0.000 |
| 2 | 0.166 | 0.146 | 0.000 |
| 3 | 0.786 | -0.711 | 0.104 |
| 4 | 0.134 | 5.000 | 0.416 |
| ... | ... | ... | ... |

Those values have been used to calculate the ICC and the IIF of each item. Moreover, for each item in table 2 are reported the max value of the IIF and the ability level in which the maximum is reached. This is useful in the selection process since, for example, item 4 will be selected only if the subject's ability is approximately 3. It will be not informative for those subjects whom ability level is between 1 and -5.

Table 2
ITEM INFORMATION FUNCTION (IFF) FOR EACH ITEM

| Item | MAX (IIF) | Level of ability in which the MAX is reached (IIF) |
|---|---|---|
| 1 | 0.035 | -2 |
| 2 | 0.006 | 0 |
| 3 | 0.120 | -1 |
| 4 | 0.259 | 3 |
| ... | --- | .... |

The ultimate outcome of the calibration is the calculation of the $P(\theta_m)$, i.e. the probability that a subject with *m* ability level can answer correctly to the specific item. In table 3, there is an example of the different value of $P(\theta)$ for a question that is classified as difficulty level 0. This means that a subject with ability level equal to -4 has a probability of 0.36 to answer correctly, whereas for a subject with ability level equal to 2 the probability is higher (0.61).

Table 3
PROBABILITY OF CORRECT ANSWER FOR EACH ABILITY LEVEL

| Question Difficulty | $P(\theta_{-5})$ | $P(\theta_{-4})$ | $P(\theta_{-3})$ | $P(\theta_{-2})$ | $P(\theta_{-1})$ | $P(\theta_0)$ | $P(\theta_1)$ | $P(\theta_2)$ | $P(\theta_3)$ | $P(\theta_4)$ | $P(\theta_5)$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| level(0) | 0.32 | 0.36 | 0.4 | 0.44 | 0.48 | 0.57 | 0.6 | 0.61 | 0.65 | 0.66 | 0.7 |

### *4.3 The adaptive quiz-game*

The quiz-game, named QuizMania, was designed and implemented in order to be used by subjects of 15 years or more. The interaction, graphic and navigation was defined to be the easiest as possible. Moreover, since the test was implemented as a quiz-game, a score and a leaderboard were defined. The score is calculated according to the adaptive testing approach. The score for each item, indeed, is increased or decreased on the basis of the user's ability level. Thus, assuming that a user with ability level equal to *m* gives a correct answer for the question that has the level of difficulty equal to *n* the score is calculated as following:

- $1 + (1 - P(\theta_m))$, if the answer is correct
- $-1 * P(\theta_m)$, if the answer is incorrect

where $P(\theta_m)$ is defined as in table 3. This strategy has been defined since it reasonable that if a low ability user gives the right answer to a question that is higher for the ability level defined by the game, a reward should be given. Moreover, at the increasing of the user's ability the probability that s/he gives the right response is higher, then the rewarding will decrease, and the incidence of any wrong answer will increase. At the end of the quiz-game, a leaderboard is displayed in which the players with the best scores are listed.

## 5 Users Test

To evaluate the users perceived usefulness and usability a pilot test was conducted. The sample was composed of 40 users. It was impossible for us to make a classification of the users since it was distributed using the author's Facebook page. Moreover, since the game was designed for a wide range of age and the questions were concerning general cultural aspects a classification of the users could be non-informative for the goal of the research. The questionnaire submitted was composed by 20 multiple choice questions using a 5-likert scale for the answers. Some of them aimed at measuring the usability of the quiz-game, some aimed at measuring the user's perceived reliability of the adaptation process.

For what concerning the first group of questions, positive results have been obtained. The 80% of users express high appreciation about both the navigation directions and the 85% of them stated that the language used was easy to understand. There were some doubt concerning the colors used (too dark for someone) and the graphics elements, someone said that too cartoon style was used (Figure 1). This is due to the wide range of age of intended users. A profound restyling of the graphic aspect is needed. The same reasons could explain the results in Figure 2 about the fun and entertainment dimension.

Moreover, a quiz-game is not the funniest form of entertainment.

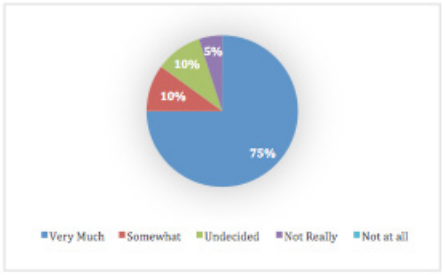



Fig. 1 - Are colors and graphic pleasant?

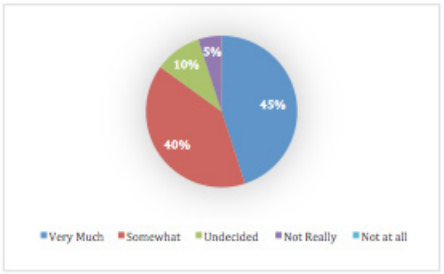
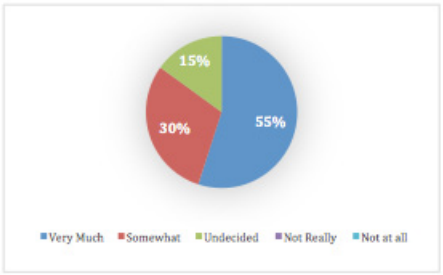



Fig. 2 - The game is fun?

As regards the user's perceived reliability of the adaptation process, 34 users agreed with the proposed classification of questions, only 6 did not give any judgement (Figure 2). For what concerning the score obtained, the majority of the sample stated that the obtained knowledge assessment was acceptable, thus they think that the system is able to measure the knowledge owned by the users (Figure 3).



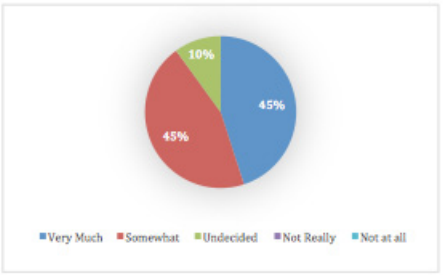




Fig. 3 - (1) The classification of questions represents the actual difficulty of the questions; (2) The system is able to measure the knowledge

## Conclusion

The assessment is one of the trend topics in education, both from pedagogical and technological point of views because of the spread of online courses. Moreover, the adoption of new models for e-learning, as MOOCs are, requires more reliable methods to assess the knowledge acquired using the didactic contents. Because the massive peculiarity of MOOCs, multiple choice quizzes are the most largely tools used in final exams. Thus, it is necessary to use innovative algorithmic strategies that allows to differentiate the learning

measures. The paper proposed to use a CAT that allow to dynamically compose a test according to the user's ability. This prevents also user's frustration in answering quiz that are too difficult for their specific profile. A first prototype of a CAT was implemented using a quiz-game, and a first experience about the definition of an algorithm to assign a score was used. The appreciation of the users allows us to go ahead in this research. The next step will be to apply this approach to a MOOC.

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# MOOCS AND SOFT SKILLS: A COMPARISON OF DIFFERENT COURSES ON CREATIVITY

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**Keywords**: MOOCs, OERs, Soft skills, Creativity, Learning behaviours.

The development of soft skills in undergraduate students is a key factor to ensure an effective transition from university to the labour market. The eLene4work project, carried out between 2014 and 2017, focused on the selection and definition of these soft skills, including digital soft skills. The project proposes a series of actions and practical tools to help students better understand the employers' expectations, to assess their own level of competency and to develop their skills through MOOCs (Massive Open Online Courses) and OERs (Open Educational Resources). The overall goal of the project is to test and monitor the possibilities offered by these resources to fill the gaps between the university and the labour market. It might seem quite challenging to develop soft skills through online resources since these skills are mainly behavioural components. One of the main outputs of the project consisted in designing an Orientation Guide for students and young workers, to help them in choosing and effectively using MOOCs to train

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soft skills and digital soft skills. This paper reports the results of the work carried out by the project partners during the selection and classification of MOOCs. Furthermore, the comparison of different MOOCs on creativity, based on distinctive pedagogical approaches and involving different types of activities and assessment tools, highlights some important trends in the ways used to foster students' learning behaviours and different patterns of engagement.

## 1 Introduction

In the last few years many studies, surveys, even newspapers articles highlighted a problem of the labour market: they reported a skill shortage. For example, we know that in the USA more than 600.000 positions in manufacturing went unfulfilled due to a skill shortage in employees (Deloitte, 2011) and this skill shortage concerns mainly applied skills, such as work ethic, punctuality and professionalism.

According to many documents issued by the European Union (European Commission, 2012) and human resources experts (ISFOL, 2012; IUL, CRUI, & Centromarca, 2012; Manpower Group, 2012) soft skills are closely connected with employability but they are not thought at University. Mourshed, Patel & Suder (2012) highlight that providers, employers, and young people seem to operate in "parallel universes": for example, in Europe 74 percent of education providers are confident that their graduates are prepared for work, yet only 38 percent of youth and 35 percent of employers agree.

Companies need a more skilled workforce and opportunities should be given to young people to develop those soft skills, such as entrepreneurial skills, coping skills (i.e. the capacity to deal with a problem in a creative way), learning to learn and other skills (such as the ability to work in team, to communicate clearly and effectively, to adapt to different cultural contexts, to solve problems, to manage conflicts, to show endurance in complicated or stressful situations etc.) that will help university students to make a successful transition from full-time education to entering the labour market.

Nevertheless, at present, EU countries have different methodologies and approaches to the teaching and recognition of skills for employability. This has led to a mismatch between academic education and skills required in the labour market. The presence of such discrepancies requires that cooperation is strengthened among the different stakeholders to find common solutions and educational models that provide a common set of skills and of training tools. Another obstacle is represented by the absence of a common language. There are different ways of naming 'soft skills' (sometimes called even 'competences'), different definitions of them, different ways of classifying and clustering them (Cinque, 2016). Furthermore, the theme of soft skills intersects and sometimes overlaps with that of the so called 21st century skills (Ananiadou & Claro,

2009) or of future work skills 2020 (IFTF, Institute for the Future, 2011), that refer to all those skills which should be acquired by all citizens, in order to ensure their active participation in society and the economy, taking into account the major drivers of change.

This paper presents some results of the eLene4work project, which was focused on the selection and definition of soft skills, including digital soft skills. The project proposes a series of actions and practical tools to help young talents better understand the employers' expectations, to assess their own level of competency and to further develop these skills through open educational resources, particularly MOOCs (Massive Open Online Courses). It might seem quite challenging to develop soft skills through online resources since these skills are mainly behavioural components. The paper analyses the results of the work carried out by the project partners during the selection and classification of MOOCs. Furthermore, the comparison of different MOOCs on creativity, based on distinctive pedagogical approaches and involving different types of activities and assessment tools, highlights some important trends in the ways used to foster students' self-regulation and autonomous learning.

## 2 The project

The eLene4work project (http://elene4work.eu), supported by the ERASMUS+ programme (Key Action 2, Strategic Partnerships) involves 11 partners from 9 European States. The project is tackling the definition of soft skills, including digital soft skills, and proposes a series of actions and practical tools to help young talents better understand the expectations of employers, to assess their own level of competency and to further develop these skills through open education initiatives such as MOOCs (Massive Open Online Courses) and OERs (Open Educational Resources).

The first output of the project is represented by a comparative analysis on the state of the art of soft skills and digital soft skills in different European countries (Belgium, Finland, France, Germany, Greece, Italy, Poland, Spain and UK). In order to collect the data from all these countries in a homogenous way, the project consortium agreed on a common definition of "soft skills". According to the eLene4work definition: "soft skills represent a dynamic combination of cognitive and meta-cognitive skills, interpersonal, intellectual and practical skills. Soft skills help people to adapt and behave positively so that they can deal effectively with the challenges of their professional and everyday life". Moreover, a template was designed and a glossary with the definition of the different soft skills was made available to all the partner institutions in order to share a common framework to work with. Results of this work include an overview of the main initiatives carried out in different countries and

transnational projects.

The second output of the project is represented by a report, *Which soft skills do students have and which should they have?*, that describes and compares qualitative data about soft skills gathered through focus groups carried out in 9 partner countries.

The third output is focused on the design and implementation of a self-evaluation tool for the assessment of students' soft skills and digital soft skills, while the fourth one consists in the design of an Orientation Guide for students and young workers, to help them in choosing and effectively exploiting their participation in MOOCS aimed at the training of soft skills and digital skills.

The preliminary steps to design the Orientation Guide consisted in defining a list of the soft skills and digital soft skills to be developed by students, and in identifying already existing MOOCs through which these skills could be developed. The soft skills selected during the previous phases of the project included: *social/inter-personal skills* (communication, team work, conflict management, negotiation); *personal/intra-personal skills* (leadership, self-evaluation, adaptability and flexibility), *methodological skills* (learning to learn, analytical skills, creativity and innovation, problem solving), *digital skills* (information and data processing, digital communication, digital content creation, digital problem solving).

As far as concerns the MOOC selection, the partners involved in the fourth output identified 20 platforms to be explored. After that, a common template was defined, in order to collect homogeneous information for each MOOC. The results of this work are illustrated in this paper, highlighting some important findings concerning the tools used to foster self-regulation and active learning.

### *2.1 MOOCs and soft skills*

There is growing evidence to suggest that MOOCs will have an important role to play in the continuing development of the 'soft skills' of employees throughout their careers. As Brabon (2014) highlights, while MOOCs seem to offer the opportunity to gain subject-specific knowledge and understanding, the lack of systematic accreditation, detailed attention to questions of learning outcomes and 'levelness', as well as programme planning, mean that the majority of MOOCs are not designed to create subject-specialists who will go on to obtain a degree. Although the topic of a MOOC may initially attract learners who simply want to know more about a specific subject, the underlying impact of the learning experience is more readily quantified through an appreciation of the 'soft skills' that MOOCs can nurture. Through their different pedagogies and self-directed learning, many MOOCs cultivate communication and problem-solving skills, flexibility and creativity, as the primary features of

the formative learning journey. It is here that MOOCs can make a significant intervention into enhancing these often nebulous and personal characteristics of 'soft skills' that are highly valued by employers. MOOCs require individual learners to be able to self-regulate their learning, determining when and how they engage. However, MOOCs attract a diverse range of learners, each with different motivations and prior experience.

Margaryan and colleagues (2015) analyzed the instructional design quality of 76 randomly selected MOOCs, including 26 connectivist cMOOCs and 50 xMOOCs, in the light of ten instructional principles derived from contemporary learning and instructional theories about effective instruction. The study found that the majority of MOOCs of both types rely on design principles that privilege high quality content rather than overall instructional design and learning experience.

In order to foster active learning and self-regulation, some instructional researchers (for example Scagnoli, 2012; Bartoletti, 2016) highlight that there are some important elements that need to be considered when creating a MOOC so that students get the benefit of education from an expert but also feel contained and empowered to share and open their minds to grow in knowledge and within a new community of learning.

These elements are:

1. *Novelty and leverage for previous experience*: content that challenges and interests any participants with any level of expertise in a topic, no matter what their previous experiences about the topic are.
2. *Input from diversity of sources*: Rich amount of sources that come from diverse perspectives to help participants think and develop understanding of the topic. Videos, readings, ebooks, movie clips, and a variety of digital materials that can enrich the experience of being informed and learning.
3. *Gauge for understanding and further thinking*: Self graded activities that allow participants to check their understanding of the weekly topic or discussion, and at the same time, make the participant think deeply about the issues presented in the week.
4. *Motivation for engagement and community learning opportunities*: Encourage participants to select topics within the topic of the class to have their own discussions and learning hubs. Invite them to use class materials to trigger conversations and learning.
5. *Planning for legacy*: Inspire participants to create digital spaces that will continue the discussion or the information seeking for the topic of the class. Suggest students to take what they learn and be agents of change or discovery in their worlds of work or life.

Some of the inputs gathered from this framework represented our background while planning the MOOC guide, fundamental part of the orientation tool for students and young workers.

## 3 The selection and analysis of MOOCs

As previously mentioned, the fourth output of eLene4work project consists in an orientation tool specifically designed for university students and young workers interested in developing their soft skills and digital soft skills.

The aim of this tool, which is hosted in a website[1], is to help them to understand:

1. the transversal skills required by the international labour market, useful for the mobility in European Countries (the tool will include the updated data on the subject, gathered during the first two phases of the project);
2. the new learning model that eLearning implies and the main differences between studying online compared to face to face;
3. the potential of MOOCs. The tool will include information about their classification, organisation, and functioning (e.g. enrolment, teaching assistance, assessment);
4. how to optimise their participation in a MOOC;
5. what pre-requirements are necessary;
6. what obstacles students may encounter in attending a MOOC and how to overtake them.

To reach these goals, the orientation tool will be structured into the three following sections:

1. "Explanation of the learning process" (section A);
2. "How to develop soft skills and digital soft skills through MOOCs and OERs" (section B);
3. "The MOOC Guide" (section C).

For the subject discussed in this paper, the third and last section of the tool is of interest. This MOOC Guide is indeed the first guide to map all the existing MOOCs on soft skills and digital soft skills.

Five partners were directly involved in this phase of the project: European University College Association (Belgium; activity leader), University of Helsinki (Finland), University of Bremen (Germany), Maria Curie-Skłodowska University (Poland), and METID - Politecnico of Milan (Italy). The coordination of the Output and the design of the guide was carried out by another partner: University of Aunege (France).

[1] http://og.elene4work.eu/en/

MOOC providers were equally distributed between partners, who analysed 20 platforms totally: Canvas; Coursera; ECO; eGeneral Studies UniBremen; EdX; EMMA; FUN; FutureLearn; iMoox; Iversity; Mooin; NovoEd; Open2Study; OpenHPI; OpenUpEd; POK – Polimi Open Knowledge; Saylor; Udacity; Udemy; World Education University.

Partners were asked to fill in templates concerning MOOCs on the soft skills and the digital soft skills identified in the previous phases, indicating the following information:

- MOOC title
- Language
- Main soft skills or digital soft skills trained in the MOOC (max 3)
- Creating institution
- MOOC Provider
- Link to the source
- Period of activation (self-paced, next opening period)
- Duration
- Cost (for free, fee for enrolment, fee for final certificate etc.)
- Target (students, professionals, others, not specified)
- Level of commitment required
- Level of assistance offered
- Learning outcomes
- Final examination methodology and general assessment methodology
- Program
- Teaching learning methodology
- Partner's opinion on the need to add the MOOC into the final guide (in case of negative answer, we asked to justify it)
- Keywords.

All the templates, filled-in with information, were then sent to the EucA staff to be analysed, since they will constitute the basis of the MOOC Guide.

A total of 165 MOOCs on soft skills and digital soft skills were found by the partners, thus divided: Canvas (8); Coursera (16); ECO (1); EdX (28); eGeneral Studies UniBremen (5); EMMA (2); FUN (1); FutureLearn (11); iMoox (4); Iversity (5); Mooin (3); NovoEd (15); Open2Study (9); OpenHPI (4); OpenUpEd (1); POK – Polimi Open Knowledge (3); Saylor (15); Udacity (1); Udemy(32); World Education University (1). 151 out of the 165 MOOCs analysed train one or more soft skills and/or digital soft skills identified during the previous phases of the eLene4work project: communication (44); leadership (19); adaptability and flexibility (14); self-evaluation (11); learning to learn (10); teamwork (10); digital communication (8); analytical skills (7); digital

content creation (7); creativity and innovation (6); negotiation (5); problem solving (5); information and data processing (3); conflict management (2).

Most of the MOOCs on soft skills and digital soft skills we identified are taught in English. Some exceptions are: 1 MOOC in French, 2 MOOCs in Italian, and 16 MOOCs in German.

Furthermore, we analysed the tools used in these MOOCs to foster self-regulation and active learning with the categories created by Scagnoli (2012) and highlighted, for each one, different activities and tools.

Table 1
ANALYSIS OF MOOCS ON SOFT SKILLS AND DIGITAL SOFT SKILLS

| Element | Activities/Tools |
|---|---|
| **Previous Experience** | Presentation of the theme and final activating question<br>Videos on Youtube<br>News and/or reports<br>Questions |
| **Input** | Instructor's short videos (5-10 mins.)<br>Readings<br>Videos from other sources<br>Other digital content |
| **Check for Understanding** | Multiple Choice or True/false<br>Matching exercise<br>Investigate and complete<br>Cloze – Fill in Blanks<br>Instructor wrap up and setting a stage for the next session |
| **Engagement** | Community Regulated Discussions<br>Digital materials that result from the discussions (for example: a poster that reflects the community conclusions; a web page; a blog etc.) |
| **Legacy** | Spaces that students may create to continue the conversation after course is done:<br>Blog<br>Website<br>Social Media Site<br>Video or Photo Blog<br>Wiki |

We observed that the first three elements (recall of previous experiences, input and check of understanding) are required to complete courses, whilst the last two ones (engagement and legacy) are optional and only concern highly self-motivated participants.

Tools aimed recalling *Previous experiences* are triggers for thought or discussion, content that may appeal to students' reflection and will help as a starting point for the topic. Everybody will process the information in a

different way, based on their own experiences, and everybody will bring new insights to the interaction. Instructional designers of MOOCs have to be ready to accommodate people with no knowledge about the topic to people with PhD's in the subject.

The *Inputs* offered in MOOCs are, generally, rich number of sources that come from diverse perspectives to help participants think and develop understanding of the topic.

*Check for understanding* include self graded activities that allow participants to check their understanding of the weekly topic or discussion, and at the same time, make the participant think deeply about the issues presented in the week. Activities can range from simple to more complex dimensions, from identify and respond, to analyse, and to search and respond.

To foster *Engagement* it is important to encourage participants to select topics within the topic of the class to have their own discussions and learning hubs. Forum moderators should also invite them to use class materials to trigger conversations and learning.

How to motivate participants to continue their activities even after the end of the course, i.e. to look for *Legacy*? It is important to promote participant-created digital spaces that will expand and continue the discussion or the information seeking for the topic of the class. Participants may take what they learn and be agents of change or discovery in their worlds of work or life.

## 4 The comparison of four MOOCs on creativity

In order to further investigate on this theme we carried out a qualitative analysis selecting four different courses on creativity:

1. *Ser màs creativos*, a course published by the Universidad Nacional Autónoma de México on Coursera;
2. *Reinvent yourself*: *unleash your creativity*, published by the University of Texas, Houston, on Edx;
3. *A crash course on creativity*, published by Stanford University on NovoEd;
4. *Creative problem solving*, published by the University of Minnesota, on Coursera.

We enrolled in the courses for the whole duration of the paths (respectively 5 weeks for the first course, 9 weeks for the second, 6 weeks for the third and the fourth) and compared them in terms of pedagogical approaches, activities, progress monitoring and assessment. A brief overview of the results is illustrated in Table 2.

Table 2
COMPARISON OF 4 MOOCS

| Ser màs creativos | Reinvent yourself: unleash your creativity | A crash course on creativity | Creative problem solving |
|---|---|---|---|
| **Pedagogical approach:**<br>Content-based (xMooc) | **Pedagogical approach:**<br>Reflection-based | **Pedagogical approach:**<br>Project-Based | **Pedagogical approach:**<br>Activity Based |
| **Structure:**<br>Session-based<br>5 weeks | **Structure:**<br>Self-paced but with TA<br>9 weeks | **Structure:**<br>Session-based<br>6 weeks | **Structure:**<br>Session-based<br>6 weeks |
| **Activities:**<br>Videos (teacher with slides; interviews, testimonials)<br>Tests | **Activities:**<br>Videos<br>Stop and think exercises (Reflections + Case studies)<br>Topic Wrap-Up (and 5 tests)<br>Project (optional)<br>Homework (optional)<br>Weekly Readings<br>Voting up best projects | **Activities:**<br>Videos<br>Assignments (2 individual and 4 group assignments) | **Activities:**<br>Videos<br>Readings<br>Tests<br>Assignments and Review<br>Peer Graded Assignments:<br>DSD (Do Something Different)<br>Eat Something different; Talk to a stranger; Give differently |
| **Progress Monitoring / Assessment:**<br>Tests<br>Final Peer Grading Assessment | **Progress Monitoring / Assessment:**<br>Tests<br>Stop & Think Discussions (at least 30 on a total of 40)<br>Project Self-Assessment | **Progress Monitoring / Assessment:**<br>Peer Graded Assignments | **Progress Monitoring / Assessment:**<br>Peer Graded Assignments<br>Tests |

As illustrated in Table 2, the first course, *Ser màs creativos*, is mainly based on videos and tests; it is focused on contents and has the structure of a "x-MOOC", i.e. a traditional course organization with a clearly specified syllabus of recorded lectures and self-test problems. Although the course is session-based (i.e. it has a starting date and an end), teacher-student interactions and student-student interactions are very rare or limited.

The second course, *Reinvent yourself: unleash your creativity*, is based on different tasks that involve reflection. It includes very original activities, besides videos, such as Stop and think exercises (Reflections + Case studies), Topic wrap-up (and 5 tests), Project (optional), Homework (optional) etc. Nevertheless, all these activities are designed to be carried out mainly alone, since the course is self-paced and does not require interaction among the participants.

The *Crash course on creativity* published by Stanford University on NovoEd requires participants, after two individual assignments, to create groups (mainly

international, cross-cultural groups) and to work in team to produce creative ideas and creative products. The course is project-based and involves the production of real artefacts. Even the shape of final State of accomplishment was designed by some participants. The platform has additional tools (in comparison with other MOOC providers) to help people create teams and organize their works. During the course participants can explore several tools and approaches that can be used to increase both individual creativity and the creative energies of teams and organizations. Futhermore, participants are invited to create groups in Social media and to continue the "discourse" even outside the platform and beyond the course. As a matter of fact, after the end of the course a group of participants created a team that aims to solve "real world problems".

The fourth MOOC, *Creative problem solving*, is also session-based and involves participants in different kind of activities (videos, readings, tests, assignments and reviews) but also on a specific type of peer graded assignments called DSD, *Do Something Different*. Participants are required, for each assignment, to undertake new, creative initiatives and to document them (with videos, pictures, or a report). These activities might include "eating something different", "talking to a stranger", "giving/donating differently" etc. Students are challenged to identify and change their own cultural, habitual, and normal patterns of behaviour and they are encouraged to understand creativity as a construct of societal norms. For this course, the persistence of the creative person is developed through practice through creative exercises. Course tasks are also designed to challenge students to consider how others (i.e. different people, different cultures) view creativity. This course supports an active learning environment for students to examine how the ideas presented in class fit within integrated education, the goal for scholarship, and the creation of new knowledge. The creative work of the learner and groups of learners (team projects) are central to the course curriculum.

The comparison of the four MOOCs shows that different tools can be used to foster different patterns of engagement. The four examples presume different learning behaviours that can be classified following the categories created by Littlejohn, Milligan and Margaryan (2011): consume, connect, create and contribute. Of course, this does not mean "ranking" the four courses, since different learning paths might be useful for different kind of learners. Furthermore, each learning practice brings together a combination of these components to form a distinct learning pathway, providing a baseline for rethinking combinations of practices for more effective learning and soft skill development.

Having an understanding of different learners and the factors affecting participation can aid MOOC developers in ensuring the success of MOOCs.

Littlejohn *et al.* (2011) suggested that while many learning environments concentrate on providing opportunities to consume information and connect with resources and people, more emphasis needs to be provided on allowing learners to create and contribute, to learn through experience, discussion, self-study and by teaching others.

## Conclusions

Educational institutions as well as education technology such as MOOCs are trying to provide 21st century skills (including both soft skills and digital skills) to their students so that they are better prepared for the labour market. However, according to Gamage *et al.* (2016), MOOCs are not effective in teaching these skills and the MOOC hype would have been fading in the last 4 years because MOOCs are not interactive and collaborative enough for students.

This might be furthermore true for soft skills, since they are "behavioural components".

MOOCs gather participants from different parts of the world and with different personal, demographic and professional backgrounds. The only thing that all participants have in common is their interest in the topic of the course. This interest, however, is diverse as well and, although they all may be interested in the topic, not all the participants enrolled have the same commitment or motivation for learning about that topic, and their interest has perspective. The interest may go from learning more about a topic, to confirming concepts, to being curious, to finding a community to host discussion and concerns.

Audience heterogeneity makes it very hard to create a course that will appeal to all levels. The analysis of 151 MOOCs on soft skills selected and the qualitative comparison of four creativity MOOCs highlighted that different elements might help an instructor plan and be prepared for diversity, creating a space that will give inspiration and intellectual challenge to any levels of participation.

We do believe that MOOCs might help train soft skills and digital soft skills but some limitations must be underlined. First of all, the majority of MOOCs are in English. Therefore, also for MOOCs on soft skills and digital soft skills, it is true what Sanchez-Gordon and Luján-Mora (2014), and Gaebel *et al.* (2014) pointed out: language can still represent a barrier to participation in MOOC learning.

Furthermore, it seems that MOOC instruction tends to substantiate as an opportunity to develop employability skills (both soft skills and digital soft skills) for those who have already benefitted from Higher Education and for those who are already employed, i.e. lifelong learners. To sum up, work has still to be done for MOOCs to set ground for digital inclusion, becoming

dynamic systems, in which those that cannot access education, because of socio-economic constraints or special needs, feel comfortable and valued.

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# MOOC DESIGN AND HERITAGE EDUCATION. DEVELOPING SOFT AND WORK-BASED SKILLS IN HIGHER EDUCATION STUDENTS

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**Keywords:** High Education; MOOC; Distance Education; Museum education; Education Experiences

The present paper describes one of the pilot activities foreseen by the Erasmus+ project DICHE (Digital Innovation in Cultural and Heritage Education in the light of 21st century learning). The above mentioned pilot activity was carried out at the undergraduate course in Educational sciences – University Roma TRE, as an internal training module for the conception, implementation and evaluation of MOOC courses in museum education.
Main objective of the module was to develop design and realisation skills in Educational science students. Those engaged in the module were asked to create cultural and heritage education courses for primary school in training and in service teachers. The two main pillars of the DICHE pilot, "MOOCs conception and delivery" and "heritage education", are in line with the

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most recent national and international field literature research and with the Italian education system directions, aiming at integrating museum education in primary school curricula and a more aware use of technology, in order to develop pivotal skills in active citizenship building. The present paper presents the methodology adopted and the results collected during the training module carried out.

## 1 Introduction

For several years, the Laboratory for Experimental Research at the Department of Education of University Roma Tre has been developing a research line aimed at promoting a critical use of technology, which could help the twofold objective of interpreting technology as a tool and of increasing critical thinking skills (Poce *et al.*, 2012). Employing structured and tested models in several interdisciplinary applications of a specific starting research hypothesis, the students were involved in different activities of analysis and reflection, individually and in groups, at different levels: from the presentation of cultural contents, through the medieval *lectio magistralis* scheme, to the delivery and evaluation of free online learning materials (e.g. MOOCs). The general goal of such research projects was to provide students with a long-term structural and instrumental basis, adaptable to different contexts and overcoming "the emphasis in supporting educational potentials of instrumental proposals, too often based on analogies and short-term suggestions" (Vertecchi, 2012).

On such background basis, LPS and its Centre for Museum Studies (CDM) branch have taken part in the Erasmus+ project DICHE (Digital Innovation in Cultural and Heritage Education in the light of 21st century learning), which was funded in September 2015. The project, 30 months long, involves six partners from four European countries (Netherlands, Belgium, Great Britain and Italy): Marnix Academie, Stichting Landschap Erfgoed Utrecht, ATIT, Loughborough University, Coopculture, LPS - Laboratory for Educational Research and CDM - Centre for Museum Studies - University of Roma Tre. The main purpose of the DICHE project is to integrate the use of digital resources in the primary school learning processes, especially concerning artistic and cultural heritage education. This aim is in line with the European Union directions, regarding the need of integrating today's learning systems with new methods and new technological equipment, in view of the development of active citizenship skills. The development of pupils' skills recalls the Recommendation 2006/962/EC of the European Parliament and Council dated 18th of December 2006, on key competences for lifelong learning [Official Journal L 394, 30.12.2006, p. 10]. In particular, the DICHE project intends to develop the so-called "4Cs" ability scheme (*Critical thinking, Creativity, Communication* and *Collaboration*), already defined by Trilling and Fadel (2009) as fundamental educational skills

for the development of more complex skills.

## 2 State of the art

Over the last few years, an extraordinary development of MOOC courses has taken place, mainly at University level, both nationally and internationally. The great diffusion of such free courses raised, after the first experiences, a series of critics (Daniel, 2012; Dillahunt *et al.*, 2014, Hollands & Tirthali, 2014; Rohs & Ganz, 2015, Schuwer *er al.*, 2015). Those were mainly due to the following issues: drop out rates, in some cases extremely high, low participation from the Third Countries, lack of pedagogic and didactic strictness in the design of the MOOCs, together with the lack of quality criteria (Stracke, 2014).

Despite all of the above, the spread of the MOOC phenomenon demands attention by all those engaged in education who, through the conception and design of such courses, have the chance to improve their teaching competences as well as their cross sectional digital, analytical and critical thinking skills.

Moreover, the application of digital resources in the field of artistic and cultural heritage education is a real challenge for innovation: museum education has the opportunity to be integrated with technology and, at the same time, develop new teaching methods for the benefit of all but especially for young users. In 2013, the MoMA, in New York, produced a MOOC addressed to museum operators and educators. Over the first 4 weeks, it was able to reach 17,000 users from all over the world (Mazzola, 2013). In 2015, the University of Leicester promoted a MOOC entitled "Behind the scenes at the 21st Century Museum", first example of accessible online course, created with the support of Liverpool National Museum. The project underlined the importance of shared management between museums and Universities in the planning and realisation of courses such as MOOCs. Such methodology significantly improved the quality of the proposed contents and, in a broader sense, also museum and academic didactics (Parry *et al.*, 2016).

Starting from the above-mentioned remarks, the LPS/CDM research group designed and realized a training module for Educational Sciences students, with the aim of making students develop their teaching skills in the field of cultural and heritage MOOCs implementation. The Italian school system, moreover, promotes the experimentation of new models, the use of innovative tools and the dissemination of best practices through the National Digital School Plan (issued in 2008 and transformed in one of the pillars of the 107/2015 act, aiming at creating new learning environments). Besides endowing schools with technological tools, it is mandatory to train prospective teachers and educators in the use of innovation and didactics design and in the use of integrated digital contents (CDI – L. 221/2012), Learning Objects, LIM and OERs.

Providing students with the necessary tools in order to design a sound structured MOOC, and to peer evaluate the proposed online course, constitutes a basis for the promotion of learning to learn and learning by doing activities, but it is also a way to increase their analysis and critical thinking skills development. The main objective was to let students independently build learning courses based on innovative museum education issues and evaluate the quality of online digital resources addressed to any external users but especially for future educators.

### *2.1 Methodology*

The students' objectives within the internship module "MOOC, critical technology and museum education" were the following:

- to take part in critical online discussion groups on specific topics;
- to investigate issues of their interest, guided by an online tutor;
- to develop and create MOOCs in the field of museum education;
- to develop and implement specific evaluation tools for distance learning;
- to learn how to use a virtual learning environment (VLE) for distance learning;
- to learn how to use collaborative writing tools to draft a group project;
- to become familiar with MOOCs and their potential;

The module had the macro-objective of providing students with the necessary tools for the design, implementation and evaluation of prototypal MOOCs in contexts of museum didactics. The courses had to be designed by the students on the basis of the national guidelines for primary education (DM 254/2012). They also had to be described in a booklet, outlining the educational course and its detailed structure, and be introduced by a video, appropriately included in the course plan.

The activities foreseen by the internship module "MOOC, critical technology and museum education" involved 42 students from the course in Educational Sciences and were carried out in groups of 5-6 students; peer assessment of the MOOC products was individually carried out by each student. All the activities foreseen within the internship have been outlined on the basis of "peer learning" methodology (Topping, 2005), with the precise aim to create a positive interdependence within each group and among all the groups involved. This, consequently, allowed the increase of knowledge quality and skills' levels ultimately acquired by the students.

Three compulsory face-to-face meetings and a number of distance activities on the *Orbis dictus* virtual learning environment (www.orbisdictus.it) were organized within the course, according to the schedule described below:

- Presentation of the project's objectives and description of the VLE course. Presentation of the MOOCs phenomenon, introduction to MOOC design and its use within the course. Students were divided into groups of 5/6 persons.
- First online activity: critical discussion and draft of the MOOC design. On the basis of both the available material and the task, students were asked to carry out online researches and discussions on the presented topic and summarise them in the virtual space at the group's disposal. The discussion about the project took place in a dedicated group forum within the VLE. The writing phase of the project took place in collaborative form on a shared writing paper.
- Second online activity: realization of the MOOC and of the connected teaching tools. In particular, the groups were asked to realize at least one video, as planned into the educational path created during the first activity. Discussions about activities were carried out on the dedicated forum. Besides moderating discussions, tutors provided brief summaries of the work in progress.
- Intermediate face-to-face meeting. The various groups met in person, and presented the implemented MOOC prototypes to other course students. During the meeting, all the videos created by the groups were shown. At the end of the presentations, the assessment grid for evaluating MOOC prototypes were introduced by the tutors.
- Third online activity: assessment activities on the implemented MOOCs. Each student was asked to individually assess, using the VLE tools, the MOOCs realized by fellow students during the course. The activity was completely carried out online, on the Orbis dictus platform.
- Final meeting: the results of the MOOCs' peer assessment conducted by the students were presented to them by the tutors. At the end of the last meeting, students also filled in a short evaluation questionnaire on the entire experience.

Peer assessment results of the MOOCs created by the students during the module are provided in the next paragraph and represent the core section of the present contribution.

## *2.2 Results*

Peer assessment was the last activity for the students taking part in the course. While in the other activities students were asked to cooperate, this assignment was designed for them to work individually and evaluate the MOOC paths developed by their colleagues. In particular, with the help of an

ad hoc created assessment grid, every student was asked to evaluate the didactic videos and learning paths created by the other groups. The rationale behind this activity is that the students develop metacognitive reflections on the learning process they outlined as well as on the multimedia materials produced. The next step is to build a critical evaluation of peers' productions.

The assessment grid provided to the students to help them carry out the peer assessment activity is structured in the form of a questionnaire organized in the following 4 sections: Video and contents quality (Likert Scale); Module skills evaluation (Likert Scale); MOOC assessment (Multiple Choice); Strengths and weaknesses (Open Ended). The results of the evaluation are provided below.

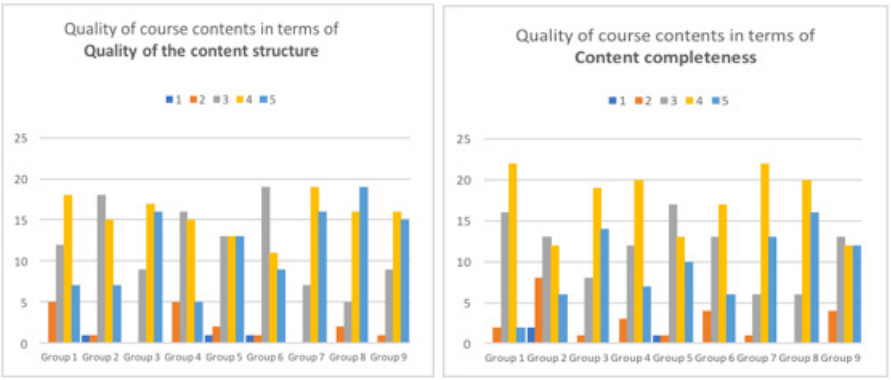


Fig. 1 - Video and contents quality evaluation.

Most of the MOOCs designed within the course were positively evaluated. In particular, the MOOCs' clarity of structure and teaching unit design was positively assessed in all cases. Groups 3, 7, 8 and 9 were given the highest marks. This indicator proves to be especially relevant taking into consideration the main objective of the module the students were engaged in. Abilities involved in reflecting and arguing on project and draft of a teaching unit, even if written by others, together with tools analysis, are pivotal to be acquired as prospective educators. As far as content completeness is concerned, results rank in the medium high slot of available marks. On average, the MOOCs' learning paths outlined by the students appear to be consistent with the identified target group and clear, as far as structure and contents are concerned. The technological and non-technological tools developed during the course, such as the assessment tools, are generally introduced in a fairly consistent and clear way. Clarity of vocabulary, essential indicator in a teaching and learning activity, was given a medium high-level score for every course and video produced.

According to the module skills evaluation, the competences that were more frequently given the highest marks (level 5 and 4) are *Collaboration* and *Creativity*: these skills have been introduced in every MOOC designed by the students. The reason for such a choice is probably based on the peculiarity of such competences: teaching and learning methodologies based on cooperation and the creation of new products are fundamental in every primary school curriculum. *Creativity*, as above stated, is the competence able to get children closer to the world of art, thanks to its richness of emotions and experiences. It is not surprising, therefore, that students of Educational Sciences stress such aspect in the teaching and learning paths conceived in the module.

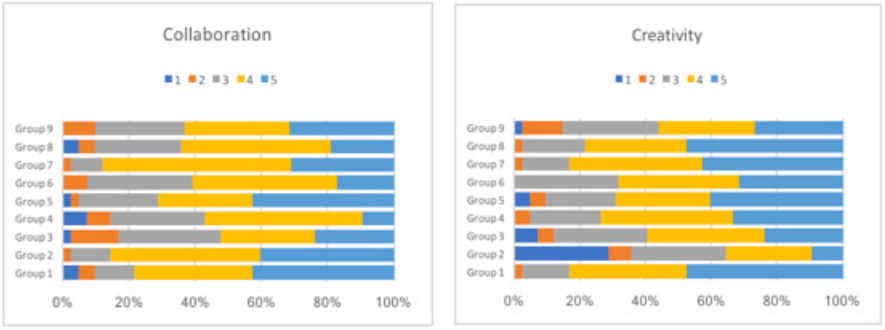


Fig. 2 - Skills evaluation.

*Critical thinking*, the most complex skill to be inserted in a primary school path, has been taken into account by a significant number of groups: group 3 ranked best with a multi-disciplinary MOOC on water saving, which ranges from ecology, to geography, to history, to science and art education, developing a course on Roman aqueducts.

Such multi-disciplinary approach allowed an innovative development of the topic. The merging of ideas from various scientific subjects, regarding contents and methodologies, overcomes knowledge localisation (Morin, 2000) facilitating the reasoning of the pupils in terms of complexity and globalisation. It also helps children to consider knowledge in a critical and united way. On average, the Communication indicator was given medium/high scores. Marks are 40%. higher than other evaluation results.

In the general evaluation phase, both MOOCs' paths and videos were taken into consideration. The results of the assessment survey are summarised in the following graph.

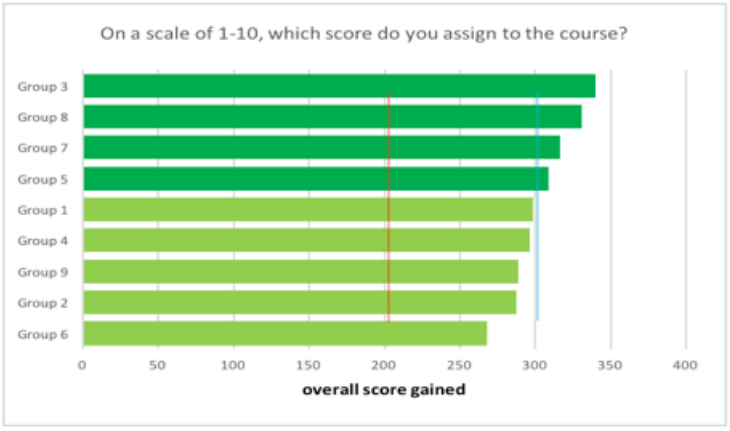


Fig. 3 - Students' evaluation.

The best scores are shown in the medium–top slot. They rank above the average value of 303 (group 3: 340 points; group 8: 331 points; group 7: 316 points; group 5: 309 points) out of 400 points available. Overall, every group was awarded more than the minimum pass score (210 points. The average score is given by every student giving the average of 5 in the individual evaluation, that is 42 times). Such result mirrors the good average level of teaching and learning paths developed according to the guidelines. Support and feedback by online tutors, especially as far as group activities are concerned, proved to be crucial for the successful completion of the activities.

The last questions of the peer assessment questionnaire were open. Students were asked to summarize the strengths and the weaknesses of each MOOC under scrutiny. Every open-answer feedback provided by the students was collected to create a unique corpus. A content analysis was carried out, in order to understand which terms appeared most frequently.


Fig. 4 - Tag cloud representation.

## 3 Discussion

As shown by the synthetic representation of the content analysis performed (Figure 4), the core elements that were identified, reflecting the strengths and weaknesses of the courses, are the following: the MOOC video, the structure and the design of the educational path ("struttura", "corso"), the role of the museum object ("oggetto museale") in the learning path, the enhancement and development of certain skills ("creatività", "competenze"). Regarding such items, students also made suggestions on improvements of the planned courses; such improvements mainly focus on the educational units' duration (in the above tag cloud: "durata", "lezione", "corso"), on the activities carried out and on the teaching and learning methodologies employed. Clearness, creativity and originality are considered as strengths in the educational paths proposed: the use of a particular kind of museum object has been appreciated by all students as a way to develop specific knowledge.

The structure of the MOOC videos is one of the main weaknesses identified during the peer assessment activity: videos were conceived by some groups as a presentation of the learning path and not as its integral part as they were meant to be. As for the pupils' activities, group 1 has been commented by other students due to a use of museum objects based on gender connotation (jewellery for girls and swords for boys): this is why the word "femmine" ("girls") is so evident in the tag cloud shown above. Moreover, assessment activities ("valutazione") are seen as a "weakness" for some groups: not all groups planned clear assessment modalities (e. g. formative and summative assessment sessions) and inserted a predetermined assessment grid in the structure of their MOOC courses.

## Conclusions

The proposed system of educational-training experience within the DICHE project proved to be innovative in the field of distance learning in general and in university education in particular. The promotion of the MOOC phenomenon is rapidly developing on a large scale, demonstrating the educational potential of a teaching technique which, apparently, has no limits. The connection between the MOOCs and the promotion of artistic and cultural heritage is fairly new in the field of museum education. The skills to be developed by students who want to get a degree in Educational Sciences are fully related to their educational and general training (planning, implementation and evaluation of educational courses) and will also contribute to the development of soft skills (e-skills, critical thinking, research skills) necessary for their future access to labour market as educators and teachers. Participation in European and international

projects also allows students to put in practice the knowledge acquired through their involvement in courses and allows them to compare the acquired skills with the latest international research standards.

Peer learning, in particular, allowed the further development of acquired knowledge and abilities. The peer assessment activities, in particular, helped as a critical and metacognitive reflective session on the learning paths outlined by the students themselves.

The above-listed results can be useful to plan differently the training of future educational staff at different levels of instruction. In the near future, those students will have to prove to be able to show a series of competences that the educational scientific and academic community, the European Union and the global system strongly demand today. The ability to develop a project, carry out an analysis, show critical evaluation abilities and prove to be able to use ICT in a reflective way are essential to train active citizens and, at the same time, educators able to stimulate such competences in the pupils attending their classes.

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# OPEN PLATFORM OF SELF-PACED MOOCS FOR THE CONTINUAL IMPROVEMENT OF ACADEMIC GUIDANCE AND KNOWLEDGE STRENGTHENING IN TERTIARY EDUCATION

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**Keywords**: Automatic assessment; Learning management system; Self-paced MOOC; University guidance; Virtual learning environment.

In the academic year 2014/2015, University of Turin started the Project Orient@mente[1], aimed to support students in the transition from high school to university. Several Massive Open Online Courses have been developed to support three main actions: guidance to the University offer, automated self-testing of basic knowledge, self-paced review of fundamental disciplinary concepts learned in high school; all of them are useful to help students

[1] The project name comes from the fusion between the Italian words for orientation and mind, where the middle @ remembers the use of the internet.

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successfully attend scientific courses of the first year of University. A key feature of the Project is the continuous open-access to the platform. Contents are built according to educational models grown thanks to the experience and the research in e-learning carried out by the University, especially in the use of an accessible learning management system integrated with an advanced computing environment, an automated assessment system and a web conference system to enhance teaching and learning. In this paper, the adopted methodologies are discussed, the obtained results are presented and future developments are proposed in light of relevant data collected from the platform usage and feedback received by users.

## 1 Introduction

The use of Massive Open Online Courses (MOOCs) is making inroads worldwide. As a matter of fact, over the last years the evolution of open-access online courses in terms of pedagogical studies and technical implementation has rapidly increased (Grainger, 2013). It is known that online education can pursue several goals that are not necessarily strictly related to disciplinary contents, such as the enhancement of the ability to self-evaluate and self-regulate one's learning or the development of digital, problem solving and collaborative competences (SMEs & e-LEARNING Project, 2015). The transition from high school to university is a critical turning point in students' lives: they need to be aware of their choice and prepared for the moment when expectations meet reality. Schools and universities are responsible for making this experience as positive as possible. The use of new technologies and virtual environments can be helpful for this purpose: multimedia resources are effective to show students what they will face at university; the possible interaction between users allows them to contact university students and professors to know their experience; online tests with feedback allow students to check whether they have an adequate preparation to attend first year's courses, while interactive learning materials can help them fill their gaps (Pyke, 2012).

This paper discusses the actions undertaken by the University of Turin and developed under the Project Orient@mente for the orientation of students who want to enrol to the university. The chosen asset for such a guidance is a Learning Management System (LMS), an Advanced Computing Environment (ACE), an Automated Assessment System (AAS) and a Web Conference System (WCS). MOOCs for academic orientation were created according to three main goals: making students more aware of their skills to fulfil certain academic curricula, informing students about what they are going to study and strengthening students' weaker skills. In the following paragraphs, the methodologies adopted in Orient@mente are shown and the results obtained ten months after the service went live are discussed.

## 2 State of tertiary education in Italy

The University of Turin addressed the need of providing students with help in their careers and study choices after considering the state of higher education in Italy. From 2010/11 to 2014/15, the percentage of students who enrolled at Italian Universities right after the conclusion of upper secondary education slightly decreased from 54,4% to 49,1%. One student out of two acquires more than half the credits (CFU) expected by the first year. In contrast, one out of four gets less than half and one out of five does not get anyone. One year after enrolment, 74% of students confirm the subscription in the same graduating class in which they have registered, 14.8% change it, while 11.2% abandon the studies. Moreover, the scientific area records the highest number of movements after the first year (MIUR, 2015).

Comparing the state of education in Italy with the European scenery, Italy ranks in the lowest places for the diffusion of tertiary education: the percentage of 30-34 years old people having completed tertiary or equivalent education is 23.9% in 2014, far from the European average (38%) and from the European target defined by Europe 2020 strategy (40%) (European Commission, 2015; OECD, 2014).

Orient@mente arises in this panorama as the first example of open platform. Its openness is a relevant aspect, since it is a little choice that has big impacts not only on users' self-preparation, but also on the formative offer itself: the university guidance can be better designed according to feedback collected from a range of users wider than the students' community.

## 3 The birth of Orient@mente

The Project Orient@mente started in the academic year 2014/15, thanks to a funding from the Ministry of Education, University and Research and with the support of the Managing Director of the Regional School Management of Piemonte and of several high school executives (USR Piemonte, 2015). The Project consists in the development of an open online platform for the fruition of self-paced MOOCs, serving as an effective dematerialized orientation for secondary school students who intend to apply to a scientific course at the University. Orient@mente services are hosted on a dedicated instance of the LMS Moodle integrated with a suite of specific-scope selected software: Maple ACE, MapleTA AAS and Adobe Connect WCS. Our University has a wide experience in the use of this digital asset, which is adopted in many courses to share lectures materials with students. Practices of using Moodle and its integrations for enhancing learning of scientific disciplines are studied and experimented by the University in several projects at local, national and

European level (Barana & Marchisio, 2015; Brancaccio *et al.*, 2015; Barana *et al.*, 2017).

The Project started under the direction of the Department of Mathematics with the joint participation of 15 scientific University courses: 9 courses of the School of Science of Nature (SSN), 4 courses of the School of Agriculture and Veterinary Medicine (SAMEV), 1 course from the Department of Drug Science (DDS) and 1 course from the Department of Molecular Biotechnology and Health Sciences (DMBHS).

Platform development is coordinated and controlled by a team of researchers of the Department of Mathematics and of the ICT services of the Computer Science Department who are responsible for the correct functioning of the platform. University professors have been designated to select and arrange the materials to be implemented in the courses, as a guarantee of its quality.

## 4 Orient@mente methodologies

The platform is conceived to offer the chance to connect with existing e-learning resources of University, to add different-purpose MOOCs, to connect with new tools developed for specific disciplinary requests and to update the material depending on changes of University admission tests that may occur in the near future.

While preparing and realizing Orient@mente, great attention was put into ensuring the high quality of all courses and of the whole project. The process was based on team-working and modelled on the Deming cycle: plan–do–check–act (Walasek *et al.*, 2011). Preliminary studies and planning with managers and digital experts from the University have been carried out to define suitable instruments and methodologies. 21 students, holders of research-grants, were selected and trained by tutors of the Department of Mathematics in the use of the digital tools; they then started to create the course contents, coordinated by the referents of the University Courses involved. The platform developers and their collaborators continuously adjust the materials and the services offered on the base of feedback collected from users through specific and ever-open surveys.

Orient@mente is built according to the principles of immediateness of communications and self-explanation: users are directed to the platform from advertisements on the University websites which link to Orient@mente front page (http://orientamente.unito.it); the high structured MOOCs are equipped with mind maps of the contents and delineations about learning methodologies suggested by professors; interactive activities are self-explanatory. In addition, users are redirected to the websites of the courses of study involved for further information and specific resources.

In the platform, the MOOCs are grouped in three different areas (course categories) which correspond to the three purposes of the Project:

1. orienting courses which provide information about the study courses and the careers that can be undertaken with such degrees;
2. testing courses to verify students' basic knowledge and skills and to enhance their awareness about their initial situation;
3. realignment courses to strengthen their competences and filling the gaps in their preparation.

The three categories of MOOCs are implemented and updated according to their needs.

The **orienting area** consists of 15 MOOCs, one for each scientific university course involved in Orient@mente, aimed at showing students what studying a subject actually means and the career opportunities to which it can lead. They share an identical structure, composed of sections dedicated to several services: essential information about the related university course, interactive resources for helping students to be more aware of whether the chosen study path is the right one, forums to ask for further information and advice, online tutoring conducted by trained tutors who have just graduated in the course of interest and facsimiles of the admission tests. While their structure is similar, each course differentiates for the innovative orienting resources and guidance activities it stores, which depend on the subject; resources varies from simple text files to complex interactive lessons and algorithmic automatically graded assignments made through the integration of the platform with the ACE and the AAS. Since these MOOCs are related to scientific courses, an important example of orienting resource is the presentation of relevant experiments that students are going to carry out at university, digitally exposed from the students' point of view.

The structure of the **testing area** reflects the one of the screening tests: for each scientific subject involved, a dedicated MOOC is proposed (Basic Mathematics, Advanced Mathematics, Logic, Physics, Chemistry, Biology, Earth Science, and Comprehension of Scientific Texts). MOOCs are composed of a series of tests, a preliminary guide about how to perform a test and collect results or feedback at the end, and an appreciation survey. Each test covers a range of required knowledge and skills to be mastered at different levels, in order to fit all students. About 2000 is the total amount of automatically graded questions created by the trained postgraduates under the supervision of professors.

The **realignment courses** consist of four MOOCs respectively on Biology,

Chemistry, Physics and Mathematics. Each MOOC is highly structured, composed by a list of modules (which correspond to the Moodle course sections), in turn split in smaller submodules, or lessons, which focus on a specific topic. With the purpose of making its structure clear, on top of each MOOC there are a general description and a mind map of the topics covered, while each module and submodules have their own summary. In order to facilitate the learning process (and to be adaptable to the widest range of learning styles), each topic is exposed in different modalities, such as video lessons, tests, and interactive files. More specifically, lessons are organized according to a regular pattern consisting of the following activities: Explore, Applications, Quizzes, Exercises, Solutions. At the end of the module there is a final test about the whole module's theory.

Explorative and interactive materials are created with the ACE Maple, which is one of the most innovative and effective tools for learning Mathematics and Scientific disciplines. Maple allows to perform numeric and symbolic computations, geometric visualizations in two and three dimensions and to add interactive components where students can change parameters and analyse different results. Maple worksheets can be added to a Moodle page thanks to its integration with MapleNet, which allows Maple worksheets to be visualized within Moodle maintaining their interactivity.

Questions in quizzes and tests are created through MapleTA, which is integrated in Moodle. MapleTA questions can contain algorithmically generated variables, so that students obtain different data and graphics at every new attempt to perform the same assignment. The algorithmic peculiarity of questions brings two main advantages: on one side, it offers students more chances of drills for the admission tests, on the other, it forces them to repeat the reasoning until it has been mastered, thus strengthening the learning. Online tests allow students to acquire confidence with modality, structure and time limits of the admission tests. Students can work independently and whenever they want: immediate automatic feedback allows them to acknowledge their level of preparation (Barana & Marchisio, 2016).

Online tutoring is performed through the integration of Moodle with the WCS Adobe Connect, which enables synchronous interaction among users thanks to the sharing of voice, chat and desktop. Students from all over Italy can thus meet graduate students from Turin to ask questions and curiosities. Tutoring is carried out at fixed times, mainly close to the enrolment period. Thence, Orient@mente is not simply an illustrative archive of the formative offer of University: interactivity and interaction turn university guidance into an active process where students are protagonists. Challenged to actively try and explore, they can become more aware of their attitudes, knowledge and

skills, and find out whether the courses offered by our University will meet their interests or not (Pyke, 2012).

The surveying action is conducted in several ways: on the platform each user can ask for help via an integrated Helpdesk or request information to a dedicated mail address; daily answer is guaranteed. At the end of every testing course, an open questionnaire asks about personal scholastic career, usefulness of the services, and free suggestions. Moreover, starting March 2016 there is a second questionnaire open to all platform users.

University affiliates have federated access to Orient@mente, while everyone may access the platform via the use of personal credentials from social networks that are popular among students: Facebook, Github, Google, Linkedin, Windows Live. Lastly, the default platform aspect uses the high-legibility font EasyReading® (EasyReading), that was chosen in order to maximize the website legibility to dyslexic students.

## 5 Results and discussion

Since the service go-live on July, 14 2015, the platform has registered a constant activity. 4657 is the total amount of subscribed users, updated to May, 23 2016. 48% of users is from Piedmont, 50% from the rest of Italy and 2% from foreign countries. During the first 4 months, that overlap the period of admission tests, an average of 198 users per week have enrolled to the platform. A comparable rate of registrations was also recorded during the week before the early session of admission tests organized in April 2016, addressed to students of the last year of secondary School. Clearly, the rate of usage of the platform is different according to both the MOOC's category, subject, and type of materials stored. Orienting area collects 2460 users' subscriptions. As shown in Figure 1, the main activity was recorded during the first four months, which correspond to the opening of the University enrolments. The testing area is the most visited. It collects an average of 1210 subscribers per test course, with the highest registrations to the courses of Biology and Mathematics, subjects which occur in the majority of the admission tests. Until May, 23 2016 users have submitted a total amount of 38464 disciplinary tests. Figure 2 shows the numbers of completed tests grouped by discipline.

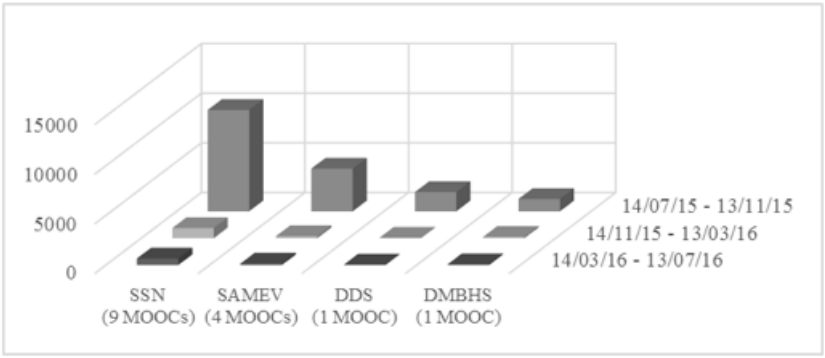


Fig. 1 - Users' activity in Orienting area's MOOCs grouped by Schools and Departments.

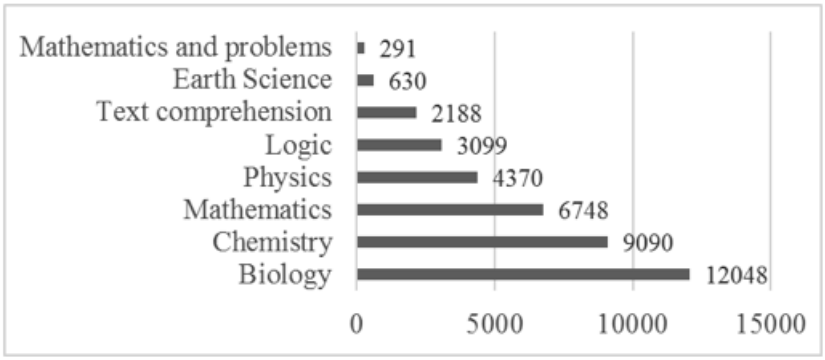


Fig. 2 - Disciplinary completed tests.

Besides the completed tests, the platform has registered other 4152 attempts to tests which have not been submitted (graded) - it means that users did not request the correct answers and feedback: it is likely that these tests have been opened just to have a look at the contents.

The questionnaire at the end of the test courses shows a high level of appreciation of the Project: 95% of the submitters answered "Yes" to the question "Do you consider Orient@mente a useful service offered by the University?". Moreover, several suggestions helped to identify some improvements for the didactic materials.

The results collected by the second questionnaire show a high approval of the platform: the easiness of use, the usefulness of the services offered and the overall appreciation were evaluated by at least 3 points out of 5 by more the 86% of the interviewed (Figure 3).

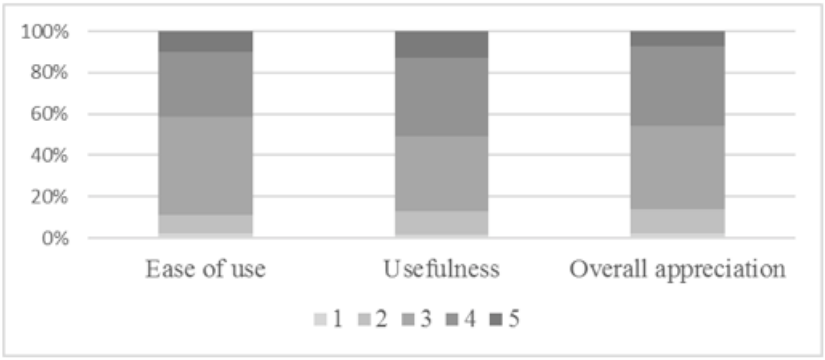


Fig. 3 - Approval of the platform.

The questionnaire inquires about users' academic career: a considerable percentage of platform users has not enrolled to a scientific course during the academic year 2015/16 (40%). However, 95% of the remaining has enrolled at our University. The feedback points out that the testing area covers the lack of a free area to verify self-preparation for the main subjects of the university courses. The question "Did the testing area help you to pass the entry test of the study program in which you subscribed?" have been evaluated with at least 3 points out of 5 by 80% of the interviewed who used the tests. Conversely, from the answers to the question "Did the orienting path influence your choice of study program?", which are on average 2.1 out of 5, it emerges that Orient@ mente was used mainly for strengthening students' choice, rather than to choose a University course. This is evident also from the answers to the question "How can Orient@mente be improved?": 69% of the interviewed asked for "more tests", while about 35% asked for "more video lessons", 38% for "more topics" and 36% for "more orienting activities".

During 2015/16, a meaningful increase in the access to the Italian university system has been registered: statistics show that more than half of the students who finished high school enrolled to university in Autumn 2015. This trend is growing, after several years of decrease. At University of Turin, the amount of enrolments to scientific courses increased by 15%, while the average increase in Italy is about 2% (MIUR, 2016). Orient@mente could have had a considerable positive influence.

The Project is a virtuous example of mutual entailment between the academic world and social networking. While students are guided to face their academic choice decisions, University monitors and tries to meet students' needs. Furthermore, every owner of a common internet connection (not broadband) and a not too old digital device (such as a smartphone or tablet)

can take advantage of the digital guidance certified by the University. Other institutions, such as high schools, can benefit from the Project services, as they can be used by teachers for orientation activities, and from the Project outcomes, since a high credit is guaranteed to the high schools whose graduates successfully complete university degrees.

Orient@mente is also listed in the library of strategic goals for the current year by the University for the middle-management annual target goals, once more confirming the perceived value of this project.

## Conclusion

The Project is expanding towards several directions. First of all, since some of the information of the orienting MOOCs can change every year, the Project will continue to keep it updated. Thanks to its effectiveness, Orient@mente is starting to engage also University courses outside the scientific area, such as Economy and Foreign Languages, Psychology and Political Sciences. During the academic year 2015/16 the Project has been extended with 2 new orienting MOOCs: Philosophy and Strategic Sciences.

An important action that will be considered is to extend the monitoring action to the realignment courses: a questionnaire will be added to each of these MOOCs, similarly to what has been made for the orienting ones. They will be oriented to collect feedback about the appreciation and completeness of the learning materials proposed. Results of the admission tests and information on the provenance of university students who use the services of Orient@mente could be correlated to the survey's outcomes.

In the future Orient@mente will also contain open access to university courses in e-learning modality, which are currently in development. Far from the realignment courses, such MOOCs will be full university courses that could be delivered completely online.

Orient@mente also includes other projects which are currently in progress: ATTRASS and Digital Archive Erasmus. ATTRASS is addressed to foreign students who are interested in attending courses at the University of Turin or any other Italian university. Its main objectives are to facilitate their inclusion at the University and in the city and to help them with their university career. Digital Archive Erasmus is dedicated to students who are interested in joining the Erasmus program: a new category of MOOCs - named Internationalization - will contain useful resources and activities collected from outgoing and incoming Erasmus students of the previous academic years, such as information about the universities and cities involved, interviews to students and representatives, contacts and statistics.

Lastly, Orient@mente opened many possibilities of research in several

directions: strengthening connections with other social university e-learning environments, studying the role of automatic assessment in improving learning, extending similar opportunities to other disciplines.

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# PEER ASSESSMENT TO PROMOTE DEEP LEARNING AND TO REDUCE A GENDER GAP IN THE TRADITIONAL INTRODUCTORY PROGRAMMING COURSE

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**Keywords:** Peer assesment, Gender gap, Programming skills.

Peer assessment mechanism is becoming increasingly important in different computer programming courses to give students opportunities to learn from each other, to improve the learning experience and to reach efficient learning outcomes. Nevertheless, new methodological approaches developed to help students in computer programming courses have had to deal with a thorough study of the aspects related to the gender difference in this context.
The paper presents a web-based system, which improved students' program skills by reviewing peers' source codes and delivering feedback to peers. The purpose was to provide evidence that peer assessment in computer programming has a positive instructive effect. Moreover, we want to investigate if there is a gender gap in the traditional introductory programming course and how can we use peer assessment principles to reduce it.

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## 1 Introduction

Programming skills are becoming ever more important, quickly turning into the core competency for all kinds of 21st Century workers. Therefore, programming skills have become a core competence especially for engineering and computer science students; that inescapable fact is leading individuals to seek out new ways of learning to code. However, learning to code is usually challenging and difficult for most students, because it involves comprehension and a lot of practice about a range of theoretical background, semantic and syntactic knowledge, coding and algorithmic skills (Yang *et al.*, 2015). To cope with such difficulties, various teaching strategies and learning activities have been applied to support programming courses, including mechanisms to ensure continuous assessment during a programming course to guarantee enough practice as well as give feedback on the quality of student's solutions. But providing quality assessment manually for even a small class requires time and when the class size grows, the amount of assessed work has to be cut down or rationalized in some other way.

Automatic assessment of programming assignments is one major task in programming classes used to evaluate and mark student's programming exercises. Relying on computer assistance allows for instant feedback without the need to reduce exercises. Research in the context of automatic programming assessment has a long history. It has been of interest to computer science educators since the 1960s and has continued to gain vast attention until present.

Students learn programming skills when they review code, write and read comments and see how other students tackle the same problems. These practices/skills are necessary also to work in a team environment in their future careers.

Peer assessment has been used successfully in different computer programming courses for many years to get students opportunities to learn from each other. In those situations, each student acts as both an author and a reviewer. Positive feedbacks report better learning experience and efficient learning outcomes (Wang *et al.*, 2012); in fact, when students evaluate each others' work they think more deeply, learn to criticize constructively, and display important cognitive skills such as critical thinking.

Several authors have found that female students are much less confident in their programming abilities than male students. So, if we want to involve more women in computing, the pedagogy of introductory programming courses needs to change. Although there have been several studies about gender differences in introductory programming, to our knowledge no one study compared the effect of the peer assessment.

In this paper, we propose a web-based programming-assisted system, which improved students' programming skills by reviewing peers' codes and delivering feedback to peers. The purposes were to investigate the extent that peer assessment in a programming course promotes deep learning, to assess the accuracy of students' judgements during a peer assessment exercise and to provide evidence that peer assessment in computer programming has a positive instructive effect. Moreover, our aim in this study is to answer the following research questions: is there a gender gap in the traditional introductory programming course? And, if the answer is affirmative, can we use peer assessment principles to reduce it?

The paper is organized as follows: the next Section introduces the literature related to automatic programming assessment in the context of programming assignments and explores research efforts related to the gender difference in this context. Section three describes our implemented web-based programming-assisted. Section four proposes the conducted questionnaire survey to evaluate the system. Finally, Section five provides some considerations on case study and experimental results.

## 2 Literature review

In the context of programming assignments, several approaches to automatic programming assessment can be found in related literature; they are typically based on either static analysis or dynamic testing. This refers to whether a program needs to be executed while it is being assessed and focus on which features of programming assignments are automatically assessed. Dynamic analysis (assessment based on executing the program) is often used to assess functionality, efficiency, and testing skills, while static checks that analyze the program without executing it are used to provide feedback on style, programming errors, software metrics, and even design. Tools that cover both static and dynamic testing are also well presented in the survey (Ala-Mutka, 2005).

On top of that, the assessment process can be done by looking into a code structure (white-box) or simply based on a functional behavior of a program (black-box) (Gupta & Dubey, 2012). Output comparison is the traditional approach used by many of the systems we found (Ihantola *et al.*, 2010; Ala-Mutka, 2005) already reported several variations of output comparison including running the model solution and student's code side by side and the use of regular expressions to match the output

In the peer assessment process, students are involved both in the learning and assessment processes. Peer assessment plays an extremely important role in helping students see work from an assessor's perspective, with

potential additional benefits (Kulkarni *et al.*, 2015). For example, it exposes students to solutions, strategies, and insights that they otherwise would likely not see. Evaluating peers' work also helps students reflect on gaps in their understanding, making them more resourceful, confident, and higher achievers. Peer assessment has been used for many different kinds of assignments, including design, programming (Chinn, 2005; Wang *et al.*, 2015) and essays (Kulkarni *et al.*, 2015).

We want to use peer assessment to promote learning in programming courses rather than for summative assessment (Sitthiworachart & Joy, 2003) remark that "peer assessment is not only a tool to provide a peer with constructive feedback which is understood by the peer. Above all, peer assessment is a tool for the learner himself."

There are many successful examples of new methodological approaches developed to help students in computer programming courses due to growing interest in learning and teaching programming, however, they rarely deal with the aspects related to the gender difference in this context. In fact, the number of women involved in computer science is surprisingly low (Rubio *et al.*, 2015). In the United States only 0.4 percent of girls entering college intended to major in computer science in 2013 and they made up 14 percent of all computer science graduates, down from 37% in the mid-80s (Patitsas *et al.*, 2014; Tiku, 2014).

Other studies show similarly disproportionate ratios of participation between male and female students in computer science programs (Stoilescu & Gunawardena, 2010). This problem is global: a study conducted on the use of computers and the Internet among fifteen-year olds showed that boys report using computers more often than girls in the vast majority of the 40 countries under investigation (Rubio *et al.*, *op. cit.*).

## 3 System framework and functions

Practice is very important in acquiring programming skills and there should be room for mistakes and learning from them. Automatic assessment can help as it can give feedback despite the limited human resources. Peer assessment has been successfully used to get students opportunities to learn from each other.

Besides, one of the biggest difficulties for most programming courses is to get and keep the focus and commitment of the students right from the beginning and constantly throughout its development. We propose a web-based system that automatically manage reviewing peers' codes and delivering feedback to peers in a process that favors the incremental learning of the concepts throughout the duration of the course.

The authors of this paper have many years of experience in modeling and

implementation of teaching support systems in also in mobile settings (Riccucci *et al.*, 2005; Andronico *et al.,* 2003; 2004; Carbonaro, 2010). We now conducted experiments in the winter semesters from 2014 to 2016 at the University of Bologna, Italy, with around 240 first year computer science students within the Introduction to Algorithms and C programming language course which is offered during the first semester. The course is six traditional lecture hours and four practical class hours per week, for a total of 13 weeks. The purpose of the course is to introduce C language tools with lots of programming examples and to gain algorithmic thought. Each week a new C language element is covered and practiced by writing several sample programs. The coursework consists of weekly incremental programming assignments of increasing difficulty.

At the end of the course, we conducted a questionnaire survey to evaluate the system and the multi-peer assessment model.

Unlike automatically graded quizzes and programming assignments, peer assessments require a good-faith effort on the part of each student not only to submit their original work, but also to then anonymously evaluate the work of others attentively and constructively. Therefore, for each assignment submitted in a course, students are generally then asked to evaluate the work of up to 8 or 10 peers. That is not a negligible amount of work or time, especially in a course requiring weekly peer-assessed assignments and when the students' prior programming experience varies significantly.

Each student that participates in weekly peer assessment mechanism acts as an author when she/he writes the weekly assigned program, as a reviewer when she/he reviews a program written by another student and as a reviser when she/he revise her/his program as suggested by reviewer's comments. The teacher gives weekly assignment, grading and quality assurance

The system manages different type of documents: code submission that is the source code of a program written by an author (a program passed steps of compiling, building and testing) and submitted within deadline. Authors should complete submission of their codes before a given deadline but they may submit several source codes within the deadline; in this case, the system will consider the last one, corresponding to the final, and presumably best solution. Review comments, that is the suggestions and criticism that a reviewer gives to an author, mainly including coding standards, fatal defects, design logic, redundant code and non-functional requirements. Revision code, that is a new edition of program submitted by a reviser based on the review comments.

To ensure the review equality and exclude personal relationship factors, the implemented system does not use a fixed designation strategy to accomplish blind review. That is, it does not implement a mutual review by two students or a ring review by three or more students (Wang *et al.*<, 2011).

Our system uses a random designation strategy as the strategy of reviewer

designation; that is when designating reviewers, the system generates correspondences randomly thus no student is aware of who will review her/his program. The designation algorithm randomly assigns the total N source codes of one class associated to weekly coursework to at least 10 students of the class. On a weekly basis, the system randomly generates new correspondences without creating group of students; in this way a student does not review another student's code from the same group but she/he reviews the code of students from other groups.

## 4 Questionnaires and analytic results

At the end of programming course the research team conducted a questionnaire survey to evaluate the system and the assessment approach proposing a set of multiple-choice questions. The analytic results of the questionnaire can be classified into the following categories: degree of student satisfaction, rationality of review process, acceptance of real-time assessment, rationality of online peer evaluation, impacts on students and time management capability.

1. Degree of student satisfaction. The students were generally satisfied with the proposed assessment approach. About 90% ("satisfied" plus "very much satisfied") of the students positively considered implemented peer assessment approach while only 10% of the students consider themselves not satisfied with the experience. Analyzing male vs female students' opinion we gather a difference satisfaction levels; in particular, 100% of female are satisfied against 89% of male students. This result corresponds to the overall perception of differences between male and female in their perceived ease of programming. We will come back to this point in section XYZ.
2. Rationality of review process. The survey results indicated that 75% of the students considered the blind review a rational process. They held the view that this mechanism could eliminate the factors of personal emotion. The peer assessment could produce a more objective attitude of making suggestions and accepting criticism and encourage students to share their opinions more directly. Gender differences in rationality of review process are much smaller and none is statistically significant.
3. Acceptance of real-time assessment. Most students (89%) applauded real-time assessment. When the deadline of an assignment had passed, the system assigned students' work to a pool of other students so that they could get real-time information about the assignment evaluation within a week of their submission. As a result, students could remain

aligned with respect to the development of the lesson content working on their assignments. Gender differences in acceptance of real-time assessment of review process are much smaller and none is statistically significant.

4. Rationality of online peer evaluation. The survey results of this item have reasonable levels of satisfaction. 65% of the students consider the whole blind peer review mechanism to be rational. In this case male and female students answered slightly differently: 75% female versus 63% of male. Once again, the data confirmed the increased demand of the female students to participate in the peer review mechanism to improve their programming skills. In both cases, some students were confused by evaluations that were not described with enough detail and hoped to identify specific error types to facilitate more accurate reviews and better revision.
5. Impacts on students. Student programming competence was improved significantly in the code review stage. As shown in the questionnaire responses, 65% students agreed that this process improves their programming skills because they are able to enhance his/her programming skills and learn different programming techniques from reviewing programs written by other students. However, in this case, gender differences in impacts of review process on students are significant: 83% of female students reported that they are improved their programming competences due to peer review process while only 61% of male students are agree with this statement. In particular, only 40% of female students consider the peer review process too long to run, while this percentage increases up to 78% considering male students. Moreover, only 16% of interviewed female students consider peer review process a tedious mechanism, while this percentage increases up to 83% for male students. Finally, 60% of the students were pleased to support the class with the review process and in this case, gender differences aren't statistically significant.
6. Time management capability. Rigorous process control helps to build students' time management capabilities. The teacher set two deadlines for each assignment in the assessment system. Uploading source code, submitting reviews and uploading revision code should be completed by student on time. If a student fails to complete a certain step on time, the system will automatically take some points off from the step. The system data showed that almost all students submitted their assignments and completed review process on time. At the end of the semester, most of the students reported that they had developed solid time management skills.

## Conclusions

With the aim of improving deep learning in a programming course, we have developed a novel web-based peer assessment tool. It has advantages over ordinary automatic assessment in several aspects. Peer review can stimulate student interests in learning and enhance their awareness of active learning. When compared with traditional assessment processes, this process helps to improve the actual programming ability adding more fairness to assessment and helping to achieve learning objectives more efficiently.

In order to positively influence students learning outcomes it is necessary to take into account several approaches to enhance the traditional teaching methodology in teaching computer programming. These approaches comprise peer evaluation mechanisms. We demonstrated that student programming competence was improved significantly in the code review stage because this process improves their programming skills enhancing his/her programming skills and learning different programming techniques from reviewing programs written by other students. Furthermore, peer assessment process provides encouragement of students' deep learning skills in programming by making judgements and providing feedback on other student's work. It provides opportunities to compare and discuss what constituted a good or bad piece of work, which helps students to improve their programming style and think more deeply about the quality of work.

Our first question was: is there a gender gap in computer programming course? The answer is affirmative. We have found differences in perception between men and women; the perceived complexity of programming and the intention to actively participate to a guided group development mechanism to improve acquisition of program skills were significantly higher in females than in males. Female might find easier to overcome their lack of confidence thanks to the assessment mechanisms.

One of the most remarkable results from our experience was that students reported that assessing others' work was an extremely valuable learning activity.

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# IMPACT OF THE FLIPPED CLASSROOM MODEL AND COLLABORATIVE LEARNING IN CHILDHOOD TEACHING UNIVERSITY DEGREE

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This study presents the applications of the flipped classroom model (JITT) as an emergent didactic strategy with two groups of students in Childhood Teaching Degree, using the methodology of collaborative learning, where the professor implemented the flipped classroom model in one of the groups. From a quasi-experimental design, a total of 152 students participated on it. After applying the model to one of the groups, the student presented positive scores in the flipped classroom group. The students from the experimental group completed an open survey –online- before the implementation of the flipped classroom model and another one at the end of it to organise and follow the on-site sessions. The conclusions of the study based on the designed instruments showed progress regarding the use of collaborative learning in both groups, appearing particularly more valued in the flipped classroom group. In reference to the implementation of the model teachers´ amount of work and students´ effort are highlighted, underlining

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the increase of students' competence in the obtained average score.

## 1 Introduction

The European Higher Education Area has encouraged the implementation of new technologies in Higher Education in the university context, representing one of the most innovative changes in university teaching. In the frame of the *Europa 2020* strategy, we consider the introduction of the flipped classroom model in university teaching to identify the impact of its application in the classroom under the topic of school organisation, times, spaces, means and resources in preschool education degrees, in line with the flexible models centred on student learning.

The importance of this study lies in the last edition of the Horizon Report (Johnson *et al.*, 2014), focusing on the short and medium term among the tendencies. On the one hand, the *Flipped Classroom and Learning Analytics* (short term) connected to the growing omnipresence of social media and integration of online learning hybrids, and on the other hand, the collaborative aspect involving 3D printing, games and gamification (medium term).

Apart from this, the ICT Tendencies Report of CRUE (Conference of Rectors of Spanish Universities), identifies 16 tendencies supporting university teaching (Llorens, 2012), focusing on learning and the importance of the pedagogical model before the technological model. It proposes a clear view to learning throughout life, in which the importance of teaching methodologies is manifested. Additionally, it emphasises good practice for the improvement of university teaching, which reinforces in this way student participation throughout the learning process.

Regarding the OECD (2009), it focuses on the necessity of supporting learning methods that promote relationships among students, the development of interpersonal skills and strategies for problem solving. These are believed to teach them how to share responsibilities and divisions of tasks, to facilitate correction and the addressing of ideas, while promoting respect, tolerance and open-mindedness towards others. These approaches follow the principles and core of a collaborative work methodology, which encourages complete and balanced education of students (Hernández & Martín de Arriba, 2017).

Flipped classroom is a didactic model that compares the learning processes developed until now in the classroom and during class time, using this time for processes of acquisition and knowledge practice in the classroom. Authors such as Bergmann & Sams (2012) found improvements in the students within five years, both on an individual level as well as concerning global progress in their studies.

The flipped classroom model uses technology as a way to turn around the

traditional structure of the teaching/learning process, setting the students' learning process as a priority. The basis of "flipped classroom" are: a flexible atmosphere, which favours the space and time to adjust the subject to the students; a learning culture, based on the implication of the student in building knowledge; intentional content, by adapting methods of active learning focused on the student and on the professional educator –with less visibility in this model and being the main engine of the object of learning, some similarities to blended learning can be found (Chocarro *et al.*, 2015).

The development of the flipped classroom requires active methodologies, problem-based learning, projects and learning by discovering (Santiago, 2014) which promote its implementation in the class period. We face a complete and integral focus (Bloom *et al.*, 1956) that combines direct instruction with constructivist methods, the students' implication with the content of the course and the improvement of conceptual comprehension (Touron & Santiago, 2015). The studies from Mazur (1996) come from this approach, completing it with what he calls just-in-time, which allows the teacher to retrieve information from students the day before class, to adjust and prepare strategies and activities adapted to their necessities.

We can find the possibilities of the Flipped Classroom model in teaching, among others, in Hamdan *et al.* (2013) who interviewed 403000 students, parents, teachers, and administrative staff about the use of the model. Yarbro, Mcknight & Mcknight (2014) gather studies of cases that reflect how classes with different educational levels experience an increase in performance and satisfaction regarding students and teachers in the use of the model. The studies developed by Finkel (2012) in a secondary school in Michigan show how the failure rate of maths students decreased from 44% to 13% after applying the inverted methodology.

The study made by Al-Zahrani, (2015) had the objective of researching the impact of the flipped classroom in the encouragement of creative thinking by students. The results suggest that the flipped classroom can promote creativity in students, various other problems were found. Furthermore, the studies developed by Yungwei (2016) revealed the level of preparation for the implementation of this model from the point of view of the students, finding ways of improving the future application of the model in a beneficial way for the students.

In addition, we share the basis of collaborative learning as a work methodology with ICT (Hernández & Martín de Arriba, 2017), from a socio-cultural perspective of cognition, in line with Johnson & Johnson (1987) works and Johnson & Smith (1998), in relation with the effort between individual learning and group learning, seeking motivation and student learning in the group exchanges. Furthermore, the works of Pierce & Fox (2012), revealed

how the impact of student performance was improved by the methodological change.

## 2 Method

The investigation has followed a quasi-experimental design with two groups. One group attended the traditional class (CG) and the second group applied the flipped classroom model (EG), following the methodology of collaborative learning in both groups. The experimental group followed the experimentation of the model through ICT tools of collaborative work: a blog created for the occasion and *Ilias*, the platform of the University of Jaén. Meanwhile, the control group only used the university's *Ilias* platform. For this, an online survey *just-in-time* (JITT) was applied, whose results allowed work organisation in the classroom –planning the work in a small group for the debate and following exhibition. In this way, the exchange of information and cooperation in problem solving is encouraged (Al-Zahrani, 2015, 1139:1140). Once the classes finished, the students fill in an online survey to know their progress in the theme of study and analyse the obtained results. The data analysis in the open surveys is made with the support of the Aquad7 programme (Huber & Gürtler, 2013), for the creation of categories and the quantification of the results, making the categories' analysis of frequencies and percentages the object of the study.

The survey (JITT) consists of eight open questions based on the benefits of the flipped classroom strategy that allows us to know the perceptions of the students in relation to the model. As a base to the analysed studies, we have considered the following questions of investigation, attempting to answer two issues:

- Are there significant differences in the academic results between the two groups of students?
- What is the opinion of the students in respect to the implementation of the flipped classroom model?

### *2.1 Participants*

The research has been performed with two groups of students studying for an early childhood education degree at the University of Jaén in order to know the impact of the model on topic of "virtual teaching/learning environments". The choice of the topic responds to conceptual and temporal variations, as methodologies of collaborative work and project work have been applied to the groups. Additionally, we understood that content wouldn't present a problem, thanks to online resources which have already been designed, consequently adapting well to the intended innovation.

The length of the project has been four weeks, coinciding with the assigned course by the university curriculum. The students were offered to participate voluntarily in this modality or to continue in that of the university's subject guide. We were thus able to know if there were significant differences between the groups and the final results obtained in the evaluation of the subject. In both groups, the question was to answer to competences 7 and 11 and to train as a pre-school (*educación infantíl*) teacher (Orden ECI/3854/2007) accordingly: *knowing the educational implications of information and media technology and, (...) in early childhood, as well as considering classroom practice to innovate and improve educational work, acquire habits and skills for autonomous and cooperative learning and encourage it in the students*.

The application of the flipped classroom was supported by the creation of a specific blog, in which the basic information of the project was presented to the students: online surveys and specific materials for the topic (video clips, documents and presentations) which they were required to work with outside the classroom. They had one week to decide whether to join the project or continue with the subject's common methodology in a parallel group class. In total, the distribution of students participating in group A was of 49 students, 22 being the number of students who decided to continue with the methodology of the subject. In group B, 70 students participated, 11 being the ones who did not join in the project. Therefore, a group C was formed with the 33 students who followed the traditional classes (CG) and a group A&B with 119 students who implemented the flipped classroom model (EG), summing up to a total of 152 students participating in the project (Table 1). On both groups A&B and C the ANOVA test was performed to know if they belonged or not to a same population with different samples, confirming new groups from the obtained results.

Table 1
PARTECIPANTS IN THE STUDY

| Groups | Flipped Classroom | No Flipped Classroom |
|---|---|---|
| GROUP A | 49 | 22 |
| GROUP B | 70 | 11 |
| Group A&B (FC) | 119 (EG) | |
| Group C (NFC) | | 33 (CG) |
| TOTAL | 152 | |

## *2.2 Procedures*

The objectives of the project are ultimately focused on knowing the

application of the flipped classroom model with two groups of students in early childhood education at the University of Jaén (Spain). This is done while verifying if there are differences in the results from learning following this model in one of the groups, bearing in mind the students' perception of the model's application in the context of collaborative learning (Fig. 1). For that, we designed a scale on collaborative learning in which students were asked for their perception of this work methodology, in order to compare the results with the data obtained in both groups – the EG that followed the flipped classroom strategy and the CG that followed the conventional class.

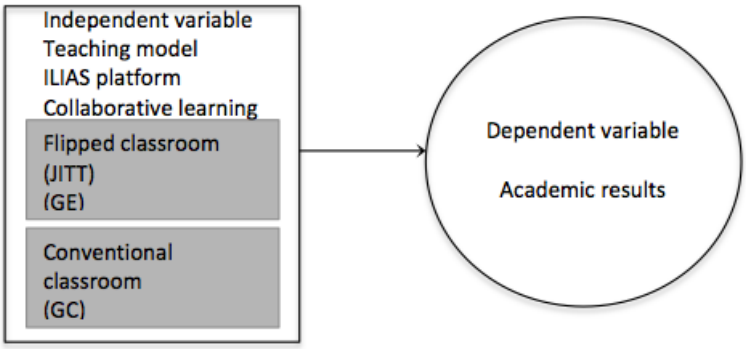



Fig. 1 - Research model

With the objective of knowing these perceptions, the students who participated in the project had to grade the level of identification with the items of collaborative learning, establishing a comparative between the results of those who followed the flipped classroom (EG) and those who followed the traditional class (CG), thus confirming if they were differences between both groups.

The scale gathered 28 indicators of the collaborative learning methodology intended to work in class. The scale was validated by six experts (three in education investigation methodology of and three in information and media technology) with the intention of checking that the items were really representative of the dimensions they intended to measure. For this, the experts received a template in which they had value from 1 to 5 the clarity, coherence and relevance of each item. The final instrument would collect the items with a 100% agreement between the experts. Those items that didn't achieve 100% were eliminated. Once the validity of the scale established, the reliability of the instrument was calculated by Cronbach's alpha coefficient, which reaches a value of.83 in the total scale.

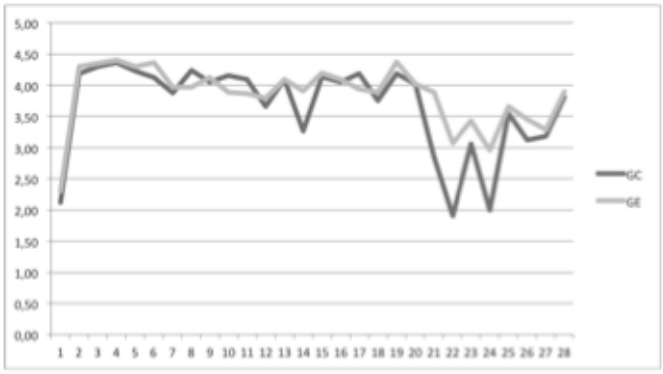
The organisation of the face-to-face sessions derived from the previous survey that had been incorporated to the flipped classroom model (JITT), which students accessed from the blog created for this use. They were supposed to complete the survey before beginning the topic, with the purpose of knowing some aspects referred to in the experience as well as the content of the topic, in order to adapt the face-to-face sessions and their completion (Prieto & Díaz, 2014). The sessions tried to suit as much individual work outside of the classroom as collaborative work in the classroom, problem solving and student learning through activities that benefit solving doubts about the topic studied. The work was supported by the use of the ICT: conceptual maps (*Cmaptools, googleDocx*), audiovisual presentations (*Prezi*), shared folders (*Dropbox*), video clip compilations (*Youtube*) and blogs (*Blogger* and *Wordpress*) as well as the *Ilias* platform. All of these facilitated the development of student learning and the methodological approach of teachers in terms of both the ICT tools and those designed in the blog and the virtual platform of the University of Jaén.

The results of the project are carried out from the instruments designed and adapted to this effect (*Ibidem*), for this research as well as for the average score obtained by students after performing the same evaluation test in both groups.

## 3 Results

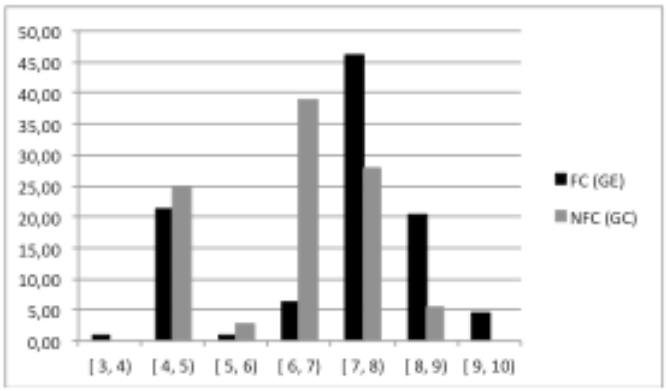
We have observed that flipped classroom increases the motivation of students in their performance of the addressed topic, not only in the previous activity, but also in the context of the classroom (Hernández & Martín de Arriba, 2017). The obtained results are presented based on on-line surveys (JITT), perceptions of the learning methodology scale, and students' academic results. It has been possible to determine as well that the designed material for the purpose of the blog has been suitable to work on the topic, despite the project's short time of implementation from student's perceptions.

The obtained results on the collaborative learning scale (Graph 1) indicate that there are few differences between groups and inside the groups: in the experimental group, observing advantages referring to the items 1,4,7 and 20 with respect to the CG, *in relation to the reluctance to work in group* (2.30/2.12); *ideas are discussed and exchanged when you work in a group* (4.35/4.30); *the interaction with peers increases the level of learning* (4.36/4.12) and finally *acquired knowledge is shared* (4.38/4.18), as is shown in the graph attached.




Graph 1- Average Collaborative Learning Scale CG and EG

In relation to the analysis of the academic results in the students who followed the flipped classroom model (EG) and the ones who chose the established methodology in the academic guide (CG), the average score in the flipped classroom group (EG) is: $\bar{X}$= 6,74 and in the group who didn't follow the flipped classroom (CG): $\bar{X}$= 6,40. We can observe significant differences between groups, relative to 0.34, in the average score obtained between the students who followed the flipped classroom model and the ones who chose the traditional class. The deviation has been 1,61 in the EG and 1,50 in the CG as shown in the attached graphs. Results are presented in percentages, as the groups are not homogeneous, and the largest variability appears in the experimental group, the control group being more uniform and consisting of students who did not follow the experiment.




Graph 2 - Score Intervals. Experimental and Control Group

In the graph (Graph 2), we can observe that the number of students with low marks coincides in both groups, but it is noticeable that in the interval [7,8) scores increase in the experimental group, while declining considerably in the control group.

The obtained results of the data analysis from the JITT survey questions expressed by students make reference to the certain categories: knowing other work methodology (n=60), ability to use ICT (n=28) and lack of experience in the new strategy (n=25), being the categories with the highest frequency.

## 4 Discussion and Conclusions

The flipped classroom may effectively promote skills of higher-order thinking (Bergman & Sams, 2012) through the integration of technology. It has been key to promote suitable activities in the classroom focussed on debates, problem solving, cooperation and effective communication in line with the proposal raised by Kuo *et al.* (2014).

Collaborative learning has formed a valid methodology to implement the flipped classroom model, obtaining related results –motivation- in students' perception of both groups of study, in line with the nearest methodologies to the flipped classroom model (Bishop & Verleger, 2013).

As an answer to the question raised in the research, in reference to the existence of significant differences in the academic results between the two groups of students, we have indeed found significant differences: these are visible among students in the obtained score of topic evaluation, in accordance with Borao & Palau's work (2016), where satisfactory results were obtained, raising the academic results and following the tendency of other flipped classroom studies (Strayer, 2007; Ali *et al.*, 2010; Bergmann & Sams, 2011). We can confirm more precisely that the results match the studies made by other authors, in which the students in the experimental group obtained a better academic performance (Bishop & Verleger, 2013). Along this line of thought, the impact of the flipped classroom model is confirmed in the discrete advantages obtained in the academic results of the students belonging to the group where the model was implemented.

In reference to the second question considered about students' opinions with respect to the implementation of the flipped classroom model, the opinions confirm once again the findings of Leis *et al.* (2015), in relation to the increase in workload for both students and teachers, the importance of ICT tools (video clips and media presentations) in their learning and surpassing their own abilities.

Students' opinion of the flipped classroom revealed that in general, they were satisfied with the approach (Turan & Goktas, 2016). These results agree

with the ones taken by Butt (2014), Davies *et al.* (2013), De Grazia *et al.* (2012); Mason *et al.* (2013); McLaughlin *et al.* (2013) and Wagner *et al.* (2013) who found that the flipped classroom could be a more satisfactory approach for student learning, independently of its level of execution. Other researches were closer to Strayer's thinking (2012), who found that students in the flipped classroom were less satisfied with this approach in respect to the structure and learning tasks. However, it can be argued that the application of flipped classroom creates a new atmosphere to support learning and creativity based on students' answers.

The integration of "just-in-time" (JITT) as a complementary element to the flipped classroom model has been considered very valuable thanks to survey input, which has given teachers data of interest for adapting activities to the sessions, essentially in relation to students' experience and knowledge.

As far as limitations are concerned, we can observe the necessity of widening the length of the study – although, this limitation has also proven to be an advantage in helping to focus and deepen our study. On the other hand, it is necessary to decrease the number of students per group in the University in order to foster student learning personalisation. Finally, it is essential to continue advancing in research that considers the flipped classroom model from other angles and approaches.

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