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Edited by
Miguel Baptista Nunes
Pedro Isaias



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E-LEARNING 2019

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FOREWORD

These proceedings contain the papers of the International Conference e-Learning 2019, which was organised by the International Association for Development of the Information Society and co-organised by ISEP – Instituto Superior de Engenharia do Porto, 17 - 19 July, 2019. This conference is part of the Multi Conference on Computer Science and Information Systems 2019, 16 - 19 July, which had a total of 926 submissions.

The e-Learning (EL) 2019 conference aims to address the main issues of concern within e-Learning. This conference covers both technical as well as the non-technical aspects of e-Learning.

The conference accepted submissions in the following seven main areas: Organisational Strategy and Management Issues; Technological Issues; e-Learning Curriculum Development Issues; Instructional Design Issues; e-Learning Delivery Issues; e-Learning Research Methods and Approaches; e-Skills and Information Literacy for Learning.

The above referred main submission areas are detailed:

Organisational Strategy and Management Issues

- Higher and Further Education
- Primary and Secondary Education
- Workplace Learning
- Vocational Training
- Home Schooling
- Distance Learning
- Blended Learning
- Change Management
- Educational Management
- Continuous Professional Development (CPD) for Educational and Training Staff
- Return on e-Learning Investments (ROI)

Technological Issues

- Learning Management Systems (LMS)
- Managed Learning Environments (MLEs)
- Virtual Learning Environments (VLEs)
- Computer-Mediated Communication (CMC) Tools
- Social Support Software
- Architecture of Educational Information Systems Infrastructure
- Security and Data Protection
- Learning Objects
- XML Schemas and the Semantic Web
- Web 2.0 Applications

e-Learning Curriculum Development Issues

- Philosophies and Epistemologies for e-learning
- Learning Theories and Approaches for e-learning
- e-Learning Models
- Conceptual Representations
- Pedagogical Models
- e-Learning Pedagogical Strategies
- e-Learning Tactics
- Developing e-Learning for Specific Subject Domains

Instructional Design Issues

- Designing e-Learning Settings
- Developing e-Learning Pilots and Prototypes
- Creating e-Learning Courses
 - Collaborative learning
 - Problem-based learning
 - Inquiry-based learning
 - Blended Learning
 - Distance Learning
- Designing e-Learning Tasks
 - E-learning activities
 - Online Groupwork
 - Experiential Learning
 - Simulations and Modelling
 - Gaming and Edutainment
 - Creativity and Design Activities
 - Exploratory Programming

e-Learning Delivery Issues

- e-Delivery in different contexts
 - Higher and Further Education
 - Primary and Secondary Schools
 - Workplace Learning
 - Vocational Training
 - Distance Learning
- Online Assessment
- Innovations in e-Assessment
- e-Moderating
- e-Tutoring
- e-Facilitating
- Leadership in e-Learning Delivery
- Networked Information and Communication Literacy Skills
- Participation and Motivation in e-Learning

e-Learning Research Methods and Approaches

- Action Research
- Design Research
- Course and Programme Evaluations
- Systematic Literature Reviews
- Historical Analysis
- Case Studies
- Meta-analysis of Case Studies
- Effectiveness and Impact Studies
- Evaluation of e-Learning Technologies
- Evaluation of Student and Tutor Satisfaction
- Learning and Cognitive Styles
- Ethical Issues in e-Learning

e-Skills and Information Literacy for Learning

- Teaching Information Literacy
- Electronic Library and Information Search Skills
- ICT Skills Education
 - in schools and colleges
 - for business, industry and the public sector
 - in adult, community, home and prison education
 - informal methods (peer groups, family)
- Education for Computer-mediated Communication Skills
 - Netiquette
 - Online safety for children and vulnerable users
 - Cybercrime awareness and personal prevention
- Student Production of Online Media
 - Web design
 - Digital storytelling
 - Web 2.0 tools
 - etc.
- Digital Media Studies

The e-Learning 2019 conference received 187 submissions from more than 40 countries. Each submission has been anonymously reviewed by an average of four independent reviewers, to ensure that accepted submissions were of a high standard. Consequently, only 30 full papers were approved, which meant an acceptance rate of 16 %. A few more papers were accepted as short papers, reflection papers, posters and doctoral consortia. An extended version of the best papers will be selected for publishing in the Interactive Technology and Smart Education (ITSE) journal (ISSN:1741-5659) and also in the IADIS International Journal on WWW/Internet (ISSN: 1645-7641). Other outlets may also receive extended versions of the best papers, including journals from Inderscience.

Besides the presentation of full, short and reflection papers, posters and doctoral consortia, the conference also included one keynote presentation from an internationally distinguished researcher. We would therefore like to express our gratitude to Prof. Jaime Villate, Faculty of Engineering, University of Porto, Portugal, for being the e-Learning

2019 keynote speaker. Furthermore, the conference featured a workshop entitled “Learning as a Verb: Promoting Active Learning in Higher Education through Effective Design Strategies and Measurement” by Prof. Pedro Isaías, The University of Queensland, Brisbane, Australia and Prof. Paula Miranda, Sustain.RD center, School of Technology, Polytechnic Institute of Setubal, Portugal.

A successful conference requires the effort of many individuals. We would like to thank the members of the Program Committee for their hard work in reviewing and selecting the papers that appear in this book. We are especially grateful to the authors who submitted their papers to this conference and to the presenters who provided the substance of the meeting. We wish to thank all members of our organizing committee.

Last but not the least, we hope that everybody will have a good time in Porto, and we invite all participants for the next years’ edition of this conference.

Miguel Baptista Nunes, School of Information Management, Sun Yat-Sen University, Guangzhou, China

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e-Learning 2019 Conference Program Co-Chairs

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Yannis Psaromiligkos, Technological Education Institute of Piraeus, Greece
Yousef Daradkeh, Prince Sattam Bin Abdulaziz University (PSAU) - KS, Saudi Arabia

OPEN PROFESSIONAL DEVELOPMENT OF MATH TEACHERS THROUGH AN ONLINE COURSE

Anna Brancaccio¹, Massimo Esposito¹, Marina Marchisio², Matteo Sacchet² and Claudio Pardini³

¹*Direzione generale per gli ordinamenti scolastici e la valutazione del sistema nazionale di istruzione, MIUR
Viale Trastevere 76/A, Roma, Italy*

²*Department of Mathematics "G. Peano", Università degli Studi di Torino, Via Carlo Alberto, 10, 10124 Torino, Italy*

³*Istituto Statale Superiore Carlo Anti, Via Magenta 7, Villafranca di Verona (VR), Italy*

ABSTRACT

The professional development of teachers is a task recognized by the European parliament and pursued by many institutions, both national and international ones. The support to teachers in STEM disciplines was one of the aims of the Erasmus+ SMART (Science and Mathematics Advanced Research for good Teaching) project, born in a European context, which developed as its main intellectual output two open online courses called Mathematical Modelling and Observing, Measuring and Modelling in Science, in order to help teachers in their continuous professional development. Both courses contain interactive problem-based materials ready to be downloaded, modified, used in the classroom and redistributed to the community. This paper gives an overview of the structure of the course Mathematical Modelling and analyzes its instructional quality, taking into account some measurables obtained in two years of operativity.

KEYWORDS

Continuous Professional Development, Digital Education, E-learning, Mathematical Modelling, Problem Solving, Teacher Training

1. INTRODUCTION

The training of teachers, especially in disciplines such as Science, Technology, Engineering and Mathematics (STEM), is essential for the development of society in Europe. In this respect, in 2006, the EU member states developed the "key competences for all" as part of their learning strategies and "Key competences for Lifelong Learning – A European Reference Framework" was approved as Recommendation of the European Parliament and the Council (European Parliament and Council, 2006). These policies, shared by the community, spread in all European countries. These guidelines were taken into account in Italy through a national action, born in 2012, involving secondary school teachers of STEM disciplines, called the "Problem Posing and Solving" project (Brancaccio et al., 2015b, 2014; Demartini et al., 2015, 2013). In this context, the European Erasmus + SMART Project was born. SMART, which stands for "Science and Mathematics Advanced Research for good Teaching", was coordinated by the "Carlo Anti" Italian high school in cooperation with an international partnership composed of other vocational schools, universities and corporate representatives of the countries: Italy, Germany, Hungary, the Netherlands and Sweden. This large partnership aims at developing initiatives addressing different fields of education and training and at promoting innovation, the exchange of experiences and know-how between different types of organizations. (Brancaccio et al., 2015a, 2016).

This project has many different aims: the first one is to improve professional competences of teachers and to support innovation in teacher training system. Secondly, another objective is to develop skills which can be used in order to contribute to a cohesive society, in particular to increase opportunities for learning mobility and strengthening cooperation between the world of education and training and the world of work, formulating and solving complex problems autonomously, consciously and constructively. Finally, yet importantly, one last task is to provide teachers with an online environment where to find teaching materials that are validated and ready for use in the classroom.

The project operated in these directions through pedagogical solutions and innovative practices based on the new computer and multimedia technologies in order to provide tools and methodologies to facilitate the acquisition of STEM skills - mathematical competence and basic competences in Science and Technology. All those involved took advantage of discussion and sharing with European partners, and of the introduction of advanced technological tools in the teaching of Mathematics and Science to support learning.

The expected results arising from this experience are the definition of common educational models, the development of a European database on training needs, the development of a European database containing Best Practices, the implementation of a dedicated international website report on the results of the experimentation of laboratory modules, the delivery of two open online courses for teachers: one called "Mathematical Modelling" for teachers of Mathematics, and one called "Observing, Measuring and Modelling in Science" for teachers of Physics and Science.

This paper analyzes and discusses the open online course Mathematical Modelling both from the perspective of structure, of organization of resources, instructional quality, and from the point of view of measurables obtained in two years of operativity. Section 2 explains the state of the art of teacher training and instructional design in different contexts, especially the online ones. Section 3 presents the methodology adopted for the analysis of the open online course Mathematical Modelling. Section 4 and 5 present the results and the discussion of the outcomes of the analysis.

2. STATE OF THE ART

Teacher training play a very important role in the development of good practices in schools and in many other contexts of contemporary society. It is clear that teachers need a follow-up during their first years of work. That is why Murray and Male (Murray and Male, 2005) analyzed the path of 28 new teacher educators for their first three years. The study shows that, despite the previous successful teaching careers. It took them between two and three years to adapt to their new professional profile.

Teacher training is usually given in person, even though online contexts seem to be the most suitable according to the condition of teachers, who work fulltime at school and find it hard to attend scheduled meetings (Barana et al., 2018a). With a blended modality, teachers can follow synchronous online meetings and interact with the tutors in an asynchronous way, sharing materials in a virtual community, which is peer supported and facilitates the building of new professional competences and knowledge.

The online components become essential when teacher work in very distant or rural areas, not easy to reach (Eaton et al., 2015): with this approach teachers are motivated in using technology in the classroom, with a positive effect on students, too. It is thus very important to take care of all the needs of students and teachers with careful planning. In (West and Jones, 2007), the authors prepared a framework to assist people who want to integrate technology and teacher training programs. Among the many tools available for online support, Fry (Fry, n.d.) found a discussion board and compressed video sessions to be effective in their supportive role. Beyond these basics, for STEM disciplines there is plenty in the literature about the use of an Advanced Computing Environment (ACE) (Marchisio et al., 2017). One tool which is known to be very effective and well-integrated with other tools is the Maple suite, which, besides the powerful computer engine, allows us to use an interactive online worksheet player and integrates with the Automatic Assessment System (AAS) Möbius (Barana et al., 2018b). Apart from teacher training, this environment has been proved to be effective with students, because of its interactive components and its graphics in two and three dimensions (Barana and Marchisio, 2016).

It is important then to consider Massive Open Online Courses (MOOCs) to be delivered for teacher training, which is one of the outcomes of the SMART project. The University of Torino has a long history of e-learning about e-learning with many online projects. The basis for the development of SMART mainly follows two experiences. The already mentioned "Problem Posing and Solving" project, which deals with Mathematics and Italian teachers in high school, involved in a community of practice with online meetings and asynchronous support provided by tutors and "Orient@mente" (Barana et al., 2016, 2017a), which provides open online courses for university guidance and realignment courses, created to support students in the transition from high school to university, in particular to fill the knowledge gaps in the STEM disciplines.

The design of an online course has several factors to take into considerations. In the last few years a discipline that is valid for traditional teaching as well has been associated more and more to online materials: Instructional Design (ID). According to the current situations, many MOOCs are well-packed, but they have poor instructional quality: in (Margaryan et al., 2015) the author analyzed many online courses hosted in the most famous platform, taking into account instructional parameters.

3. METHODOLOGY

The methodology of analysis of the MOOC “Mathematical Modelling” passes through several steps:

- exploring the structure and the number of users who subscribed to the course;
- observing the measurables of the course: how many problems and materials have been posted, how big the repository of question is;
- studying the materials from the Instructional Design point of view.

We decided to use the method adopted in (Margaryan et al., 2015), called CourseScan, in order to detect the presence or the absence of the main principles of effective learning: problem-centeredness, activation, demonstration, application, integration, interactivity and other further properties, like collective knowledge, collaboration, differentiation, authenticity, feedback. Moreover, teachers attending “Mathematical Modelling” were frequently asked to fill in a questionnaire about their previous experience, the expectations and their improvements: this helped to scan the usability of the course.

4. RESULTS

4.1 Structure

The course is available at <https://opensmart.miurprogetttopps.unito.it>, whose homepage is depicted in Figure 1.



Figure1. Two captures from the platform homepage

It is an instance dedicated to the project of a Moodle platform (<https://moodle.org>) and it is entirely in English, managed by the University of Turin. The platform is integrated with various tools useful for learning STEM disciplines, in particular the Advanced Computing Environment Maple (<https://www.maplesoft.com/>) and the Automatic Assessment System Moebius Assessment (<https://www.digitaled.com>). The University of Turin has a great experience in the development and use of the Moodle platform for teaching (Barana et al.,

2017b, 2017c). The open online course is designed for teachers of Mathematics, but access is free through any social media, so all interested people can access it.

The course is divided into 11 sections. The first module contains one section and this part is the introduction to the course. The second module contains one section about the methodology adopted by the course, namely problem posing and problem solving, including a reflection on what these competences are and how to activate them in the students. The three following modules are devoted to self-training in: Virtual Learning Environment, Advanced Computing Environment, and Automatic Assessment System, three tools considered important for teaching and learning mathematics. Then there are an explanatory and four Topic modules, which contain ready-to-use learning materials, about the four main areas of Mathematics: Quantity, Space and shape, Change and relation, Uncertainty (see Figure 2).

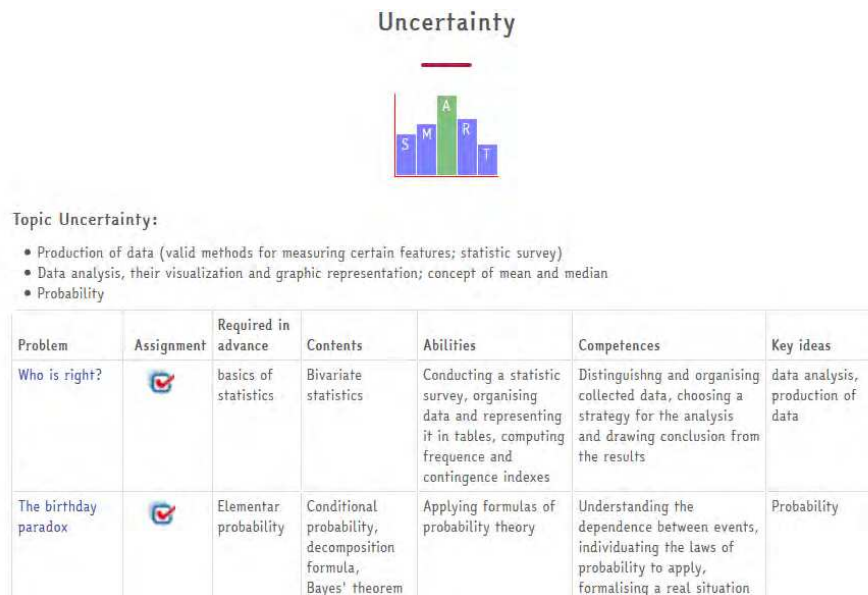


Figure 2. A glance on the topic Uncertainty

Finally, the last part is a course evaluation module. The user can freely decide which sections to follow. Perhaps a conceptual map may facilitate a better understanding of the possible prerequisites and guide the users towards the path they wish to take. Probably a presentation of the 11 sections through Moodle grid mode would make it easier to follow the course. The open on-line course is all written with Easy Reading (<http://www.easyreading.it/en/>), a certified font for dyslexics, which ensures high inclusiveness.

4.2 Measurables

Up to the 21st January, 253 users have self-enrolled to the course, most of them from Italy. The number of users at the moment is not particularly high, but probably many secondary school teachers in European countries have not heard about the existence of the course through official channels. In Italy the general manager of the Direzione generale per gli ordinamenti scolastici e la valutazione del sistema nazionale di istruzione ¹ has issued a note on the opening of online courses to all managers of secondary Italian schools. Probably for this reason, the number of Italian users is higher. Certainly, a further presentation of the courses could be carried out in order to reach the professors of the STEM disciplines on a nationwide basis. The course is composed by 111 activities and interactive resources, 37 of which are assessment activities of two different types. Those of the first type are formative assessment activities that the teacher can use with their students related to the interactive materials of the four areas of High School Mathematics: Quantity, Space and shape, Change and relations, Uncertainty. They are prepared with Moebius assessment because it allows immediate and interactive feedback. The tests contain algorithmic questions of different types (multiple choice, true or false, insert a

¹ The Italian Ministry of Education

formula, numerical, matching ...). Some of them are adaptive for a personalized teaching. The Maple mathematical engine behind Moebius Assessment allows recognizing the accuracy of a mathematical formula independently of the formulation chosen by the student among the infinite possibilities (Figure 3).

SOLAR PANELS

▼ Problem

We want to instal a squared solar panel in a terrace of Rome; its side is 3 m long.
The manufacturer recommended to install the panel so that it forms with the horizontal floor an angle of 10° lower than the latitude of the place; we recall that Rome is located at a latitude of 41° .
Referring to the image, which will be the room occupied by the panel?
That is, we want to find out:
- Which is the vertical height reached by the panel;
- Which is the horizontal space occupied by the panel;

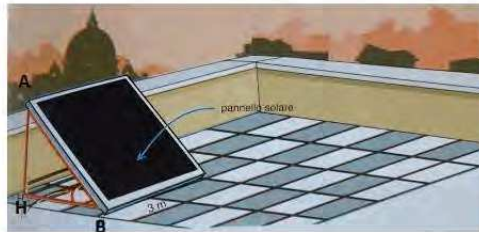


Figure 3. A problem-based approach with Maple

The evaluation activities of the second type are 10 questionnaires, which allow the user to receive feedback on the course. The course also contains videos, but it does not contain animations. The files prepared with Maple contain completely solved contextual problems, discussed through interactive components, which can be used both to develop precise mathematical skills and problem-solving skills (Figure 4).

The winery

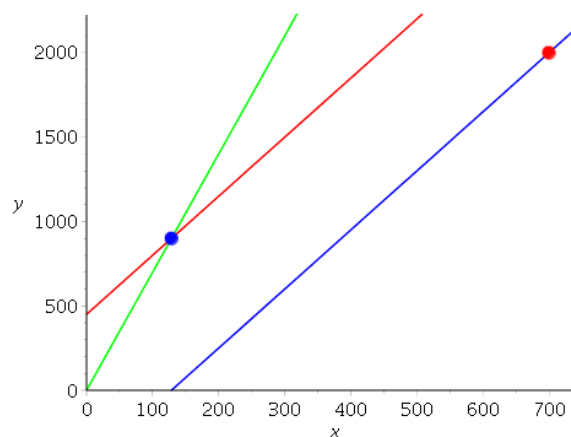
Question 5

1 point

A local company produces in a day up to 700 craft beers.

The daily fixed cost that the company encounters is 450 €, while for each bottle of beer produced there is an addition of a variable cost equal to 3.50 €.

Knowing that each beer is sold at the price of 7 € and according to the following diagram of profitability determine the point of equilibrium and the maximum profit.



Note that the functions of cost, revenue and profit are respectively shown in the graph in red, green and blue, while the equilibrium point and maximum profit are respectively represented by the colors blue and red.

Figure 4. A problem-based approach with Möbius

For each problem, the prerequisites are declared as well as the knowledge, skills and competences that are to be developed. The variety of resources present in the course ensures a high level of effectiveness and usability. The materials were created under the Creative commons license.

From the teacher's point of view, only 18 users completed the entire course. Many users only attended a part of the course, only accessing activities deemed useful and interesting for their teaching. The completely open character of this course allows you to move in a targeted way. From the questionnaires, it emerged that 52% of teachers particularly appreciated the Problem Posing and Solving methodology proposed. They said that it was effective when applied in class, because it improved student motivation, as well as because of visualization of concepts and its connection to real life. 44% of teachers used learning materials from the course, mainly problems, with good evaluation of the materials both from the teacher's and from students' side. The teachers of the schools participating in the project with their students have tested the proposed materials. This has certainly increased the teaching effectiveness of the materials.

4.3 Instructional Point of View

The course is explained and organized quite well. It is clearly described that the main target of the course are secondary school teachers, even if anyone can attend the course. There is a first section, called "Getting started" that states which the main objectives are. There is also a complete outline of the course, which does not have a fixed but just a recommended structure. It is also specified how to get badges and certificates, and which license the materials hold. About the problem-centered approach, one has to be very precise because it is a course in problem solving and certainly there are many real-life problems, but these are related to the contents that students will face, while a problem-centered approach for teachers would be, for example, how to present a specific topic to the class or which technique to use with respect to the students. It would have been useful to study some successful and unsuccessful cases, what to do and what not to do. It must be recognized that all resource can be re-used in the work place of users and the activities plunge the teacher directly into the knowledge and skill they need for every day's life in the classroom. There are no collaboration activities, due to the nature of the course, which is completely open, and any user can attend lessons at their own pace anytime in the day. All the traits that have been considered delineate a phase of instructional design prior to the implementation of the course. The sections dedicated to learning how to use the Virtual Learning Environment Moodle, the Advanced Computing Environment Maple and the Automatic Assessment System Moebius should be accessible without prerequisites because in this way it is possible to make use of parts aimed to deepen the knowledge without forcing those who are already familiar with those tools to complete the entire required path.

5. DISCUSSION

The presence of an online course for teacher training has been recognized to be useful by its users. The self-training modules helped teachers to develop new skills and competences, from didactics to the use of technology in classroom activities. One of the special features is the permanent availability of online resources. The literature confirms that this experience is in some way unique, since many experiences in teacher training mediated by technology are provided in a blended modality or by means of a MOOC that set the pace and therefore teachers are not always able to attend them for school and family commitments.

It is still to be noted that some adjustments could improve the quality of the course. The navigation through the course in some of its parts is conditional, mediated by the completion of questionnaires, making the navigation more tiring. There is a significant presence of hyper-references to activities, which is beneficial to a nonlinear navigation. The course could be enriched with further interdisciplinary characterization activities to facilitate the dialogue between the STEM disciplines and the other disciplines. In order to make the online course known to more Mathematics teachers, it could be useful to make it available on platforms like Merlot (www.merlot.org) which contains many different open educational resources. In Italy, the course can be a valid tool for implementing CLIL - Content and Language Integrated Learning - which includes teaching some content in a foreign language.

6. CONCLUSION

During the last year, the University of Turin has developed a great experience in open online designing courses in several areas. For example, 20 full online university modules were prepared with the project start@unito (Bruschi et al., 2018). This competence could be used to improve the Mathematical Modelling course to further increase its effectiveness. Mathematical Modelling could also foster the development of a similar course of continuous training for professors in Mathematics and more generally in STEM disciplines at the university, to professors that teach to students enrolled in degree courses other than Mathematics. The latter are often to be motivated and are more interested in applications than theory.

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