DEVELOPING INTERACTIVE E-CONTENTS FOR A MATHEMATIC ERASMUS+ PROJECT – CHALLENGES AND EXPERIENCES

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Abstract

Stimulating students for learning is a regularly recurring theme that never seems finished, remaining in the frontline of teachers' day to day struggle, and this recurrent factor is exponentiated when the subjects are directly related with Mathematics.

In November 2018 the European Project EngiMath started work the development of a common Mathematics course for engineering students from the 6 countries of the consortium – Estonia, Ireland, Poland, Portugal, Romania and Spain. This course will be an online course with all the usual features and e-contents, however the project partners have been particularly focused on the pedagogical features and real digital competences when developing all the materials and interactive e-contents. An exhaustive search has been developed for the best way to build interactive content that would stimulate students to improve their basic mathematical skills, dealing with all the time and financial constraints, common to European higher education.

This paper will describe, in a detailed way, all the steps of the construction of the theoretical contents, in English, which are the basis of the course proposed by the project and that are now being translated to each of the five distinct mother languages to avoid the frequent interpretation misleading problems for students and other cultural hitches. These e-contents are based on the construction of SCORM packages (Shareable Content Object Reference Model) for the Moodle platform, created over animated presentations to promote students' interaction and avoid drop out behaviours.

Keywords: Erasmus+ Projects, Mathematics Curricula, Higher Education, Engineering Education, Teaching Methods, Learning Objectives, Math Skills, Educational Experiences.

1 INTRODUCTION

The development and use of new technologies have been generally and globally dizzying, being at the forefront with regard to the most varied areas of our society in recent decades. Facing this fantastic evolution, several documents have emerged from the institutions that govern us ([1], [2], among others), referring to the future demands of society and presenting general indications that should direct those responsible for the academic development of the new generations.

Meeting students' expectations and needs is a constant struggle inside the educational sector, and this is even more difficult when dealing with different support background generations. It is never too much to remember the distinct generational features that often promote serious frictions, and even fractures, in the teacher/student relation, having in mind that the "*unwillingness to take a different generation's frame of reference into account can contribute to misunderstanding, miscommunication, and discouragement*." ([3], pp.111). In this sense, Higher Education Institutions (HEI) must foresee to adapt, motivate, challenge and inspire the "Net Generation" (or Generation Z – born after 1995) of students that are actually entering HE since this is the first generation that does not know a world without "internet connection".

The Erasmus+ EngiMath project idea originated from the practical needs and long-term communication with the project partners: the TTK University of Applied Sciences/TTK UAS from Estonia (project coordinator), the Letterkenny Institute of Technology/LYIT from Ireland, the Polytechnic Institute of

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Porto/P.PORTO from Portugal, the University of the Basque Country/UPV/EHU from Spain, the Technical University of Cluj-Napoca/UTC from Romania and the Koszalin University of Technology/PK TUK from Poland. The objective is to develop an "open, centralized, core system of accessible theoretical, practical, and assessment materials and techniques, which will try to ensure maximum benefit to students and academics. New didactic methods and best practices for developing engineering mathematics on-line courses are chosen and mathematics on-line assessment systems were examined for this purpose" [4].

The first important decision to be taken was the choice of the "Platform" on which the complete course will be developed and "evolve". There are several environments that provide features for creating and structuring online courses commonly recognized as Learning Management Systems (LMS) like: Moodle, TelEduc, BlackBoard, Canvas LMS, Lessonly, Easy LMS, among others. These environments differ in many ways, either in the language they were developed, the features each one of these offers and the price – some are opensource, but others are not. LMS platforms have as principal objective, to centralize and simplify administration and management of teaching and learning through e-learning. These systems cover the entire process of distance learning, interfacing students and teachers, tutors, to administrators and the administrative part. In this sense, they "assist" staff, teachers and students to plan their teaching/learning processes, allowing them to work together, through the exchange of knowledge and information [5].

The project partners selected the Moodle platform (Modular Object-Oriented Developmental Learning Environment) since it was already used by the majority of the project partners and it is open source. This LMS was developed by Martin Dougiamas ([6], [7]), on pedagogical principles, that aims to provide a diversity of features to support lecturers in creating and managing online modules. Moodle is widely used for blended learning, distance education, flipped classroom and other e-learning projects. From the students' viewpoint, Moodle offers a virtual learning environment (VLE) that can add value or enlarge their studies by giving them access to learning materials, activities and assignments. VLEs are frequently used in both distance and presential learning. Moodle is one of the most commonly deployed systems as up to January 2020 it has over 172 million registered users, both teachers and students, in 228 countries and used in more than 20 million courses [8].

Establishing the basis of the whole set of activities of the future project are the introduction of all the theoretical and support materials, in which all the practical, assessment and application activities will rely. The search for "best practices" and the corresponding pedagogical features that should be used in the development of these "theory starter" materials was conducted after a needs analysis and the common core definition for the course [9].

The partners' main objective in the development of the all set of theoretical lessons is to innovate, presenting good interactive multimedia materials that could improve students' engagement and, at the same time, avoid dropout behaviours. Notice that there are several definitions of interactivity, in particular in the literature on multimedia learning but each gives emphasis to different aspects of the concept [10]. However, due to the project framework and main objectives, the interactivity must be seen in the context of computer-based multimedia learning and, in this sense, interactivity can be seen as a "*reciprocal activity between a learner and a multimedia learning system, in which the [re]action of the learner is dependent upon the [re]action of the system and vice versa"* [11]. This definition puts the focus on the active connexion between the learner and the learning system, recognizing that a multimedia learning virtual/online environment is not interactive *per se*, but there are several features of the setting that have the potential to engage and compel the learner to react, responding to the proposed activity in a meaningful way. This interaction is crucial to reinforce student's engagement with the presented resources, promoting active learning and self-awareness of the proposed teaching/learning path on a VLE.

2 BACKGROUND ANALYSIS, OPTIONS AND CHOICES

The first hard task the project partners had to deal with was to agree on the common core of the course. It was noticed that, even with all the global Educational System the European Community aims to implement, this mission is far from being accomplished. As shown in [9], despite all programmes at level 6, in the partner universities, representing 60 ECTS/year, the credit points for the mathematical topics in the first year of study vary in each partner institution from 10 to 28 ECTS. In this sense, partners had to struggle to get compromise basis to work with – the course common core.

After the common core was agreed, the development of all the Theoretical, Practical and Assessment materials and activities started, and the tasks distributed between partners, according to the Project Proposal. All project resources are developed in English and, afterwards translated into the other six Project languages: Basque, Estonian, Polish, Portuguese, Romanian and Spanish.

The first in the timeline schedule, as already mentioned, were the theoretical materials and the choice for the "best" presentation option was not an easy task, made even difficult by the fact that whatever the option it would require a mathematical text editor. This opening development task was in the hand of the Portuguese project team but all the partners from the other five countries had to present, discuss and approve the editing and development proposals. All the decisions were, and had to be, unanimous since they will have hands in all the materials for translation purposes.

From the partners' previous experience there was a common feeling towards avoiding video lectures, even with some interactive contents, despite several positive experiences with these ([12], [13]). This is due to the fact that video editing is very time consuming and it is almost impossible to achieve a professional quality necessary to the project. It was also discussed that the option for theory presentation should try to minimize the "expertise reversal effect" [14], and it is hard to avoid this when dealing with this type of multimedia resource.

Relying on previous experience granted by decades of teaching Mathematics to non-mathematicians and several awarded projects and ventures in on-line teaching/learning Math ([5], [12], [13], [15], [16], [17], [18] among others), the final options were reduced into the use of two possible software to create interactive lessons: H5P and iSpring.

- H5P, that stands for HTML 5 Package (Fig 1.), was originally developed by the Norwegian company Joubel (in Tromsø) for the National Digital Learning Arena, a Norwegian publicly funded learning portal [19]. Its development was motivated by the need to move away from Flash based content. It is an "MIT licensed community development project". Each H5P content type is simply a collection of HTML, CSS and Javascript files zipped together. This means interactive content can be shared between a huge range of websites and platforms.H5P provides more than 40 types of self-contained HTML5 interactive content, that can be embedded into web pages [20].

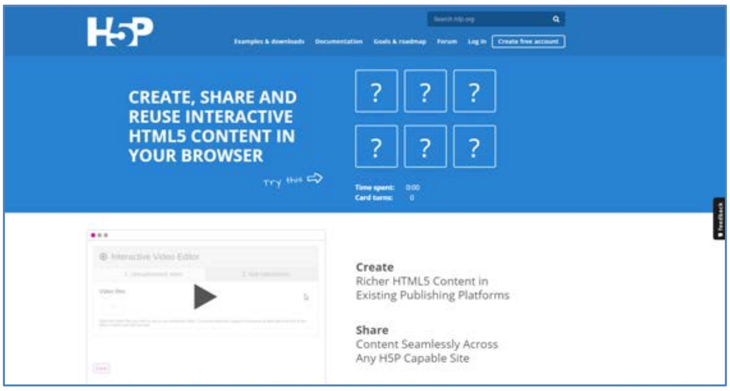

Figure 1. Print screen from h5p.org

  Mathematical expressions can be added to all text fields in the H5P authoring tool using LaTeX and rendered with the help of the open source MathJax project [21]. This tool is a JavaScript library for visual rendering of formulas created in MathML, LaTeX and ASCIIMathML using any operating systems and web browsers ([22], [23]).

  After analysing its potentialities when addressing the project objectives e future, it presented several cons that seem hard to overcome not offering the versatility of other paid tools. Most of the examples and testimonies presented are based on video lectures development ([24], [25], [26], among others), the one multimedia interactive tool that the project partners were not so interested in developing. Another point to consider is that long term hosting of content revealed to be a problem as the H5P.org web site can't host content that may be needed again in the future. Institutions should develop their own hosting arrangements.

- The other software is the Ispring (Suite 9/Presenter) software (Fig.2), that is a flash-based program which is integrated as an extension in PowerPoint (Fig.3). It presents the learning materials in the form of a flash slide that can contain images, animations, videos and audio.

For Mathematic text editing, the iSpring Visuals 9 includes a built-in equation editor, similar to MathEquation from Office tools, that allows the direct construction and insertion of equations in the interaction text.

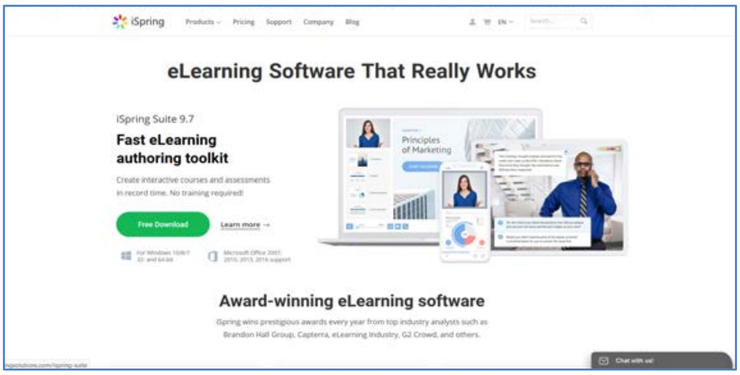

Figure 2. Print screen from ispringsolutions.com

Figure 3. ISpring Powerpoint extention features.

Despite being a paid software, its potential regarding the development of interactive contents is huge and the related impact reveals positive in several documented experiences and reports, even in the educational area ([27],[28], [29] among others).

Discussing software and platforms features and potentialities with partners and evaluating developers' skills in using LaTeX and MathEquation, and previous experiences in developing animated presentations for video development, it was decided to develop the interactive multimedia mathematical theoretical contents based on iSpring Suite 9.

3 PEDAGOGICAL FEATURES IN DEVELOPING INTERACTIVE THEORETICAL MATERIALS

In the EngiMath Project development, partners used an ADDIE (Analysis of Design Development Implementation and Evaluation) [30]. This model is a systematic instructional design model, which represents a dynamic and flexible guideline for building effective teaching and learning tools. The model consists of 5 stages, namely (1) Need analysis; (2) Design; (3) Development; (4) Implementation; (5) Evaluation (Fig. 4).

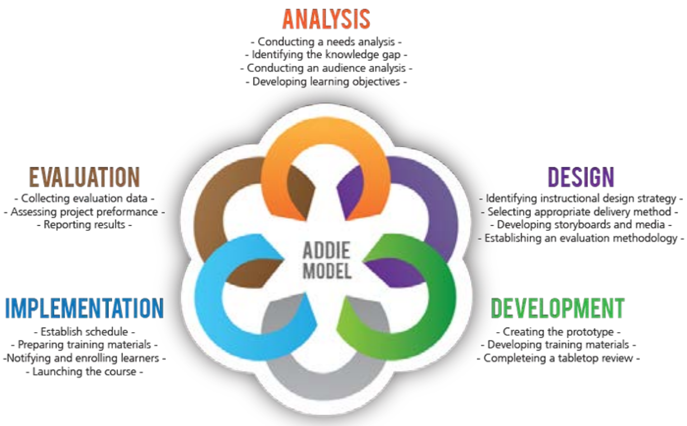

Figure 4. ADDIE Model. Image source: [31]
Photo credit: eLearning Services — NIU — Northern Illinois University.

3.1 Needs analysis

The needs analysis is the first step that must be carried out before compiling a program or media in learning because, at this stage, the problems found in teaching/learning are examined to find out how to try to “solve” them. As already mentioned, Needs Analysis and Data Gathering from all partner countries and institutions and specifying needs of assessment within Engineering Mathematics was the project first task [9]. Provisional results that formed the basis where gathered and a proforma report structure was developed, where each partner conducted a needs analysis based on their own experiences and curriculum guided by the proforma. Data was collated in a database per country.

Regarding Math contents to be developed, a common core was established – a subset of the Linear Algebra syllabus. Notice that in this multinational project, cultural, language, and social barriers exist and need to be accommodated in any engaging pedagogical paradigm. The universal language of mathematics is assumed to allow cross-cultural shared programmes however the common language of mathematics is not sufficient. It is necessary to ensure that particular support measures exist to provide for local specific issues.

3.2 Design

The design phase is the preparation stage for creating learning media by compiling several and distinct characteristics, schemes and procedures as:

- logo and presentation base model,
- competency maps,
- material maps,
- outlines of media content,
- flowcharts,
- media content.

When designing the competency and material maps and complementing them with the flowcharts it was decided to divide the subjects into very small lessons, that evolve in a logically smooth path, allowing students to advance according to their perception and specific needs.

It was decided to build these theoretical lessons by developing SCORM (Sharable Content Object Reference Model) packages based on animated PowerPoints with interactive questions generated in the Quiz segment of i-Spring software.

3.3 Development

The development process was started in the PowerPoint slides that comprises making an introduction, determining the background and navigation, creating a home menu, making a material menu, and developing formative questions inserted in the middle of a lesson or in the last section named “Try it”, a kind of self-assessment quiz per lesson.

For piloting, 22 interactive lessons were developed. These, lessons presented several sections (between 3 and 7, depending on the subject) and the navigation inside was completely free, giving students the freedom to go forward and backward, as they please (Fig. 5).

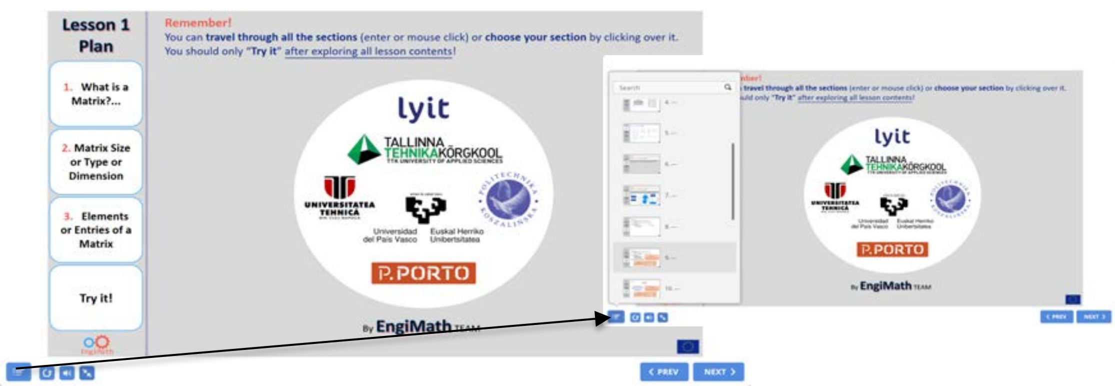

Figure 5. Lesson example – 4 sections and navigation.

All the questions developed to be inserted in any section in every lesson has, besides the correct answer, a “step by step” proposed solution (Fig. 6).

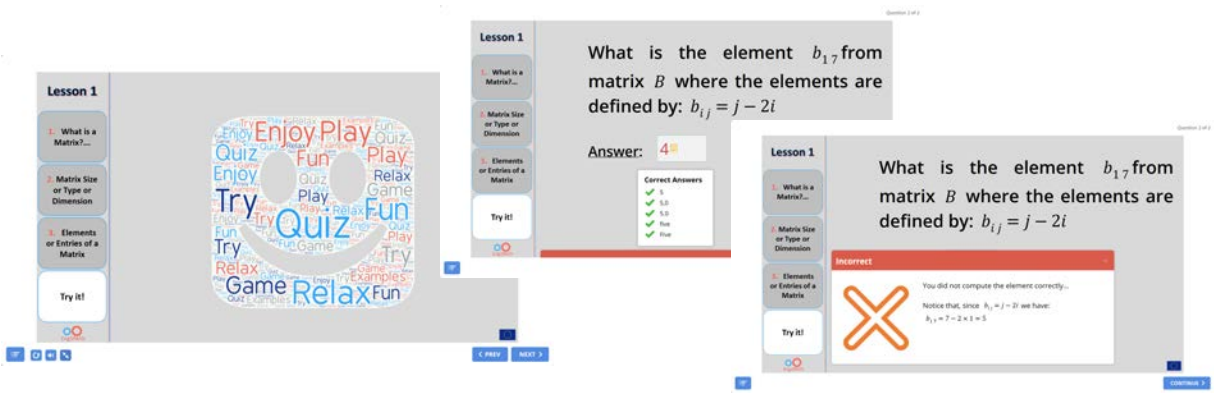

Figure 6. Formative questions – Correct answer and Proposed solution step-by-step.

In these 22 lessons, there are more than 300 slides with more than 3300 animations. The number of questions developed until now, just for these lessons, goes beyond 100, all with step-by-step solution. Notice that this proposed solution is shown to the students even if they get the correct answer.

These lessons were inserted in the project coordinator Moodle (Estonian partner – TTK/UAS), as SCORM Packages for testing and first feedback from partners. All the support documents – Powerpoint presentations with iSpring extensions and zip Scorm files, were uploaded to the project Google Drive in order to be accessible to all project partners as some were needed for translation purposes.

3.4 Implementation

The implementation phase of the project design and development, regarding the theory interactive materials developed is currently in the piloting phase. Each partner country, besides Ireland, had to take care of the exhausting translation procedures and consequent SCORM Packages creation. The piloting implementation was direct since the Moodle allows the directed insertion of SCORM packages and these seem to work properly, when having the correct definition sets applied in the PowerPoint support document. Regarding the administrative and teacher procedures in implementing phase, the difficulties, until now, are irrelevant and have been easily overcome. Since each partner/country must pilot its respective course in each mother language, the piloting schedule had to be flexible and it is too early to provide results from the students/users point of view.

3.5 Evaluation

The final stage of this instructional design model development is to evaluate the interactive media that has been implemented. The first evaluation will be done through a feedback survey questionnaire developed by the Quality Assurance team of the project, but as already mentioned, there still are no results at this moment from the piloting phase since it is still in an ongoing process.

4 FINAL REMARKS AND FUTURE WORK

ISpring-based interactive multimedia is a tool that converts presentation files not only into flash memory (SWF format), but also into the SCORM package, which can be used in Moodle platforms, showing interactive features in a friendly and almost easy way.

Based on the project partners experience so far, from the editing and developer point of view, the interactive mathematics multimedia learning based on iSpring Presenter has met the expected requirements and it may be considered to be used in the teaching/learning process as a supporting media for learning. It is expected that it can be a real supporting tool that promotes students' interest and engagement in learning through varied learning activities.

It is expected that thanks to the benefits of interaction, the teaching and learning process will be more interesting, so that students will be interested and not experience stress during training.

It is anticipated that interactive mathematics multimedia based on iSpring Presenter can support other existing tools and activities, making it easier for students to master important topics, and can be used as an alternative mean to facilitate understanding of more complex subjects. However, it is too early to present real conclusions from the students' point of view.

Regarding the project future the practical exercises and assessment quizzes are also being tested. For practical purposes, for each lesson, a set of more than 100 questions was developed in English and inserted in TTK/UAS Moodle platform by Estonian team. These sets of questions were also translated and are an important part of the pilot course. Every lesson has a practical random quiz of 8-12 questions (selected from 8-12 subsections each with at, least, 10 different question) to be answered right after going through it, constructed using Moodle Quiz with the STACK plug-in. For assessment purposes, the Spanish team has developed 2 tests, also using Moodle quiz feature. These tests were also translated and are also being used in the piloting project phase.

It is predicted that the first piloting round will be completed by the end of March 2020 and its results will be analysed and disseminated by the second semester of 2020.

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