Digital Open Library Development: A Real Path Towards Sustainable Math Education

Filomena Soares[1], Ana Paula Lopes[1], Anne Uukkivi[2], Carles Serrat[3], Selver Softic[4] and Vlad Bocannet[5]

[1]P.PORTO / ISCAP / CEOS.PP, Porto, Portugal
[2]TTK University of Applied Sciences, Tallinn, Estonia
[3]Universitat Politècnica de Catalunya-Barcelona TECH/UPC, Barcelona, Spain
[4]Campus 02 - University of Applied Sciences, Graz, Austria
[5]Technical University of Cluj-Napoca, Cluj-Napoca, Romania

fbsoares@iscap.ipp.pt
aplopes@iscap.ipp.pt
anne.uukkivi@tktk.ee
carles.serrat@upc.edu
selver.softic@campus02.at
vlad.bocanet@campus.utcluj.ro

Abstract: After the globally atypical year of 2020, distance cooperation and experimentation with virtual and blended learning opportunities are becoming a standard in all educational levels. Digital teaching/learning materials are at the forefront of this movement, presenting many advantages, since these can be innovative, engaging, interactive, and can even be tailored to meet the students' and teachers' needs. In this context, Open Educational Resources (OER) are a powerful concept for sharing the world's resources for the common good, reflecting the international commitment to Education For All (EFA). In the past few years, the development of OER has grown exponentially, however, several are quite "closed" and few have the necessary scientific and pedagogical quality certification as real "educational" resources, particularly in the Mathematics area. This was the main idea behind an Erasmus + Project, that brought together six Higher Education Institutions (HEI) from five European countries. This project, still in development, has emerged from a practical need for hybrid and remote teaching and learning open support. Its main goal is developing an Open Digital Library of Mathematics OER in seven distinct languages, encouraging its open dissemination and use, building a truly sustainable Math education promotor. An overview of the project and its main objectives will be presented, as well as its several operational and progress challenges as well as the results that have been accomplished thus far. This project entails several distinct but complementary features that started with the construction of an OER assessment model, culminating with the development of a multilingual OER bank and its continuous sustainability. This can only be achieved with the future establishment of an OER developer's community among Math teachers and students from several education levels, that will be engaged in other project programmed activities, as Teachers' Trainings, Users' International Challenge and Students' International Competition. This Project progress and success is largely based on the interaction, input and participation of all stakeholder groups.

Keywords: OER, Online learning, Mathematics learning, Multinational cooperation projects, Technology enhanced learning

1. Introduction

Mathematics in the STEM (science, technology, engineering and mathematics) field is considered as a necessary instrument to be able, through the applied exercises, to decipher the closest environment and represent various facts, be they social, scientific, or technical that occur in today's world (Williamson, 2018). However, Mathematics appears abstract to students mainly because teachers put more emphasis on the process of mathematics content than on the necessity of the content. Learning mathematics coupled with the effective application of mathematical e-learning can enhance meaningful learning of mathematics and make the subject more stimulating (Ahn & Edwin, 2018; Wæge, 2009). The interest motivates the student to put more effort into learning the content and stimulates its creative thinking, promoting creativity, autonomy development, self-esteem and entrepreneurship improvement (Titilope & Idiong, 2017). Mathematics and mathematical modeling facilitate the understanding of various phenomena, be it social reality itself, economic aspects, or historical facts, among others (Carvajalino, 2018) and by working with interactive open content asynchronously and at their own pace, students can build their own learning path, promoting the development of competencies that allow them to function independently in both personal and social life (Paechter et al., 2017).

Digital learning resources offer several specific advantages according to students' needs, as these materials can be engaging, interactive, and tailored to meet student needs. Research indicates that digital resources can significantly enhance learning outcomes by providing personalized learning experiences and fostering student engagement (King & South, 2017; Means et al., 2010). In this context, Open Educational Resources (OER) are a

powerful concept for sharing existing resources worldwide, for the common good, echoing the international commitment to Education For All (EFA) (UNESCO, 2002). In recent years, the development of OER has grown exponentially, with a notable increase in their use and creation across educational institutions globally (Hilton, 2016; Weller, 2014). However, it is evident that several materials labeled as "OER" available online are far from being truly "open" and few have the necessary scientific and pedagogical certification to be considered genuine "educational" resources, particularly and specifically in the field of Mathematics (Atkins et al., 2007; Miao et al., 2016; Wiley & Green, 2012).

2. Motivation

Recognizing the common need for certification and clarification regarding the concept of OER, a consortium of Higher Education Institutions submitted, an Erasmus+ project under the Key Action - Cooperation Partnerships in Higher Education, obtaining its approval. This consortium, comprising six Higher Education Institutions (HEIs) from five European countries (Austria, Estonia, Portugal, Romania, and Spain), is developing an 'Intelligent Library' of OER (Smart Library) under the label Gate2Math - Smart library for OERs in mathematics teaching (G2M).

3. Objectives, Target Audience and Expected Results

The main goal of G2M is to implement and put into service for the international educational community an efficient Gate2Math smart library for the optimal selection of open and multilingual educational resources in the field of mathematics teaching in the context of engineering. The scope of the content is wide-ranging and includes open resources such as videos, infographics, games, applets, presentations, animations, artifacts, blogs, bibliographic references, questionnaires, databases, wikis, courses and treatises from a theoretical point of view, practical, applied and assessment, covering the contents of Algebra, Calculus, Geometry, Statistics and Probability and their applications in STEM teaching.

The first and hardest project objective was to develop a general, intuitive and applicable OER Assessment Model. This is already in its "beta" version and with practical application, leading and supporting another G2M objective regarding the OER quality certification, specifically in Mathematics.

A final and global objective, that aligns with the project main goal, is to establish an OER developer's community among Math educators and students. The project is supporting digital transformation of secondary, vocational and higher education institutions. To increase the capacity and readiness of these institutions through the purposeful use of digital technologies, the consortium is creating quality learning materials in mathematics and preparing both teachers and students to create and use these types of learning materials through the implementation of several training and collaborative actions, namely: Teachers' Training, Users' International Challenge and Students' International Competition. To this end, a BIP (Blended Intensive Program) has already been developed for teachers and a BIP for students is scheduled for November.

As previously mentioned, the target audience are teachers and students from several levels of education, especially Higher Education, who are and will continue be involved in the evaluation and sustained development of OER, contributing to the growth of the library that is being developed, namely (Gate2Math, 2023):

- Mathematics teachers in secondary, vocational and higher schools, including visually impaired and color-blind teachers
- Students from the last years of secondary or vocational education to the first years of STEM-adjacent degrees, including visually impaired and color blind-students
- Fellows-researchers in the field of technology-assisted learning, online learning and STEM pedagogy

Regarding the project expected outcomes several can be pointed (Gate2Math, 2023):

- The smart library platform for OER in the field of Mathematics
- Research report on the typologies and characteristics that make an OER efficient and development of a standardized quality criterion for an OER.
- Inclusive and inter-connected smart library of high quality open and multilingual educational resources (which are accessible for visually impaired and color-blind students either) with the creators' community in the field of mathematics
- Training materials and trainings of how to create high quality OER
- Student competition based on the knowledge acquired from the Gate2Math smart library
- Teacher challenge for creating new learning materials

- New knowledge and skills of project partners and other teachers in mathematics and intercultural communication

4. Final Comments

G2M stands for a real international interaction, input and collaboration, reflecting the engagement and commitment of all the stakeholders to an Education for All, as its main goal is to build an OER library in seven different languages - German, Catalan, Spanish, Estonian, English, Portuguese, Romanian. As mentioned above, G2M arises from the need to promote sustainable teaching, making use of good OER. However, following extensive research, it appears that several of these resources have licenses that do not allow them to be used freely, complying with the 5Rs "model" related to OER (Wiley, 2014). It must always be kept in mind that an online digital content is frequently not an OER! The G2M Project aspires to share and alert to the existence of (real) open licenses that allow the use and reuse of good materials, contributing to true sustainability and universality in teaching, in all its areas.

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