MOOC in a school environment: ODL project

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Abstract. Unlike schools 15 years ago, contemporary schools use many ICT tools in their classes, e.g. computers, tablets, smartphones, etc. accompanying by open educational software, OER and apps. Teachers gradually turned to more student-centred approaches like inquiry, game-based, project-building, flipped learning, learning-by-teaching to name only but a few. Personalized teaching and learning supported by all these approaches help schools offer more effective and efficient education. Although Massive Open Online Courses (MOOCs) have proved to be helpful in university and adult education, until now they has not been yet deployed in school education. The 'Open Discovery of STEM Laboratories' project (ODL) exploits this potential and opens up MOOCs for it. In this paper, we discuss the first results of this implementation.

Keywords: STEM, school education, mMOOC, virtual and remote laboratories

1 Introduction

The fast-changing global economy acts like an engine that generates the demands of the skills that school, college and university graduates are expected to have in order to be competitive and have a capacity to drive innovation. Therefore, the future prosperity and social stability depend on the optimal use of our human capital. About 70 million Europeans [1] lack sufficient reading, writing and numeracy skills, and 40% of the EU population lack a sufficient level of digital skills. This potentially is one of the main sources of unemployment, poverty and social exclusion. On the other hand, 40% of European employers have difficulty in finding people with the right skills to foster growth and innovation [2]. At the same time, numerically high-qualified young people work in job positions that do not match their talents and knowledge.

Based on the research "The Survey of Adult Skills", in 2016 the European Commission has adopted a new and comprehensive skills Agenda for Europe to improve the teaching and recognition of skills - from basic to higher skills, as well as transversal and civic skills - and ultimately to boost employability. As we see, the digital literacy, and therefore, the education in applied sciences, engineering, and technologies is one of the keys to contribute to the European Commission's first political priority, "A New Boost for Jobs, Growth and Investment". It is a responsibility of all education

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players - schools, universities and policy-makers to ensure that no-one is left behind and that Europe nurtures the high-end skills that drive innovation and competitiveness.

The Open Discovery of STEM Laboratories (ODL) project [3] was created in order to introduce the use of MOOCs in school curricula and in conjunction with the STEM laboratories available online. ODL offers to school teachers a methodology for building micro-MOOCs for their students. Exploring the MOOC idea in a school context, the consortium determined that based on the content-load, activity and time consuming, it would be beneficial to chunk the MOOC course on few small learning lessons – micro-MOOCs (activity for 20-40 min in the classroom). Usually, course consists of several lectures. Each lecture in format of micro-MOOC includes laboratory work, theoretical and practical content, assessment and discussion. The suggested structure allows to easily embed micro-MOOCs in classroom time and, furthermore, to reduce a time required for creating learning materials.

In this paper we present the first outputs of our project. The main aim is to introduce the benefits and lessons learned through the integration of micro-MOOCs - an innovative approach for deploying STEM labs into a school. During the project, the team has created multidisciplinary MOOCs and trains teachers to design and implement the MOOC approach in their school. In this paper we discuss the format of MOOCs proposed for application in schools, how to introduce online labs in a MOOC environment and how to organize the individual and collaborative learning using this instrument. In order to create our MOOCs the ODL project partners use the edX open platform [4] where a MOOC space area was created for the project.

In Section 2 we describe the ODL project as it is – partners, aims and objectives as well as its structure. Section 3 is devoted to illustrate the inquiry-based learning approach used for introducing online laboratories. An example micro-MOOC is presented in Section 4. Section 5 summarizes our conclusions and introduces possible future work.

2 Open Discovery of STEM Laboratories

The ODL project aims to foster teacher collaboration in creating innovative STEM school curricula by open discovery of remote and virtual laboratories and their application in education. The consortium offers schools a micro-MOOC methodology for transforming separate education materials into coherent lessons. Micro-MOOCs preserve the principles of open teacher collaboration in STEM curriculum development. It is planned that teachers will work together on creating micro-MOOCs that will be united under the theme of one MOOC. In this case diverse national practices will be applied.

For this purposes the project proposes a MOOC methodology to be used on different subjects of school curricula and it offers an MOOC platform designed to meet teachers' needs. The project aspires to train at least 300 school teachers to develop micro-MOOCs for STEM lessons. By end of the project at least fifty-five micro-MOOCs that include the use of remote and virtual laboratories will be available on the platform. Students and teachers from EU school communities will have access openly to all the learning materials.

The methodology proposed will help educators find and organize digital learning resources while designing and delivering personalized instructions in a school environment. Our training will facilitate the teachers to find and evaluate content; collect and organize OERs, remote and virtual laboratories according the curricula; build STEM micro-MOOCs, manage lesson plans, content, student activities - laboratory and practice work; engage students through the students-centered learning and personalized feedback.

The project focuses on teachers, curriculum designers and administrators strengthening their profile by supporting them to deliver high quality teaching practices and to adopt new methods and tools. In particular, the project will extend teachers' knowledge and skills and support new teachers so that they have all necessary competences right from the start.

The project is designed to enhance digitalization of learning, teaching, and training by improving accessibility to high quality learning through micro-MOOC, use of OER, and teacher and school collaboration in modernization of STEM school curricula.

3 Inquiry-based learning

Inquiry-based learning is a contemporary educational strategy that aims on constructing scientific knowledge [5]. In this approach students perform engage in methods and practices that simulate how scientists work. During an inquiry activity, students discover connections between phenomena, the practice in formulating hypotheses and testing them by conducting experiments and/or making observations [6]. Inquiry-based learning fosters active participation of the learners and gives the opportunity to discover new knowledge. In this framework the learning process is organized by doing experiments that aim to explore the relation of one set of dependent or independent variables. It is important to mention that students explore the knowledge that is new to them but it is not novel in the science, in general.

In the last decade inquiry-based learning is gaining popularity in science curricula and it has turned out to be a powerful teaching instrument. The modern technological developments allow the use of inquiry processes with online learning environments and digital tools that can improve learning outcomes. Educational instructors organize inquiry-based learning into inquiry phases that together form an inquiry cycle. There are numerous versions of inquiry cycles proposed that can be found throughout the literature.

For example, de Jong at el suggested five distinct general inquiry phases: Orientation, Conceptualization, Investigation, Conclusion, and Discussion [7, 11]. Some of these phases are divided into sub-phases. In particular, the Conceptualization phase is divided into two sub-phases, Questioning and Hypothesis Generation; the Investigation phase is divided into three sub-phases, Exploration, Experimentation and Data

Interpretation; and the Discussion phase is divided into two sub-phases, Reflection and Communication.

In the ODL project we offer to school teachers the simple one - 5E structure (ENGAGE, EXPLORE, EXPLAIN, EXTEND, EVALUATE) suggested by Bybee [8]. On the 'Engage' stage the teachers aim to capture the students' imagination and motivation. Here students get the first introduction to the topic and understand the learning environment and tools that are used to build the inquiry curiosity. The 'Explore' stage allows to develop students' critical thinking and to help them explore new things on the subjects at hand. The 'Explain' stage requires from students to explain the involved phenomena using scientifically correct arguments. At this stage students start to create a model, discuss the data collected with their peers and the teacher and begin to communicate what they have learned. 'Extend' is the stage in which students expand their knowledge on the concept(s) they have studied, make connections to other related concepts, and apply their understanding to the real world. Finally, through discussion and disputes students make analyses and evaluate the knowledge they acquired during the activity.

Depending on the teachers' and/or students' needs three scenarios or pedagogical frameworks are suggested in the project:

- Traditional approach or Confirmation inquiry [9]
- Structured or guided inquiry approach [9]
- Elicited or Open inquiry approach [10].

4 "Light Pollution": an example of micro-MOOC

In order to fit to a "rhythm" of a school lesson we suggest a micro-MOOC structure – between one and three didactical hours (45 minutes) using an inquiry learning cycle and an online STEM laboratory. The suggested structure allows to easily perform micro-MOOC actions during classroom time.

The key outcome of the ODL project is a collection of micro-MOOCs available for school teachers. These micro-MOOCs will support the engagement of schools in innovative approaches of blended education in the everyday practices. The Light Pollution micro-MOOC[13] is one of the micro-MOOCs of our collection.

Every micro-MOOC begins by providing information on the activity (see Fig.1).

Fig. 1. Animation - intro to the theme

For example, "*Light pollution is a global problem that affects us all. In this micro-MOOC you will have the opportunity to learn more about light pollution and its impact on the planet*". In addition, requirements that allow the efficient performance of the tasks in the micro-MOOC are presented. The traditional approach with 5E structure is used to build this inquiry-based scenario (see Fig.2).

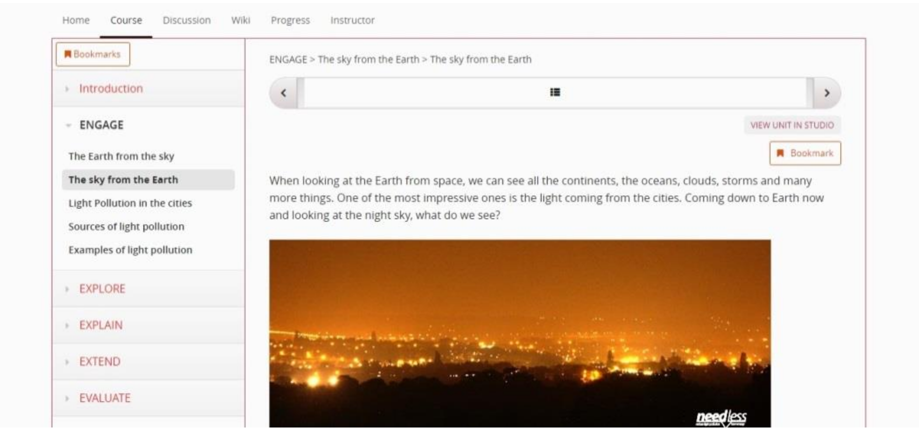

Fig. 2. 5E structure of inquiry-based scenario

At the introduction stage the research questions and tasks pick the interest of the students to the light pollution problem in the cities. The introduction of videos and animations helps to highlight the problem briefly and in an attractive visual way. Several video presentations, discussions, multiple-choice self-assessments are the main tools that keep students involved. In this scenario the STEM online labs used is an interactive map of sky glow and light pollution simulator which assist students to explore the phenomenon.

This example introduces the basic requirements of the well-designed micro-MOOC, namely:

- affective engagement of the students;
- harmonize learning process for students with different knowledge and interest;
- generating curiosity and leading to questions;
- a cognitive conflict;
- scientific investigation and explanation within the competence of the students involved;
- creating scientific knowledge;
- requiring the students to use inquiry skills to explain the involved phenomena;
- limiting time of use (1–2 lessons for the presentation and applying of remote/virtual labs).

5 Conclusion

Although the ODL project is still at the beginning stage, it is clear that teachers are interested in such approach. They see micro-MOOC as a tool to open a horizon of STEM subjects to their students; to embed the use online labs in the framework of their curriculum, which they never could use otherwise and to broad their collaboration with the colleagues on multidisciplinary aspects. In this paper we presented the preliminary outputs obtained from the implementation of the micro-MOOC approach in secondary school classes. Unlike traditional MOOCs that could last several months, the ODL micro-MOOCs are adjusted so as to meet the needs of in-class activities and last from 20 min to a few of class hours. The inquiry-based cycle based on the 5E stages (ENGAGE, EXPLORE, EXPLAIN, EXTEND, EVALUATE) was introduced. The reader can try the micro-MOOCs available on the ODL portal [12]. One of them is Light Pollution that explains the influence of the light on the ecosystem and humans, and risks caused by this influence. By gaining and understanding of light pollution students could be encouraged to search for solutions to reduce the negative impact light pollution on the environment.

In the near future, the project plans to organize a set of workshops which will offer a discussion for designing new learning materials and will give valuable feedback on the impact of the proposed methodology to school education. The consortium is planning to create at least 50 micro-MOOCs offered to schools. The study targets to evaluate the impact of the proposed methodology on students' knowledge and increase of interest towards STEM. The analytics system incorporated in edX platform will provide us with the necessary independent data and results.

The results of our trials will be published on the project website (http://opendiscoverylabs.eu/) and on the facebook group discussion wall. The study results could be helpful for secondary school sector representatives, education instructors, parents and policy makers to respond to current and future education needs.

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