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Making Learning Science Fun through Web2.0 Technologies: a Qualitative Study in Romania

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Abstract

Many countries have seen declining numbers of students choosing to pursue the study of Physical sciences, Engineering and Mathematics at university, while the percentage of Science & Technology graduates has fallen in several EU countries. The consequence is that the supply of scientists to sustain knowledge economies, which are heavily dependent on science and technology, is perceived as a significant problem. To address this problem, even starting with the pre-university education, the Erasmus+ Strategic Partnership project *"SciFUN: Making Learning Science Fun"* envisages to prepare European educators to better engage students in Science Education and as an effect of that, to increase students' motivation and achievement in science and other connected subjects, such as Technology Education, Informal Learning, Environmental Education, Multicultural and Civic Education. The current paper presents findings from a qualitative study performed in Romania during the initial phase of the SciFUN project implementation, with the purpose to identify the state-of-the-art in Science Education and teachers' needs and preparedness in relation to making learning science fun through the use of mobile devices and Web2.0 technologies. The research was achieved through Literature and Curricula Review, Focus Group and questionnaires applied to science teachers who teach to students aged 9 to 15.

Keywords: Science education; motivation; mobile devices; Web2.0 technologies.

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1. Introduction

The paper shows results from a qualitative study performed in Romania on state-of-the-art in Science Education and teachers' needs and preparedness in making learning science fun through mobile devices & Web2.0 technologies, developed within the Erasmus+ project *"SciFUN: Making Learning Science Fun"*, ref. no. 2015-1-RO01-KA201-015016, financed by the European Commission.

Many countries have seen declining numbers of students choosing to pursue the study of Physical Sciences, Engineering and Mathematics at university, while the percentage of Science & Technology graduates has fallen in several EU countries. In addition, the percentage of graduates studying for a PhD (the most common route to become a professional scientist) has dropped in all EU countries. Consequently, the supply of scientists to sustain knowledge economies is perceived as a significant problem. The predicament that Europe needs more scientists was addressed in a major report (Osborne & Dillon, 2008) showing the need for *"innovative curricula and ways of organizing the teaching of science that address the issue of low student motivation"* (p. 8). In spite of this pressing need, research in science education show a number of problematic issues: i) negative attitudes, low self-efficacy, declining interest about science and relevant subjects; ii) low achievement in international surveys on science literacy in numerous EU countries; iii) inadequate & stereotypic conceptions about science/scientists; iv) gender, race & socio-economic status differences. The Eurydice network asserts in its reports (2011a) that much more needs to be done to help schools tackle low achievement in mathematics and science education. The European Commission points towards the right direction, through one of five benchmarks included in "Strategic Framework Education & Training 2020": *"By 2020, the share of low-achieving 15-year-olds in reading, mathematics and science should be less than 15%."* In the same document, Strategic Objective 2 states that greater attention needs to be paid to *"making mathematics, science and technology more attractive",* and that more efforts should be made in order *"to ensure high quality teaching, to provide adequate initial teacher education, continuous professional development for teachers and trainers"* and *"to strengthen science teaching".* According to the policy document "Science Education in Europe: National Policies, Practices and Research" (Eurydice, 2011b), international student achievement studies demonstrate a clear link between enjoyment of learning science and science achievement. PISA 2006, 2012 showed that students' belief in whether they could handle tasks effectively and overcome difficulties (self-efficacy in science) was particularly closely related to performance. While this might not indicate a causal link, the results suggest that students with greater interest in science are more willing to invest the effort needed to do well (OECD, 2007). TIMSS also reports a link between the level of self-confidence in learning science and achievement in the subject (Martin, Mullis, Foy & Stanco, 2011). TIMSS results seem to suggest that attitudes towards science differ between grades and science subjects, however one thing is clear: young people have generally negative attitudes towards science and low interest in choosing science careers.

The SciFUN project builds on innovative pedagogical approaches & effective strategies, which have the potential to enhance basic & transversal skills and promote engagement in science through a conceptualization of science-as-practice over science-as-learning, which takes place in a variety of formal/informal learning contexts and incorporates fun & motivating activities.

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2. Theoretical Foundation and Related Literature

EU is constantly preoccupied to make science education and careers attractive for young people, to drastically improve science and technology-literacy in our society. Towards this purpose, the European Commission has established an *"Expert Group to support the preparation of new Science Education policy initiatives and policy options within the context of Horizon 2020 […]"*(SiS, 2013). Also, within the Horizon 2020 Work Programme, a Call for proposals was launched with the aim of making science education and careers attractive for young people.

Student interest and engagement with science can be better promoted through the use of a variety of innovative approaches and strategies as shown below:

Project-based science & authentic learning for civic engagement: project-based science exemplifies interactions between science, technology and the social & environmental contexts of science; technology learning is built on the idea that students engage in long-term authentic investigations that are driven by a real-life question to be explored.

Outdoors/Informal learning: an approach to supporting student interest and engagement with science, as illustrated through related literature is with teaching in outdoors settings, or more generally, in informal learning environments (i.e., zoos, museums, botanical gardens, environmental parks etc.). In recent years, a number of researchers & institutions have shown an interest in informal learning, which operates across a broad range of contexts and disciplines and reaches out to people of all ages. Informal learning environments offer unique educational environments and provide exciting opportunities for learning (Falk Storksdieck, 2004; Falk, & Dierking, 1998; McLedo, & Kilpatrick, 2000).

Use of ICT, digital storytelling, comics, mobile devices and social media: during the past few years there have been great strides in the advancement of technology with the rise of mobile devices (i.e., mobile phones, ipads) and social media and networking technologies (i.e., Facebook, twitter, blogs) leading to an era characterized by the instant access to and mobility of information. Mobile devices such as cellular phones, personal audio players, personal digital assistants and portable computers have re-shaped and re-defined the ways in which information is constructed, accessed and communicated among individuals and societies (Avraamidou, 2013a; Vrasidas et al. 2007).

Interactions with scientists: an approach to supporting students in engaging with science, in reconstructing their stereotypical views of scientists, and essentially in developing positive attitudes towards science, is through partnerships of schools with scientists (Avraamidou, 2013b).

3. Methodology

Our research was qualitative and aimed at investigating the state-of-the-art regarding the cross-curricular Science & Technology Education, Informal Learning, Environmental Education, Multicultural and Civic Education; a special emphasis was placed on Science Education. The research was implemented in all SciFUN project countries (Romania, Cyprus, Greece, Poland and Ireland) based on the following research questions: *1) What contemporary research shows on what works in Science Education? 2) What is the state of Science Education? 3) What is the ICT status in education? 4) What challenges each partner country faces? 5) How can SciFUN meet these challenges?*

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We applied a combined desk and field research. The desk research was achieved through Literature and Curricula Review and the field research through Questionnaire and Focus Group. The curricula and students in focus were the ones aged 9-15. Research framework and tools have been designed by the project consortium under the scientific coordination of the University of Piteşti.

In Romania the research was implemented, between 1st of February 2016 and 15th of June 2016.

For the Literature Review we analysed national available data (policy documents, strategies, scientific articles, surveys, reports, statistics, analyses, official web pages of institutions and authorities) to identify relevant information about: students' interest & attitudes in learning sciences; students' achievement in science literacy; their perception on science & scientists; the influence of the gender, race and socio-economic status differences on teaching sciences; what works in science education to increase motivation.

For the Curricula Review we analysed the following curricula: Physics (9th and 10th grade), Environmental education and protection (for preschool education, primary education, secondary education for grades 5th to 8th) and Civic education (for upper secondary education – high school). Additionally, the research report *"Non-formal and informal education: realities and perspective within the Romanian school"* has been also analysed.

We achieved the field research by applying face-to-face a questionnaire approved by the SciFUN project consortium to 10 science teachers (4 of Physics, 3 of Mathematics, 2 of Chemistry, 1 of Technological Education). The respondents were 9 female and 1 male, from rural and urban areas, aged 36 to 57 (average age: 47.33 years), with a teaching experience of13-31 years (average: 22.11 years). All of the respondents hold a HE diploma, 2 of them have post-university education, 6 have performed Master studies and 5 have graduated additional professional training programmes in the field of didactics or/and psycho-pedagogy. The questionnaire contained 17 multiple-choice and open items. Sampling is not required in qualitative researches, but when we selected the respondents, we did a typology mapping with care for providing differentiation in terms of: a) gender, b) discipline they teach, c) their students' age, and d) years of experience as teacher.

We organized the Focus Group with 5 teachers (1 male, 4 females): 2 of Mathematics, 2 of Chemistry and 1 of Physics. The aim was to identify students' and educators' needs on how to make science learning fun, interesting and more attractive to better motivate/engage students. The duration was of two hours. Participants signed an informed consent. The Focus Group has been video recorded.

4. Results

4.1. Results from Literature Review

Romania is one of the several European countries (amongst Greece, Spain, Latvia, Lithuania, Portugal, Turkey) where the average performance in science is lower than the EU average, although the spread of student achievement is not high. It obtained low results in the international surveys TIMSS (Trends in International Mathematics and Science Study) and PISA (Programme for International Student Assessment): the 28th place in science and the 25th place in math among 49 participating countries (TIMSS 2007); the 47th place in science among 65 participating countries (PISA 2012).

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Science and scientists are very present in the imaginary of Romanian children and teenagers, but this tends to be poor and often refers to stereotypes. Romania apparently has a maximum trust in science, being exempt from crazy scientists and having the minimum number of drawings referring to science as a dangerous thing.

According to the PISA studies (2009), Romania has the most significant growth when it comes to reducing disparities between socioeconomic status and school performance by implementing programs to help students with financial and family problems.

A present trend in Romanian education is the ICT use in teaching-learning of the scientific concepts, although the extent of involving ICT can vary. It depends on the components involved - computer and software - including applications developed for education in different programming languages. Another interesting aspect is related to the specific programmes used in Romanian schools: good results have been already obtained by using applications as AeL, Moodle, LabVIEW.

4.2. Results from Curricula Review

Although in the analysed curricula we could not find explicit curricular objectives for promoting students' interest, motivation and engagement with science, many of the statements, recommendations and objectives emphasize (indirectly, overall) promotion of science or interest for sciences.

School curricula provide specific methodological guidelines to ensure access to education and academic progress for all students including, here, their attitudes towards science. Methodological recommendations for the macro-design of the training are also provided and they clearly envisage developing at students the appropriate attitudes and behaviours towards science.

The curricula does not explicitly contain specific items regarding choosing a career in sciences. But, they are defined as an educational offer established at national level, which provides the basis for preparing in the field of science or orient on subsequent science studies.

All curricula are thus structured to make science interesting for students. They provide opportunities that cannot be acquired from other subjects: explaining physical phenomena & technological processes/products; performing experimental scientific investigation; understanding personal/environmental protection; using specialized language, notions, principles and concepts.

One of the most significant gaps in promoting students' engagement in science is the training needs of teachers for complementing and exploiting ways of non/informal learning in the school curriculum.

The *National Strategy for Research, Development and Innovation 2014-2020* foresees increasing the role of science in society and supporting smart specialization through understanding the social impact of science, technology and economic activities in the relevant sectors (p. 17).

4.3. Results from Questionnaires

Favourite science teaching methods are: discovery (90%), demonstration, problem-solving, group & individual work (80%), case study (60%), brainstorming, test-teach-test, learning by doing (50%).

Regarding including new science themes all teachers said that curriculum is not flexible (it allows changes or introducing new topics in a percentage which is less than 10% of the total curriculum).

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All respondents are *"very much familiar"* (20%) or "*quite much familiar*" (80%) with the mobile devices (GPS, PDAs, Tablet PCs), comics, digital storytelling, film, multimedia, Web2.0 technologies.

90% of the teachers use mobile devices in teaching "*from time to time"* in order to better motivate their students (computers/tablets and PC projectors, e-books, WebPages, blogs, YouTube, didactic apps, PPTs, simple calculation software).

The respondents opined that mobile devices and Web2.0 technologies are relevant and should be used within the subject they teach to better motivate and increase students' interest (10% at "*a very high extent"*, 30% at *"a high extent",* 60% at *"a moderate extent").*

The potential advantages are: increase students' interest for sciences; allow rapid documentation; substitute the lack of equipment in the laboratory develop imagination; better understanding of the phenomena; better retention of the taught concepts, while the challenges in using mobile devices and Web2.0 technologies in teaching could be the absence of these devices, the reluctance of parents and the need for extra effort from teachers.

4.4. Results from Focus Group

All the respondents have agreed that the students aged 9-15 are generally attracted by practical sciences (experiments and simulations). They emphasized that students' interest in learning sciences strongly depends on the class profile, type of school (secondary, vocational, etc.) and sometimes *their opinion could change from gymnasium to high school and vice versa.* Students from technical-vocational education are more oriented towards science than the ones from humanistic educational branches.

In general girls are more preoccupied by school, so their interest for science is higher too. There is a natural inclination towards science at boys, but girls often get better school results in science than boys. There are no *essential* gender differences in science teaching; gender difference is most obvious in Physics & Chemistry, where the academic performance of boys is higher, and respectively in Natural Sciences, where girls perform better than boys.

Boys are more spontaneous (especially in the classes with Mathematic-Informatics profile), they consider experiments as being more attractive and quickly understand the scientific concepts, while girls are more conscientious, profound and hard working so they can get better results than boys. Hence, the school performance is gender-split. A gender split occurs in relation to those sciences requiring more calculus (Mathematics, Physics, Chemistry) compared to Biology, and paradoxically, girls are better than boys.

Main difficulties that a science teacher could be confronted are: high number of students in the class (25-32 students); students' own rhythm of assimilation; and lack of equipment and mobile devices necessary in the science laboratories.

Respondents agreed that the use of mobile devices and Web2.0 technologies make classroom activities more appealing & efficient to students. All the respondents are in a large extent familiar with mobile devices: they know them and use them into an integrated manner. The most commonly used mobile devices are the Tablet-PCs, but in some urban schools the Smart/Intelligent boards have been introduced; also science channels (i.e. Discovery) are used in teaching and welcomed by students. Among

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students, the most preferred devices and tools are: the Tablet-PCs, YouTube, WebPages, discussion groups and fora.

To be able to use mobile devices teachers need suitable training and software adequate to the discipline they teach. But they see a risk in using them, if students are not supervised and the use of these devices is not limited, controlled, monitored (i.e. students may access information inappropriate to their age, may use in a wrong way the software and knowledge, can understand in a distorted way certain concepts and terms, can spend too much time with these devices to the detriment of effective learning, etc.).

5. Discussions

The findings of our research reveal key-aspects regarding how to better motivate students' for science by taking into account their needs and expectations in relation to a set of specificities: age, gender, number of weekly teaching hour per discipline, teaching methods and materials, school context and profile, performance rewarding system, career plans, family background and existing role models.

Our study demonstrated that mobile devices and Web2.0 technologies can increase students' motivation, being more interactive and adaptable to their learning needs. This is convergent with findings of other researches: An, & Williams (2010) state that *"Web2.0 has the potential to provide more interactive and customized learning environments where students create knowledge, rather than passively receive information from instructors […]."*

As revealed by our findings, students aged 9-15 are attracted by experiments, simulations and practical works when learning sciences. This also supports the study of Johnstone and Al-Shuaili (2001) which shows that practical work can increase students' sense of ownership of their learning and can increase their motivation.

We identified gender split in school performance. Okwo and Otunba (2007) also support the theory of gender split in students' achievements, reporting that gender influences achievement by 13.39% of the total influence factor. The differences revealed by our study between boys and girls are explained by the fact that boys are more spontaneous, while girls are more conscientious, profound and hard working so they can get better results than boys. There is good convergence in that with findings of Kenney-Benson et al. (2006) showing that girls succeed over boys in school because they are more apt to plan ahead, set academic goals, and put effort into achieving those goals.

Overall our study revealed that mobile tools and Web2.0 technologies are effective in making learning science fun if teachers get support and examples on how to include them in teaching. This is the solution that we applied by designing the SciFUN Toolkit to help students get motivated, learn sciences, orient towards science career, participate in the digital society and stay socially connected.

6. Conclusions

Using mobile devices/Web2.0 is not yet a very spread practice in science classrooms. Teachers are interested in using these mobile devices as stimuli in the learning activities, but in the same time the curriculum is not flexible (new topics can be introduced less than 10%). Teachers consider a positive aspect using mobile devices in science education to solve different didactic and pedagogic problems and appreciate their benefits: increase student's interest for sciences, allow rapid documentation, develop imagination, substitute the lack of laboratory equipment, better understanding of the phenomena, better retention of the taught concepts.

The role of parents and society is very important in sciences education. A "school for parents" should be organized because involving parents in the educational process is essential.

To increase engagement in science education, the results obtained in sciences competition should be mediatised and students rewarded. Students and teachers have acknowledged that there are differences between subjects in rewarding the performance (e.g. sportsmen with good results in competitions get a life annuity, while the winners in science Olympics get nothing). Motivation for science could increase through recognition and reward of results (e.g. medals, diploma, cup, books, merit scholarships, etc.).

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