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IMPROVING THE SCIENCES TEACHING STRATEGIES
THROUGH “ENGAGE” CURRICULUM MATERIALS

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Abstract

The main goal of “ENGAGE - Equipping the Next Generation for Active Engagement in Science Equipping the Next Generation” project (www.engagingscience.eu) is focused on the training of next generation of students by changing the way of teaching and learning Science. 14 institutions from 13 countries put in common their efforts to make Science lessons more attractive, by promoting different interactive - participatory teaching strategies, based on investigation of reality, identifying and testing alternative solutions, which teach students to think and apply their knowledge and take responsible decisions based on the received information. In order to achieve these goals on students' level the partnership has designed continuous development programs for teachers, organized through face to face workshops or online courses, where interactive - participatory teaching strategies and examples of applying these strategies through ENGAGE curriculum materials are introduced. This paper points out some aspects related with the improving of Sciences teaching strategies using pedagogical tools based of inquiry-based methodology. Curriculum materials designed in the frame of the project make use of the following instruments: productive dilemma, group discussion, problem solving, and conversation. A study was made on over 170 Romanian science teachers who adopted / implemented those curriculum materials in Sciences teaching (Chemistry, Physics and Biology)

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1. Introduction

The curriculum materials designed in the frame on the ENGAGE project promote Responsible Research and Innovation (RRI) in Science teaching (Gorghiu, Dumitrescu, & Petrescu, 2016). These educational materials are: Teacher's PowerPoint Presentation, the students' sheets and the teacher's guide.

In the teacher's presentation the dilemma is defined and the course of scientific investigation is described, along with the techniques of discussion used by the group.

The students' sheets could have the form of cards which contain scientific evidence or arguments.

The teacher's guide contains a short overview of the problem, the learning objectives, curriculum links and the main ideas of his lecture.

Dilemma is a situation in which a difficult choice has to be made between two or more alternatives, especially equally undesirable ones (Oxford Dictionaires, 2015). In the Science of Education, the dilemma refers to controversial social-scientific problems regarding the applications and implications of Science (Ratcliffe, 1997). Also, it includes a context of productive learning:

- It facilitates the understanding of science, the abilities, and aptitudes of students.
- It strengthens the process of decision making and problem solving (Koballa & Tippins, 2000).

The scientific evidence (Sanna, Anastasiya, & Aro, 2005) is trustful information (for example the study's conclusions, some experts' opinions and examples of good application) which offers a demand.

An “Engage” lesson on “problem solving” regards a controversial problem which starts from a real-life aspect. The requirements for the problem are similar to the six criteria of the “scientific dilemma” (Fensham, 1988) but also include the “What I want to know” aspect.

2. Problem Statement

The “ENGAGE ADOPT” curriculum materials imply the forming of groups of three or four students in order to work on a learning task in a collaborative manner, without the direct supervision of a teacher. The tasks are designed so that students may work together in order to reach a decision or a solution to the problem, and are based on authentic problems, insufficiently structured, with multiple solutions, which include a lot of uncertainty elements. These problems cannot be approached simply by using scientific knowledge because their implications are also social, economic, civic, ethical etc.

The materials proposed for implementing in classroom were: “Sinking island”, “Ban the beds”, “Take the test?”, “Attack of the giant viruses”, Ban Cola?, “Car Wars”, “Grow”, “Breaking News: 3 Parents”, ”Making Decisions”, “What does the fox say?”, “Eat insects”, “Solar Roadways”, “Ebola”, “Appliance science”, “Chocolate money”, “Big bag ban”, :Text Neck”, “Invasion!”, “GM Decision”, “Life on Encedalus”, “Death to Diesel” (Engage, 2015).

Table 01. ENGAGE curriculum materials implemented in classroom

No	ENGAGE ADOPT Materials	Curriculum Link GCSE Combined Science subject content	Dilemma
1	Ban Cola	Working Scientifically: Analysis and evaluation – interpreting observations and other data, including identifying patterns and trends, making inferences and drawing conclusions. Biology: Health, disease and the development of	Should we ban sugary drink sales to under -18 s?

		medicine – diseases influenced by nutrition.	
2	Big bag ban	Working Scientifically: Development of scientific thinking: explain everyday and technological applications of science; evaluate associated personal, social, economic and environmental implications; and make decision based on the evaluation of evidence and arguments Chemistry: chemical bonding – describe and compare the nature and arrangement of chemical bonds in polymer	What are the alternatives to ordinary plastic bags? Will degradable plastic bags solve the problem?
3	Appliance science	Working Scientifically: Analysis and evaluation: interpret data ... to draw conclusions. Physics: Energy: Power as the rate of transfer of energy	Can you make big enough cuts?
4	Text Neck	Working Scientifically: Experimental skills and strategies: plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena. Physics: Forces: use vector diagrams to illustrate resolution of forces.	Will you use your phone less to save your neck?
5	Chocolate money	Experimental skills and investigation: ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge and experience. Biology: Relationship in a ecosystem: the importance of plant reproduction through insect pollination in human food security	Is this the end for chocolate?

The most used materials are presented in Table 1.

3. Research Questions

“ENGAGE ADOPT” curriculum materials improve science teaching strategy?

To what extent students’ skills were improved after the use of these materials?

4. Purpose of the Study

The European project ENGAGE is part of the “Science in Society” for promoting Responsible Research and Innovation. 14 institutions from 13 countries (UK, Greece, Germany, Italy, France, Romania, Israel, Spain, Norway, Netherlands, Switzerland, Lithuania, Cyprus) put in common their efforts to make Science lessons more attractive by promoting different interactive - participatory teaching strategies (www.engagingscience.eu/en/consortium/). This paper points out some aspects related with the improving of Sciences teaching strategies using pedagogical tools based of inquiry-based methodology.

5. Research Methods

The study was realized on a group of 177 teachers from Romania which implemented “ENGAGE ADOPT” curriculum materials in teaching Science. 87% of the teachers which took part in this study have over 10 years of practice in teaching science (Chemistry, Physics and Biology). Teacher’s opinions were collected using a questionnaire for the evaluation of the teaching strategy and of “ENGAGE” curriculum materials. This questionnaire was composed out of multiple answers items, items with

answers on a Likert type scale (with five steps of appreciation), and also questions with open answers. The obtained data were processed by statistical and mathematical analysis.

The questions selected were:

“To what extent it helped Teacher’s Guide?”

“What are the advantages of using the “ENGAGE” curriculum materials?”

“What are the limits of using the “ENGAGE” curriculum materials?”

“To what extent students’ skills were improved after the use of these curriculum materials?”

“To what extent did “ENGAGE” materials improve your way of teaching science?”

6. Findings

The majority of teachers appreciated the fact that the Teacher's Guide was very helpful to them (on a Likert type scale of appreciation with five steps, defined as: very much, a lot, moderately, a little and not at all). This result wasn't unexpected, given the fact that these materials are rather new.

In order to find out the advantages and limits of these educational materials in teaching science, two items with multiple choice answers, preconditioned, have been selected. Among the advantages we can observe: the interest students show for the discussed subjects, the easy way in which the materials can be used in the classroom but also the linking between scientific content and school curriculum (Figure 01) During the discussions held in the classroom, the students bring pro and con arguments for their ideas, in order to clarify some notions and solving problems.

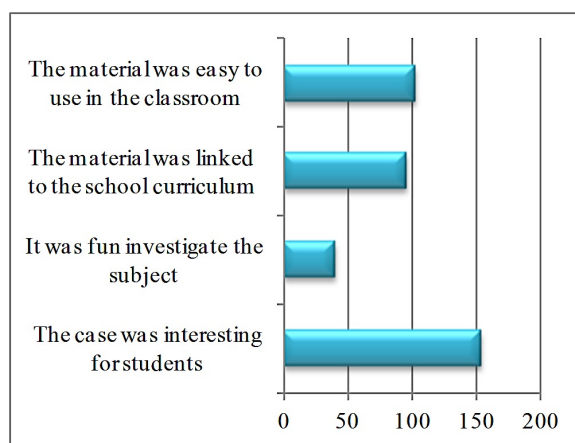


Figure 01. The advantages of using “ENGAGE ADOPT” curriculum materials in teaching science

As limits of using “ENGAGE ADOPT” curriculum materials, teachers mentioned the fact that it involves a longer period of preparation for lessons and previous knowledge which students don't have yet (Figure 02).

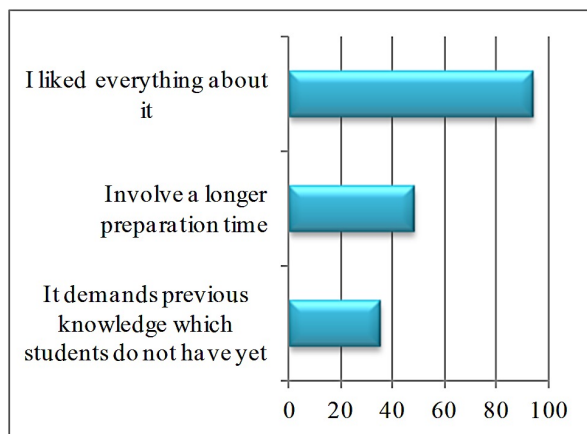


Figure 02. Limits of using “ENGAGE ADOPT” curriculum materials in teaching science]

Regarding the level of difficulty of the activities unfolded during the lessons, teachers remarked that it was adequate to the level of most students (on a Linkert type scale with five steps defined as: can't be used, too hard, adequate, almost good and too easy).

Most teachers answered the question “To what extent did ENGAGE materials improve your way of teaching science?” by saying “a lot”. We selected some of the arguments which led to this opinion:

“Scientific investigation is an essential method in teaching science. The curriculum materials helped me develop my competences which were necessary in using this method of teaching-learning-evaluation during Biology classes, but also in extra-school educative activities which I organize with students.”

“When the thematic is related to everyday life, students feel more comfortable in class and are able to connect easier to the stages of the lesson, they communicate, ask questions, do research under the supervision of the teacher and it can be seen how easily they issue their own opinions even though they are not always scientifically correct.”

“ENGAGE materials offered me challenges which required solutions, some with immediate practicability. Thus I re-thought my central approach towards students in the frame of the KWHL method (What I Know, What I Want to know, How I will find out, What I have Learnt) and of the project method, insisting on discussion, team work, questions, argumentation, searching for information and explaining them.”

“An open background is necessary during a discussion. The students were encouraged to think freely, using proper language, to accept the opinion of others, without insulting them. Students are taught how to use the rules of dialogue.”

In order to find out the degree in which students’ skills were improved after using the “ENGAGE ADOPT” curriculum materials in classroom there were selected 6 items with predetermined answers, structured on a Likert type scale with five steps and defined as: very much, a lot, moderately, a little and not at all. Thus, over 65% of teachers that implemented “ENGAGE ADOPT” type lessons estimated that students are capable and very capable to ask scientific questions and evaluate evidence and also to analyze some problems, apply their knowledge and lay down reasonable opinions, express them clearly and identify possible actions.

Also, teachers have noticed that more than 50% of students are able: to critically evaluate the credibility of obvious scientific proofs in order to discuss the continuous evolution of science/technology that is presented by media (51%); to express their own opinion about a decision regarding life, community, or society, considering a number of aspects, scientific or not (57%); to motivate their opinion regarding a socio-scientific problem (54%); to evaluate possible solutions to some problems about science/technology, based on given criteria, by applying their knowledge and by using existing data (52%).)

7. Conclusion

ENGAGE curriculum materials is trying to show students that contemporary science and technology is often based on uncertain evidence and that their own point of view and reasoning are important. The strategy of science teaching has been improved “a lot” by using the “ENGAGE ADOPT” curriculum materials. The curriculum materials encourages students to talk and think about social-scientific problems which have an impact their life as well as the planet as a whole.

After using the “ENGAGE ADOPT” curriculum materials in classroom, students' skills have been significantly improved.

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