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NEW TRENDS IN TEACHING SCIENCES: A CASE STUDY FROM THE ENGAGE PROJECT

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Abstract

Starting from the premise that *Science and Technology* represent areas where progress is accelerated in a considerable manner, the educational systems realize more and more the need to overcome the traditionalist paradigm of teaching Sciences and replace it by a constructivist one. In this environment, the student is learning by doing through an individualized process of socio-scientific knowledge building. The *ENGAGE* Project - *Equipping the Next Generation for Active Engagement in Science* - is a research project financed as part of the EU agenda dedicated to "*Science in Society*", aiming to promote *Responsible Research and Innovation* (*RRI*) in the educational practice, trying to familiarize teachers and secondary school level students with a training methodology based on scientific investigation (*IBSE*). This gives to students the opportunity to express their opinions, to develop competences related to critical thinking and investigation. This paper summarizes the teachers' perceptions related to the implementation of the ENGAGE designed-patterns Science lessons in the classroom, exploiting therefore the proposed activities illustrated in the *engagingscience.eu portal*. In this sense, a questionnaire with 3 items was developed and administered, with pre-formulated multiple-choice answers, using a five steps Likert-type scale. The answers were processed with the help of quantitative research methods and correlated with a range of information collected during a focus group discussion. The results configured the conclusion that using ENGAGE designed-patterns Science lessons, the quality of teaching and learning has increased significantly, but also the student's motivation and interest for Science activities have recorded an important growth.

Keywords: Responsible Research and Innovation, Inquiry-based Science Education, discussion techniques, innovative didactic design, ENGAGE Project.

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1. Introduction

During the recent years, one important aspect that can be noted on international level is an evident change of paradigm in teaching Science, largely determined by the decrease of the students' interest and motivation for this scientific area (Chemistry, Physics and Biology). In this sense, a relevant Eurydice Study from 2011 - *Education in the domain of sciences in Europe: national policies, practices and research* - proposes a general, comparative presentation of the policies and measures applied in the European countries regarding education in the domain of sciences, especially the strategies applied to increase the scientific knowledge level, to increase the students' interest for the disciplines framed in the domain of Sciences and to improve their motivation.

This change of paradigm is reflected, on the theoretical level, by the reconfiguration of the curriculum dedicated to Sciences, which supposes the elimination of certain contents given by their highly difficult level and the lack of connections with the students' daily life, the realization of interdisciplinary connections and the approach of certain scientific problems from the ethical, economic or social perspective.

On the practical level, the change of paradigm is translated by designing and using of modern teaching approaches, based on innovative teaching projects, turning to valuable teaching strategies of the training based on scientific investigation, based on problem solving or supposing learning by cooperation / collaboration. In this context, "students must understand the scientific research process" and "understanding ought to emerge as a result of the scientific experiences made in class and outside school" (http://www.ccdcluj.ro/Fisiere/2015/proiecte/Ghid_Predarea_stiintelor_prin_investigatie.pdf).

Moreover, a training process based on scientific investigation involves the students efficiently in their own knowledge process, because they are engaged in learning by means of scientific questions oriented by the teacher. In this way, students give priority to the evidence, which helps them formulate and evaluate the explanations by which one can answer the initial questions, formulate explanations, based on evidence and evaluate their explanations. At the same time, the students communicate among themselves and with the teacher to justify or argument their explanations, apply the information acquired in new situations, evaluate the new knowledge and the approach of their acquisition, identifying the difficulties met, and the way of overcoming them (Ciascai, 2016). The teacher has a crucial role on raising the students' interest for *Science and Technology* - where the students' involvement is very active, an increased attraction for scientific activities is recorded, which lead the participating students to deepen their knowledge and to develop particular skills for scientific issues (Gorghiu, & Santi, 2017).

2. Problem Statement

The *ENGAGE Project - Equipping the Next Generation for Active Engagement in Science* (https://www.engagingscience.eu) comes to support the teachers who teach disciplines in the area of Sciences (Chemistry, Physics and Biology), in order to facilitate the approach of certain themes of socio-scientific nature, relevant for the students of the contemporary knowledge-based society. At the same time, this project develops the teachers' knowledge, convictions and skills regarding *Responsible Research and Innovation* (*RRI*) and offers to students a solid basis to be engaged in the study of some complex,

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interdisciplinary problems, which they are going to meet during their life (Gorghiu, Dumitrescu, & Petrescu, 2016).

By the activities designed and implemented in class, the project is trying to show to the students that the contemporary science and technology often rely on uncertain evidence, which needs rigorous identification and analysis. Consequently, in the context of the lessons, a series of teaching methods and procedures are profitably used, such as conversation, discussion techniques, argumentation, workgroup techniques etc. The approach of the project in three stages (*Adopt, Adapt* and *Transform*) will lead the teachers to the development of their own professional skills, referred to their investigative skills and their quality of experts in the RRI domain - RRI expert. (https://www.engagingscience.eu/en/overview/)

Thus, the *Adopt Stage* combines a series of exciting materials for learning, assures communication in the framework of the on-line community, and includes face-to-face workshops and on-line courses for coaching and feedback. In the framework of the on-line courses, the teachers benefited of: models of lessons of the dilemma type to apply the scientific content and to shape the skills necessary to the explanation of certain problems of the daily life; good practices guides, concerning the use of the different techniques of group discussions; examples of lessons that involve learning based on problem solving and scientific investigation; information on the use of several types of conversation that can be used to engage a class in a process of argumentative debate and in decision-making based on scientific evidence; ways of using the ENGAGE materials to offer more attractive lessons to the students etc.

The *Adapt Stage* offers to the *Adopt teachers* a toolkit with examples, explanations, anecdotes and activities to support the students' efficient learning. On the project platform, the ENGAGE partnership made available for the teachers a series of materials that can be used, adapted, in the framework of the Sciences lessons. The themes of those learning units are topical, of socio-scientific nature, meant to determine the students to get engaged into a real investigative approach. Out of them we can remind: *Eco-Phone, Zika, Man or machine, Extermination, Electronic cigarettes, Death to Diesel?, GM Decision, Ebola, Big bag ban, Text neck, Chocolate money, Solar roadways, Ban Cola?, Three parents, What does the fox says?* etc. (https://www.engagingscience.eu/ro/materials/).

The *Transform Stage* provides open projects which engage teachers and students in partnership with scientists, to learn more about Responsible Research and Innovation. In this context, the *ENGAGE team* of Valahia University Târgovişte elaborated and implemented a *Transform type unit*: *The City of the Future - The Temple of the Sun* (in Romanian: *Oraşul viitorului - Templul Soarelui*). In the framework of this project, the students are invited to embark on an imaginary voyage into the future, into the cities of the year 2050, approaching the most popular vision of smart cities based on energy sources with no polluting emissions and controllable using artificial intelligence elements, answering to the dilemma: "*How long are we still safe using conventional energy resources?*". Then they are invited to experiment by the means of the game of consequences, the energy models created for personal dwellings, like renewable energy source, in particular, the energy coming from the Sun.

3. Research Questions

In the respect of the considerations mentioned above, three questions come in-line with our purpose research: (a) Did the use of the ENGAGE materials help to motivate students to learn Science?; (b) Did the

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ENGAGE materials inspire teachers to develop new teaching strategies and design new teaching scenarios?; (c) Which professional competences of the teachers have been improved by participating in the ENGAGE project?

4. Purpose of the Study

By the present study, we have in view, as priority objectives, the identification and analysis of the opinions expressed by the Romanian Science teachers involved in the ENGAGE project, related to the following aspects: the quality of the ENGAGE materials, the impact of the use of those materials during the teaching activities, the effects of the use of those materials on the learning activities, benefits of the participation to this project on the level of the professional development. We appreciate that all those pieces of information constitute relevant resources for highlighting the added value that the ENGAGE project brings to the current educational practices regarding Science teaching and learning (Chemistry, Physics, Biology.

5. Research Methods

The investigation was realized on a sample of 30 teachers involved in the ENGAGE project (24 teachers from pre-university education and 6 members of the university teaching staff), on the occasion of the event entitled: *The ENGAGE Festival of Responsible Research and Innovation in Romania* (in Romanian: *Festivalul ENGAGE al Cercetării Responsabile și Inovării în România*), organized by Valahia University Targoviste, on the 3rd of March 2017.

The questionnaire administrated to the participating teachers was structured into a formula with items and provided answers based on a five-levels Likert scale, preconfigured as follows: *to a very great extent*, *to a great extent*, *to some extent*, *to a low extent* and *to a very low extent*.

6. Findings

The first two items of the questionnaire asked for the teachers' opinions concerning the extent to which the ENGAGE project had impact on them, in general, and especially on their teaching activities. In this context, the respondents appreciated that the use of the ENGAGE materials contributed to motivating the students to learn Sciences (figure 01). Thus, 60% of students appreciated that this has happened to a *very great extent*, 37% of them expressed to a *great extent*, and other 3% of them appreciated this to *some extent*.

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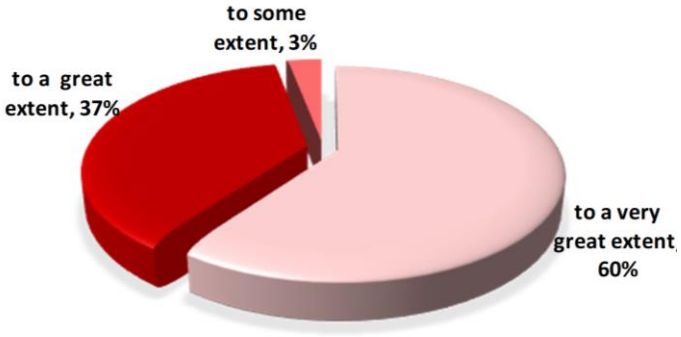

Figure 01. The teachers' opinion concerning the extent to which the use of ENGAGE materials helped to motivate students to learn Science

The second item aimed to identify the extent to which the ENGAGE materials inspired the teachers to develop new teaching strategies and to design innovative teaching scenarios (figure 02). In relation to this item, the respondents appreciate that this has been realized to a *very great extent* - 43 %, to a *great extent* - 53%, and to *some extent* - 4%.

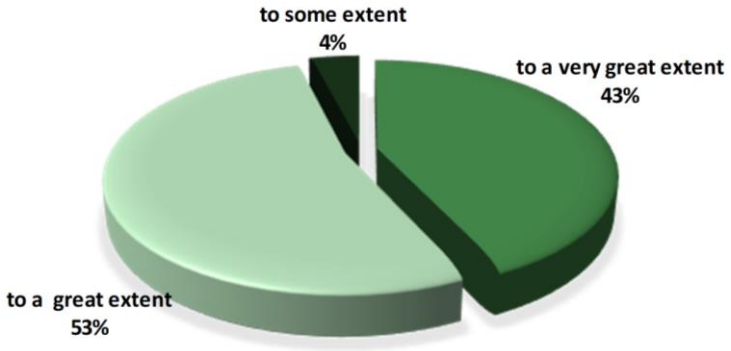

Figure 02. The respondents' answers concerning the extent to which ENGAGE materials inspired teachers to develop new teaching strategies and design new teaching scenarios

The following item aimed to offer the extent to which the participation in the ENGAGE project generated positive effects on the professional development of the participant members of the teaching staff, especially along the coordinate of the instrumental-applicative skills.

Thus, the teaching staff considered that the implication in the ENGAGE project (figure 03):

- has helped them to be aware of the implications of RRI in scientific education: to a *very great extent* - 73% and to a *great extent* - 27%;
- has helped them to understand better the needs of developing the students' investigative skills: to a *very great extent* - 70%, to a *great extent* - 27%, and to *some extent* - 3%;
- has improved the capacity of using discussion techniques during the lessons: to a *very great extent* - 70%, to a *great extent* - 27%, and to *some extent* - 3%;
- has improved their capacity of using argumentation in Sciences teaching: to a *very great extent* - 80%, and to a *great extent* - 20%;
- has helped them improve their knowledge and perception on the socio-scientific aspects: to a *very great extent* - 73%, and to a *great extent* - 27%;

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- has improved their capacity of making Science more relevant for the students' life: to a *very great extent* - 80%, and to a *great extent* - 20%.

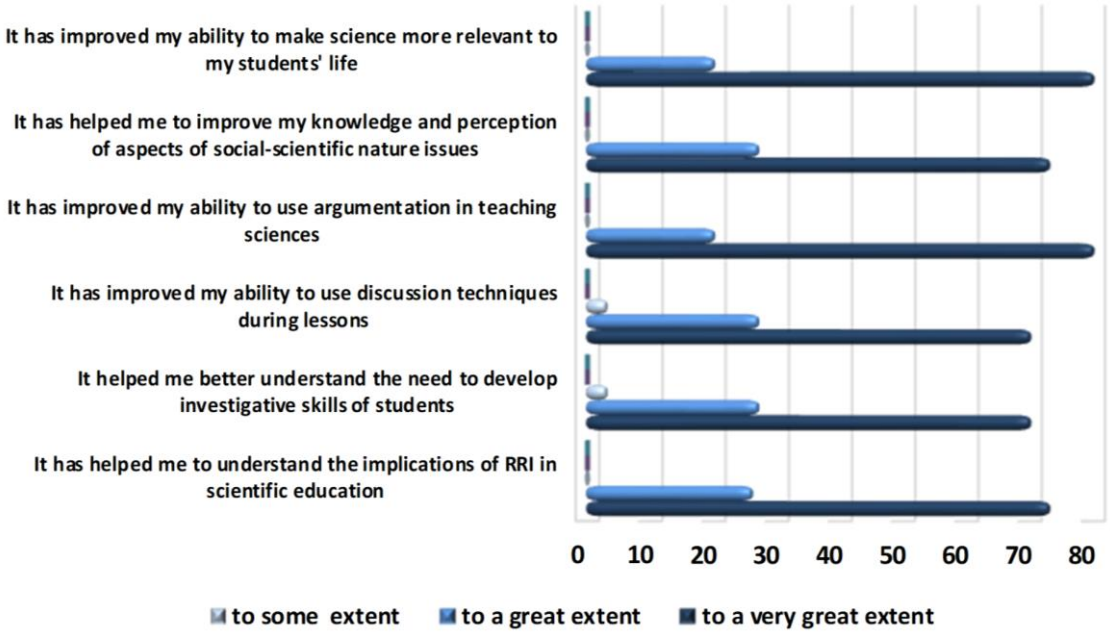

Figure 03. The impact of the *Engage* Project on the development of the teachers' professional skills

By applying the focus group method, we collected a series of pieces of supplementary information, which demonstrated the positive formative value felt by all the participants involved in the ENGAGE project (students or teachers). In this context, the teaching staff shared opinions related to the fact that through the use of those innovative teaching scenarios, inspired by the model of the ENGAGE lessons, the scientific disciplines have become more interesting for the students, the students beginning to seize the direct connections between the scientific problems and the problems of the daily life, being involved in the investigative approaches. At the same time, a part of the teachers emphasized that they have experienced a significantly higher professional satisfaction following the implementation in classrooms of the ENGAGE lessons.

7. Conclusion

As one can easily observe by analysing the figures above, most of the interviewees' answers are situated on the high side of the evaluation scale (to a *very great extent* and to a *great extent*), and very few in a median position (to *some extent*). None of the questionnaire items recorded answers on the low side of the evaluation scale (to a *low extent* or to a *very low extent*). That feed-back allows us to appreciate that the implementation of the ENGAGE project represents a successful educational experience, its success being reflected both in the quality of the teaching and learning, but also on the increasing of the students' interest and motivation for learning science.

Moreover, if we take into account the stages performed by the teachers during the ENGAGE project, on their professional development, and the significantly higher satisfaction of the teachers after the

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ENGAGE lessons are implemented in classrooms, we can say that this should normally lead to the inclusion of this type of strategies in their next activities and the use of similar materials designed by themselves.

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