THE INFLUENCE OF ENGAGE MATERIALS ON STUDENTS’ LEARNING ABOUT SOCIOScientific ISSUES

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Today’s society needs citizens who are familiar with the scientific way of thinking, and can use it in everyday life. Therefore, science education aims to engage students in socioscientific issues (SSI). In this study, two chemistry teachers used ENGAGE lesson material with 53 students to teach SSI. The study aims to investigate how successful the Engage materials are in engaging students in SSI, that is, connecting these with chemistry knowledge, personal life and society. De Groot’s Learner Report was used to gather the data, and these data were analyzed by qualitative content analysis, using Atlas.ti software. The findings indicate that the ENGAGE materials fostered students’ learning related to SSI, especially connecting chemistry concepts, society, and personal life through SSI. This study also revealed opportunities and challenges for teaching SSI in science lessons.

Keywords: socioscientific issues (SSI), curriculum materials, students’ learning

INTRODUCTION

Problem statement and theoretical framework

Science education has a crucial role in preparing future citizens to engage with personal and public science-based issues. Currently, science education does not only aim to educate future scientists but also whole student population who are scientifically literate. That means, they can make informed decisions regarding ill-structured, complex, dilemmatic social problems which deal with scientific issues, based on understanding of concepts, principles and the processes of science (DeBoer, 2000; European Commission, 2015).

Recent research in science education addresses scientific literacy, Responsible Research and Innovation (RRI), inquiry-based learning (Osborne & Dillon, 2008) and improving student cognitive abilities, i.e., scientific skills such as examining consequences, interrogating media, estimating risks, justifying opinions, and thinking ethically (Bayram-Jacobs, 2016). Today’s society needs citizens who are familiar with the scientific way of thinking, and can use it in their everyday lives. One powerful way to do this is incorporating socioscientific issues (SSI) in science education and to engage students in SSI (Driver, Newton, & Osborne, 2000; Millar & Osborne, 1998).

Socioscientific issues

Socioscientific issues (SSI) are defined as controversial, ill-structured problems which usually do not have a single solution. Through some innovations in science and technology, society is faced with dilemmas, which are related to political, economic, social and ethical aspects. Citizens need scientific reasoning to be able to make informed decisions about scientific or technologic innovations. Besides, SSI includes ethics and moral reasoning about the social problems which base on science (Zeidler, Sadler, Simmons & Howes, 2005). Dealing with SSI
means more than just using scientific and social knowledge. It requires applying scientific knowledge in a social context, and in everyday life to solve a controversial SSI problem (Sadler, Barab & Scott, 2007).

Many countries incorporated SSI into their science curricula to promote scientific literacy. By discussing SSI in science lessons, it is aimed to improve students’ inquiry skills and to make connections with society. SSI based instruction is accepted as an efficient way to support students’ science learning. There is evidence that SSI based instruction (e.g. genetic modification, climate change, hydraulic fracturing, etc.) motivates students for science learning, improves their inquiry skills and offers a context to combine science knowledge with social life (Ekborg, Ideland & Malmberg, 2009; Sadler, Barab & Scott, 2007). These real-life issues are not only meaningful but also engaging for students. By discussing SSI, making their own arguments, searching for evidences and weighing up the claims students gain required knowledge and skills to be responsive citizens. Consequently, they can participate in public debates, and can make informed decisions, which make them active and responsive citizens of the society (Fowler, Zeidler & Sadler, 2009; Lewis & Leach, 2006; Ratcliffe & Grace, 2003, Simonneaux & Simonneaux, 2009).

However, it is known that teachers have difficulties to embed SSI in science lessons, to focus on skills development, and to help their students in their learning process in SSI (Evagorou, 2011; Sadler, Barab & Scott, 2007). Limited teaching time, exam driven school goals and structure, and limited curriculum materials are just a few examples to mention. Researchers and teacher trainers have been trying to support teachers through different means such as professional development courses, workshops, curriculum materials, etc. Although there were some curriculum materials produced to foster SSI-based instruction, these materials are mostly sequential materials. Therefore, their enactment requires long lesson series. On the other hand, it is known that many teachers are not open for new practices because they require long time (Serdyukov, 2017). Therefore, in the ENGAGE project we designed SSI curriculum materials by considering teacher difficulties and time constrains.

The ENGAGE Project and ENGAGE SSI Materials

The ENGAGE project was granted by European Commission under the ‘science in society’ call. The Engage project aims equipping the next generation to participate in socioscientific issues (Bayram-Jacobs, 2015). To reach this aim, the project has several strategies including designing curriculum materials that focus on SSI for science teachers. Teachers can download these SSI curriculum materials, which are open educational resources, from the project’s website (www.engagingscience.eu) as a complete package including presentation (powerpoint), teacher guide and student sheets.

The materials were designed in a stepwise way in three categories. That means, there are three types of materials: topicals (for 1 lesson), sequences (for 2-3 lessons), and projects (for >3 lessons). In this way, we allow teachers to choose the material according to their need and time. For example, science teachers who do not have any experience in using SSI, can choose to use the topicals. In this way, they have time to learn about this new teaching practice, improve their knowledge and skills for teaching with SSI and reflect on their actions in practice.
In the materials, the 5E learning cycle (Bybee, 1997; Trowbridge, Bybee & Powell, 2000) was used as a pedagogical approach to introduce SSI to students. The material framework includes SSI goals, practices, strategies (Shwartz. & Sherborne, 2016) and the following US next generation science standards (NGSS, 2013): Content big ideas, RRI big ideas, Nature of science big ideas, and Scientific practices.

The SSI materials include controversial issues, ethical values, forming opinions, making choices, and so on (Ratcliffe & Gravies, 2003). For example, the material ‘Death to Diesel’ introduces the dilemma of ‘driving cheap versus environment-friendly’, and one of the activities involved role-playing, for example persuading car buyers to boycott diesel cars. In this way, it is expected from students to connect SSI with chemistry knowledge, personal life and society (like we presented it in Figure 1).

![Diagram of Chemistry concept, Society, and Personal life]

**Figure 1. Student learning areas through overarching SSI theme**

There are studies where teachers evaluated ENGAGE materials (Bayram-Jacobs & Henze, 2016; Okada & Bayram-Jacobs, 2016) that showed that the students liked the materials. Although there is evidence that SSI-based instruction motivates students for science learning, for the ENGAGE materials this has not been studied, yet. Therefore, it is necessary to investigate the influence of the ENGAGE materials on students’ learning related to SSI.

Given that curriculum materials should be "both effective and efficient" by helping teachers to deal with implementation problems (Davis and Krajcik, 2005), the materials that were used in this study were designed to facilitate the first step of 'classroom experimentation'. This is also based on the argument that using curriculum materials has an impact on specific teaching practices (Schneider & Krajcik, 2002). Although the materials are ready-to-use, teachers may adapt them according to level, interest and needs of their students.

**AIM**

This study aims to investigate how successful the ENGAGE materials are in engaging students in SSI, that is, connecting these with chemistry knowledge, personal life and society.

This general aim gives rise to the following specific research questions:

1. To what extent did students learn about SSI?
2. How far do students connect the SSI to chemistry concepts?
3. How far do students connect the SSI to their personal lives and society?