PRE-SERVICE TEACHERS AND SOCIO-SCIENTIFIC INQUIRY: OPPORTUNITIES AND CHALLENGES

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This paper presents the results of a teacher training program aiming to enable pre-service teachers to engage secondary education students in Socio-Scientific Inquiry-Based Learning (SSIBL). In SSIBL – an approach developed within the European project PARRISE – students formulate questions about socio-scientific issues and address these by integrating social and scientific inquiry. Socio-scientific inquiry stimulates students to form an opinion in which knowledge is balanced with social values and different stakeholder perspectives. In addition, students are asked to formulate solutions which help to enact change in a social environment. The developed teacher education program to promote teaching science using SSIBL, consisted of two 1,5 hour face-to-face training sessions and a take-home assignment to design a SSIBL lesson. A total number of 80 pre-service teachers (PSTs) from various science disciplines were involved. Qualitative methods were used to evaluate the SSIBL framework as interpreted by the PSTs and consisted of classroom observations, collection of lesson designs and a questionnaire. Results from the evaluation of the training program indicate PSTs experience the SSBL-approach as being promising in serving learning goals as critical thinking and reflective citizenship, which are considered to be important for contemporary science education. Additionally, PSTs regard the increased level of relevance of their subject for the students as a positive effect of SSIBL. Reported challenges include available time in the science curriculum and managing guidance and openness at the same time during the inquiry process.

Keywords: socioscientific issues, pre-service teacher education, values in science education

RATIONALE

Rapidly developing scientific and technological fields, like synthetic biology and artificial intelligence result in innovations that impact our daily lives now and in the future. These innovations often improve our wellbeing but go together with scientific uncertainties and social risks. Informed decisions about emerging socio-scientific issues (SSIs), requires balancing scientific knowledge with social values and stakeholder perspectives. Fostering this aspect of democratic citizenship is an important aim of science education both on the national (Bron, 2006) and European level (European Commission, 2015).

To address this need, the EU aims for responsible research and innovation (RRI) in society. The RRI-framework underpins the connection between scientific and technological innovations and social values and change (Owen, 2009). Within this framework, socio-scientific inquiry-based learning (SSIBL) fosters responsible research and innovation through science education, by connecting socio-scientific issues with inquiry based learning (IBL) and citizenship education (Levinson, 2016). SSIBL engages students in personally relevant inquiry on questions about controversial issues.

This study aims to develop a teacher training program that empowers science teachers to integrate SSIBL in their teaching practice. It features a training program in which pre-service teachers (PSTs) collaborate in designing and reflecting on SSIBL learning and teaching activities. The training program focused on three key points:

- How to raise meaningful and authentic student questions about SSIs
- How to integrate social and scientific inquiry to explore these open-ended questions
- How to stimulate student opinion-forming and formulate solutions which help to enact change

To evaluate the PST-training and develop SSIBL-pedagogy, we posed the following research question: *How do PSTs perceive the SSIBL-pedagogy, and what challenges and opportunities are foreseen for classroom practice?*

METHODS

Participants

The SSIBL-teacher training sessions featuring the key points mentioned above, were implemented in seven cohorts of pre-service teachers (PSTs) over the last two academic years. Four cohorts consisted of biology PSTs (n=11, n=12, n=5, n=16), one cohort were chemistry PSTs (n=9) and two cohorts comprised mixed groups of mathematics, chemistry, biology and physics PSTs (n=14, n=13). So, a total of 80 PSTs, 41 females and 39 males with an average age of 25,9 years were involved in this study.

SSIBL teacher training intervention

Trainings consisted of two 1,5 hour face-to-face meetings (in the context of the regular pre-service teacher course), and the development of a SSIBL-lesson in small groups. In the first session PSTs were introduced to multiple SSI-cases (or brought their own examples). They discussed the controversies, based on questions like: What is the case about? Which stakeholders are involved, which societal values are associated? What content knowledge is relevant? What questions does the issue raise that your students could investigate? After session one the PSTs received a take-home group assignment to design a SSIBL-lesson, which were presented in the second session (3 weeks later) and discussed by the whole group. The total time spent on the SSIBL training was approximately 5 hours.

Data collection and analysis

Qualitative methods were used to collect data from participating PSTs. Initial findings of the classroom observations during and video-recording of the teacher training sessions on SSIBL were cross-checked with interviews with the teacher trainers. To evaluate the SSIBL-framework as interpreted by the PSTs, their lesson designs were analysed based on the three key points. A questionnaire consisting of five open-questions was administered at the end of the SSIBL intervention, asking PSTs (n=80) how they value SSIBL and what opportunities and challenges they foresee in implementing SSIBL-activities in their classes. Answers to these questionnaires were categorised by means of the constant comparative method (Kolb, 2012), and frequencies of categories were determined.

RESULTS

The SSIBL-designs

Fifteen PST lesson designs were collected, eleven of which were explicitly linked to the Dutch curriculum. Controversial issues ranged from ‘health effects of sugar’ to ‘sustainability of biodegradable plastics’, and all could be fitted in the following categories: energy, health, food, genetic modification, biodiversity, global warming, and sustainable materials. In their designs, PSTs used classroom discussions, writing reports, presentations, and searching and checking validity of information as main teaching and learning activities. Raising authentic questions and decision making were present in all designs, and 9/15 designs included actions in their learning aims (e.g. writing an advisory report). However, integrating scientific and societal inquiry in the designs proved more difficult for some PST-groups. They mainly translated it in an inquiry to generate more factual knowledge about the topic to be able to check different claims by stakeholders.

Questionnaire

PSTs were asked how they valued the SSIBL-approach and what opportunities and challenges they foresaw. 73 of 80 PSTs thought positively about the SSIBL approach, and 67 regarded SSIBL of added value to their own teaching repertoire. PSTs having negative feelings towards SSIBL were mainly mathematicians, mentioning a lack of SSI related math topics in the curriculum as their main concern.

Regarding *opportunities*, PSTs appreciated the authentic context of SSIs and the added value of the approach for critical-thinking skills and reflective citizenship, which are considered important aims for contemporary science education. Additionally, PSTs valued making connections between their science subject and the everyday life world, making their subject practically and socially relevant to students, thus motivating them to learn. PST15: *SSIBL is important because it connects topics with 'the real world'. This answers the 'why should I learn this'-question. I like connecting school topics with contexts (teaching doesn't stop outside the classroom).*

Main *challenges* mentioned by the PSTs were the time consuming nature of both designing SSIBL activities and using SSIBL in classroom practice. Overflowing curricula were mentioned as possible challenges as well. Additionally, students found it difficult to simultaneously incorporate SSIs and IBSE in their lessons. PSTs also felt less competent in managing open and social inquiry. Providing guidance during inquiry, while at the same time ensuring openness of activities was particularly experienced as difficult.

PST54: A challenge with designing and using SSIBL lessons is that inquiry without guidance is not effective, but teacher guidance limits student autonomy'

CONCLUSION

Our results indicate that the training activities are promising in exploring the characteristics of SSIs in classroom practice. Moreover, they stimulated PSTs thinking about opportunities for social and ethical student inquiry into these topics. PSTs perceived the SSIBL-approach to be of added value to science education, since SSIBL draws on the authentic nature of socio-scientific controversies which motivates students to explore the dilemma and underlying concepts, and develop their own opinions. Implementing SSIBL in classroom practice is not self-evident, especially for mathematics education, and is experienced challenging in available time and teacher guidance for PSTs. Therefore, the training activities should focus more on practicing and scaffolding these kinds of inquiries.

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