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Citation for published version (APA):
Nielsen, J. A., & Evans, R. H. (2015). *Possibilities and limitations from a short methods course in socioscientific teaching*. Paper presented at NARST, Chicago, IL, United States.

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Possibilities and limitations from a short methods course in socioscientific teaching

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Subject and Problem:

Scholars and policy-makers widely share the conviction that science education needs to prepare students for making decisions on societal issues that relate to science (EU-Commision, 2004; Millar & Osborne, 1998). In the past decades there has been an increasing focus on supplementing science teaching with a focus on socioscientific issues – i.e. issues that are about what to do, not just what is true (Nielsen, 2011) – e.g. about whether to allow human gene therapy. In such contexts, teachers cannot just guide the learning of and assess the performance of their students in terms of whether they use science evidence or whether the claimed evidence is in fact true (Nielsen, 2013). Consequently, teaching socioscientific issues necessarily puts a demand on teachers to draw on knowledge stemming from other domains, e.g. the humanities (Simonneaux, 2011). This ought to call for pre-service teacher educators to focus on the pedagogical challenges of teaching socio-scientific issues (Forbes & Davis, 2008), but so far few countries have *systematically* made socio-scientific issues teaching a part of pre-service teacher education (PreSEES consortium, 2013a).

We implemented a three-step teaching module in which Danish pre-service upper secondary school teachers were taught about the unique pedagogical nature of socio-scientific issues and subsequently designed their own teaching units. This creative aspect of the module was scaffolded by iterative steps of microteaching to peers and teaching to upper secondary school students. The research question clarified by the present study was the following: *To what extent does a short indoctrination to, and application of, socio-scientific issues influence pre-service teachers' teaching practice concerning the facilitation and formative assessment of students' socio-scientific argumentation?* In other words, we sought to investigate how the pre-service teachers' facilitation and formative assessment of the learners' socioscientific argumentation occurred in both the microteaching session were the pre-service teachers tried out their teaching *as well as* in the implementation of their teaching in a real upper-secondary school class.

Design and Procedure:

The teacher education module for SSI instruction (See Evagorou et al., 2014) was implemented during a pre-service science teacher education course at a university in Denmark. Seven students participated over two weeks with a total of nine hours in class plus two hours at a local upper secondary school. The primary data comprises video- recordings and observations of the pre-service science teachers' microteaching in class (7x15 minutes) as well as audio-recordings and observations of the pre-service teachers' teaching in an

upper-secondary school class (6x15 minutes). In addition one pre-service teacher was followed in a case study approach five months after the teaching module as she taught an SSI topic to an upper-secondary school class. After her teaching the researchers collected her planning and teaching materials, students' evaluations and interviewed her. Thus the secondary data comprises various written and quantitative information and the recordings of a semi-structured interview with the case teacher. The primary data as well as the interview with the case teacher underwent a semantic deductive thematic analysis (Braun & Clarke, 2006) in order to identify the emergent themes in the data concerning the following interest points: (a) The strategies used by the pre-service teachers to facilitate learners' socioscientific argumentation, (b) formative assessment strategies used by the pre-service teachers to support higher quality argumentation, and (c) the manifest challenges that pre-service teachers meet when facilitating and formatively assessing learners' socioscientific argumentation.

Findings and Analysis:

In the microteaching session, all seven teachers successfully implemented teaching about a socioscientific issue in the sense of a contentious question that straddles the boundary between the scientific and the social/political realm of human life (question of what to do) that could not be reduced to factual questions (questions of what is true). For example two pre-service biology students addressed the issue of what northern Europeans can do to decrease the danger of rendering species in other areas of the world extinct. Even though questions of what is true (e.g. 'what is the ideal habitat of the condor?,' or 'which human activities threatens the habitat of the condor?') play a vital part in elucidating such an issue, in the end, the issue is about what to do, not just what is true. There was one strategy used by the pre-service teachers to facilitate learners' socioscientific argumentation that played a predominate role in the dataset. Simply put, the strategy amounts to first broaching a theme – e.g. the present possibilities to keep in check conditions that may have dietary origins (e.g. gastric bypasses for obesity and insulin shots for type-2 diabetes), which, second, leads to a factual discussion among the learners (e.g. the cost and side effects of gastric bypasses; and whether or not some persons are genetically disposed to obesity), which the teacher, third, disrupts, by raising a core SSI (e.g. "is it a societal responsibility [...] or is it the responsibility of the individual?") (Pre-service teacher C3, 38:43).) Such questions prompted learners to engage in practical argumentation about what to do rather than just what is true.

In one group, for example, three pre-service biology and one physical science education teacher taught for 15 minutes each about lifestyle choices – primarily concerning eating habits. Throughout, one teacher provided cues that often prompted learners to move from a factual discourse (e.g. about what dietary experts know) to a discourse that attempted to balance facts and values. In effect the teacher at multiple steps raised issues from the societal sphere such as "how far should [the government] go in order for people to take this dietary advice seriously?" (Pre-service teacher C3, 29:59).

Here then, the discussion about the factual issue among the learners helped to *structure* the

ensuing practical socioscientific discussion by being a forum for identifying and outlining *potentially pertinent* aspects of the overarching issue that later on should be subject for discussion. Such a way of structuring learners' socioscientific discussions has been proposed on the basis of deep analysis of the way in which students balance facts and values in discussions (Nielsen, 2011; Nielsen, 2012a; Nielsen, 2012b; Nielsen, 2013).

In the implementation of socioscientific teaching in an upper-secondary school class, the relative lack of formative assessment of the learners' argumentation was highly evident. Her overall reflection was that she found implementing a socioscientific issues lesson was really worth all the effort. This was confirmed for her while reading the student feedback. She noted that 'small modules on how to teach socioscientific issues are valuable because you can see how it is done and then you have an example and can see it can be taught like this, so then you can continue with SSI.' However, she also noted that the students were not very good at constructing arguments and that she was not able to facilitate that with the tools she acquired when working with the modules and in just one 90 minute lesson.

Contribution to the teaching and learning of science:

This investigation into the influence of a short indoctrination into socioscientific issues teaching, shows that some but not all targeted tenets of such teaching was facilitated. Pre-service students were able to fashion basic lessons which successfully engaged participants through some of the unique pedagogical aspects of teaching socioscientific issues like ethical evaluation and moral reasoning. However they were less able to facilitate successful argumentation events. The increase in expressed self-confidence about teaching socioscientific issues and demonstrated willingness to do so, shows that a relatively short induction may provide pre-service teachers with the necessary self-efficacy to develop and begin to use issues teaching in their own classrooms. The apparent insufficient instruction and experience for teaching argumentation may indicate that such advanced pedagogical methods need more opportunities to encounter, assimilate and practice them. Similarly, the most common methods for formative assessment such as peer to peer feedback and teacher questioning, used by these teachers were fairly easily implemented. However methods demanding more expertise and experience such as argumentation concept map diagrams and exercises where students practice levels of issues discussion were not used.

Contribution to the interests of NARST members:

Given the already large curricula of many science methods courses, knowing what aspects of teaching socioscientific issues can be readily assimilated by pre-service teachers in short lessons such as these, can help science teacher educators make judicious use of their time. Since this study's curriculum modules were tested with pre-service science teachers in a teaching methods course, the setting can be generalized to many teacher education settings. Our students experienced learning about a socioscientific issue in a model lesson and then created their own lessons which they then tested through microteaching with formative peer feedback. They learned through experience and feedback how to use basic methods of

teaching and formative assessment and were made aware of the potential to develop more advanced methods.

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