Chapter 2
Teachers and Socioscientific Issues – An Overview of Recent Empirical Research

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2.1 Introduction

Teachers play a central role in determining the uptake and quality of socioscientific (SSI)[1] teaching – i.e., science teaching in which students are engaged with socioscientific issues (Forbes and Davis 2008; Zeidler et al. 2005). From much of the 'early' research (pre-2010) on SSI, in general, and on SSI-teaching, in particular, we get the sense that science teachers face many challenges. For example, SSIs and their pedagogical potentials in science teaching seem somewhat alien to teachers (Lazarowitz and Bloch 2005; Lee et al. 2006); the lack of time to adapt to a fundamentally new practice and the lack of materials may be a key challenge to the uptake of SSI-teaching (Sadler et al. 2006); and, last but not least, SSI-teaching may require a pedagogical repertoire most often only held by non-science teachers (Simonneaux and Simonneaux 2009). To be sure, full-fledged SSI-teaching will inevitably involve guiding students' argumentation or decision-making processes (Nielsen 2009) while they weave together and weigh incommensurate factors – such as information coming not just from the natural sciences (Nielsen 2010).

This chapter explores the most recent empirical (2016–) research on pre- and in-service teachers' approaches to, or thinking about, teaching SSI, and presents some of the main trajectories in the findings. The reported research was identified through searches for the string OR ('socioscientific issues', 'socio-scientific issues', 'SSI', 'societal issues') in the Web of Science and ERIC databases. Only peer-reviewed journal articles or book chapters were included and only publications that

[1] I will use the standard abbreviations, 'SSI' for socioscientific issues and 'SSI-teaching' for socio-scientific teaching'

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reported on *empirical* investigations of (pre-service) teachers in relation to SSI. This ruled out publications that reports on students in relation to SSI and how teachers and researchers co-design SSI-units.

While the process was indeed done systematically, the aim of this chapter is not to be a systematic review of the literature on (pre-service) science teachers and SSI. Indeed, the chapter aims at providing a backdrop for the rest of this book. In recent publications – such as the ones by Tidemand and Nielsen (2017) and Evagorou and Puig (2017) – one can get a general overview of the pre-2016 literature on the topic (bear in mind that by far the most literature on SSI reports on investigations about students, and not teachers).

2.2 Pre-service Science Teacher' Relations to SSI

There is a growing body of research on SSI and pre-service science teachers (PSTs). Much of the literature focuses on the delivery and/or impact of special workshops or programmes on SSI teaching that are woven into an existing teacher education courses – often in the frame of a (research) project (see, for example, Evagorou and Puig 2017; Kilinc et al. 2017a, b). Of course, the fact that competence development in terms of SSI teaching is often an addendum to existing teacher education is not just a feature of the most recent research (see, for example, Evagorou et al. 2014b).

So there seems to be a clear sense among teacher educators that learning to teach SSI-based activities is not necessarily something that comes naturally. Indeed, Genel and Topcu (2016) recently went against the main research design trend and elected to study Turkish PSTs as they went into practice *without* furnishing them with special workshops or programmes in order to simply investigate how equipped 'normal' PSTs were for teaching SSI in the classroom. Unsurprisingly the conclusions of Genel and Topcu were not positive: 'Almost all aspects of SSI-based instruction we covered in the study confirmed that PSTs' understanding, and practices of SSI are not adequate' (2016, p. 116). My hypothesis is that similar studies in many other countries and cultures would generate similar findings.

As an aside, it is worth mentioning that a significant portion of the recent research on PST and SSI is situated in Turkey (Cebesoy and Oztekin 2016; Cinici 2016; Es et al. 2016; Genel and Topcu 2016; Kilinc et al. 2017a, b; Kutluca and Aydin 2017; Ozturk 2017; Ozturk and Yilmaz-Tuzun 2017; Ural Keles and Aydin 2017; Yapicioglu and Kaptan 2017). The fact that Turkish scholars are so prolific in this area can, in part, be traced back to a curriculum reform that focusses on SSI, but which has not been adequately substantiated on the level of teacher education (Genel and Topcu 2016). Many of these studies, not just the ones from Turkey, end with a plea for a more focused introduction to SSI during science teachers' education.

Now, it seems that SSI needs to be addressed at the level of teacher education. But how? Some recent research indicates that both shorter workshop sessions or training programmes about SSI for pre-service science teachers have positive immediate effects, but often limited effects on the PSTs ensuing practice. For exam-

ple, when working with 20 PSTs, Evagorou and Puig (2017) found that while a programme on SSI teaching had an immediate impact on the degree to which the PSTs were able to identify societal aspects of science and science related issues, the PSTs did not manage to make the societal aspects operational in their ensuing teaching (see also Evagorou et al. 2014a). Similarly, Kilinc et al. (2017a) conducted a longitudinal in-depth single case study in order to identify how and why a PST can change her beliefs about dialogic teaching about SSI. They found that while training workshops that focus on dialogic argumentation in teaching can positively influence a pre-service teacher's valuing of dialogic teaching, the ensuing teaching experiences, to some effect, revered this positive change. In a study of PSTs' informal reasoning about a given SSI, Ozturk and Yilmaz-Tuzun (2017) found that while the participating PSTs seemed to have enough topic specific knowledge to understand the science aspects of SSI, the PSTs were not immediately able to mobilise this knowledge in their own informal reasoning and decision-making.

There seems to be a connection between PSTs' epistemological beliefs, on the one hand, and their own engagement with, or thinking about, SSI, on the other. For example, N. Ozturk and Yilmaz-Tuzun (2017) documented that PSTs' epistemological beliefs seemed to correlate with their ability to engage in informal reasoning concerning SSI – coarsely put, PSTs who believe that scientific knowledge is certain are less inclined to present counter arguments in their informal reasoning. Interestingly, when querying PSTs about their beliefs about the teacher's role in SSI teaching, Kilinc et al. (2017b), found a paradox: while most respondents identified teacher roles that afford dialogic SSI teaching, many of those held an *absolutist* epistemology of science knowledge – that is, that 'knowledge is certain and is given by authorities' (p. 197) – which the authors argue in practice would favour a monologic teaching practice. This study then indicates that while being positive when *talking* about SSI, other factors such as beliefs may influence practices in a way that undermines full-fledged SSI-teaching.

The general findings from these recent studies are less than uplifting. To my mind, the field of science education is still on the search for a viable way to place an emphasis on SSI-teaching in teacher education programmes in a way that really enables teachers to bring SSI into their future classrooms. In particular, it seems to be an open question whether the main factor behind these less-than-ideal findings is the (lack of) status of SSI-teaching in teacher education programmes – recall that in all the above cases, SSI-aspects were auxiliary and more or less added into an existing teacher education programme.

2.3 Science Teachers' Relations to, and Experiences with, SSI

A general theme in the research on in-service teachers' approaches to, or thinking about, SSI-teaching concerns teachers' assessment practices in relation to SSI-activities. For example, when Steffen and Hossle (2017) investigated German biol-

ogy teachers' reflections on how to assess students' SSI decision-making abilities, they found that while the teachers embraced SSI decision-making as being very relevant, recognised that high quality formative assessment is central in learning processes and were clearly aware of potential student abilities pertinent to SSI decision-making, the teachers deferred from focusing on these abilities. Instead they focused on students' mastery of biological content. This finding resonates with those of Tidemand and Nielsen (2017) that while SSI is an explicit part of the Danish biology curriculum in upper secondary school, biology teachers cannot really be said to assess students' SSI abilities in class or in oral examinations. Similarly, Christenson et al. (2017) found that Swedish science teachers avoid assessing anything more than students' mastery of disciplinary content when assessing students in SSI-teaching. So, while SSI-aspects are woven into the curricula in countries such as Germany, Denmark and Sweden, the relevant assessment criteria are most often not integrated in classroom assessment practices. This, of course, is a major obstacle for the uptake of SSI-activities. As we know, assessment is a key determinant for what and how teachers focus their teaching on (Harlen 2007).

The apparent avoidance of SSI-related assessment criteria in classroom assessment may have several different but interrelated causes. The teachers in the abovementioned study by Steffen and Hossle (2017), referred to a 'lack of assessment criteria' (p. 47) and they placed greater value on the 'usual assessment criteria' (p. 48) – leading the authors to suggest that the position taken by the teachers may be due to the fact that SSI-teaching had not yet been integrated into the German school practice. Other studies, such as the one by Christenson et al. (2017) and the one by Tidemand and Nielsen (2017), indicate that science teachers may simply not have enough experience in focusing on the SSI-relevant assessment criteria. Future research might investigate whether teachers are poised to exclude SSI-related assessment criteria because they are unfamiliar with assessing along such criteria or because they simply feel that such criteria are only marginally important.

Christenson et al. (2017) seized on the notion that teachers from other subjects may be more experienced with certain elements of SSI-teaching by comparing how science teachers and Swedish language teachers approached issues concerning the assessment of students in SSI-teaching. Their analysis indicates that both science and Swedish language teachers focused on students' mastery of disciplinary content, but that the Swedish language teachers *also* 'included students' abilities to use content knowledge by selecting and citing references, the structure of the argumentation, and, in addition, language' (p. 1416). Neither the science teachers nor the Swedish language teachers included students' ability to engage in considerations about the foundation of ethical principles. Based on their findings, Christenson et al. (2017) argue that science teachers may benefit in the long term from interdisciplinary collaboration with language teachers – but they also stated that this may be too time-consuming and that everything hinges on whether science teachers are able to accept that the radius of their discipline expands to include SSI.

Pitiporntapin and Srisakuna (2017) conducted a study of the development of three Thai science teachers – with no SSI-teaching experience – over a semester in a TPD programme on SSI-teaching. While they found that the teachers positively developed their SSI-teaching, the study highlighted the fundamental need of local support structures for sustaining SSI-teaching. Indeed, Pitiporntapin and Srisakuna (2017) found that while the teachers wanted to change their practice they were – as relative novices (in terms of SSI-teaching) – challenged by the fact that there was no one with more experience on SSI-teaching among their colleagues.

Leden et al. (2017) followed a group of science teachers over 3 years in order to, among other things, investigate changes in teachers' identification of issues (hereunder SSIs) for teaching and opportunities and challenges related to the teaching of these issues. The main intervention in the study consisted of 12 group discussions that were distributed over the 3 years and that were thematically focused on aspects of the nature of science. Leden et al. (2017) found that over time the science teachers notably became better at identifying potential issues for teaching, that the issues they identified went from being dominantly imprecise and general to being dominantly aligned with SSI-teaching, and that the teachers found more and more opportunities and benefits related to teaching such issues – such as 'as increased engagement and the development of critical thinking and reflexivity' on the side of the students (p. 500). Thus the study of Leden et al. (2017) suggests that it may be a good investment to take time out to allow teachers to collaboratively negotiate the meaning of, and reflect on their own practical experiences with, a SSI as a new teaching approach.

Leden et al.'s (2017) findings resonate with the findings in the study of Tidemand and Nielsen (2017), that without specific training in aspects concerning SSI teaching, Danish upper secondary biology teachers tend to elicit very general and imprecise issues as examples of SSI. Indeed, in the study by Tidemand and Nielsen (2017) the teachers interviewed tended to see *all* biology teaching as SSI because all biology content is *potentially* relevant to something in society. In the study by Tidemand and Nielsen (2017), this narrative may be seen as legitimising a content-centred approach to SSI-teaching, the origins of which can be traced back to a curriculum that, on the one hand, includes SSI-laden aspects and, on the other, focuses heavily on the student being able to exhibit knowledge about core biological content.

More prominent were Sund's (2016) findings from interviewing 29 science teachers from Swedish upper-secondary schools about what they value in and about science teaching. He found that 12 out of the 29 had closest affinity with a teaching tradition according to which 'the relation between facts and values is important and teachers offer situations in which students can develop abilities to use their knowledge in daily life and also at a societal level' (p. 401). Sund's (2016) refreshing study suggest that the outlook for the Swedish curriculum reform (which, in part, focuses on SSI) is less bleak than suggested by most other research studies internationally.

2.4 Conclusions

One of the key threads in the most recent research on pre- and inservice teachers' relation to SSI is the need for facilitating processes in which teachers (perhaps with guidance by trainers and/or researchers) work to make SSI-related learning objectives *operational* for assessment and teaching (Nielsen et al. 2018). The lack of a clearly operationalised notion of SSI is a specific episode of the general problem that generic or cross-curricular learning goals are often ill-defined and not sufficiently operationalised (Belova et al. 2017; Dolin et al. 2017; Nielsen and Dolin 2016).

Further, attempts to add SSI-elements onto existing teacher education curricula has had mixed results on teachers' views and competences. In so far as it is a political aim that future students develop their SSI decision-making abilities, it might be supported by a move to substantially integrate SSI aspects into teacher education programmes. But it is not yet clear what is needed in order to enable teachers to bring SSI into their future classrooms.

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