Chapter 12
New Perspectives for Addressing Socioscientific Issues in Teacher Education

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12.1 Introduction

The purpose of this book was to bring together international researchers working on teacher professional development, with an emphasis on SSI, to share their work. We are proud to see the truly international and multifarious character of the preceding 11 chapters. As such, the chapters reflect just how diverse the international landscape of science teaching, in general, and of SSI teaching, in particular. We want to use this final chapter to connect some of the larger threads that seem to run across multiple chapters. We identify three main emergent themes:

- Teachers' (and student teachers') backgrounds and beliefs are often deciding factors in the uptake and quality of SSI teaching,
- SSI teaching is often not the sole "new" pedagogical principle that is being implemented – e.g. SSI will often be combined with inquiry – and that has benefits and challenges,
- (Long-term) professional development or training of student teachers is needed in order to facility the uptake and quality of SSI teaching.

After presenting these themes through the findings of the individual chapters, we identify gaps in knowledge that still need to be covered even after this volume.

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12.2 Teachers' Background and Beliefs

The first emergent theme from the contributions in this volume relates to how the background of teachers and student teachers – in terms of their knowledge, skills and attitudes – mediates the implementation of SSI-teaching. In Chap. 3, Leung et al. (2020) present an intricate connectedness of the beliefs about and priority of SSI and a range of other components of the curriculum in Hong Kong. In particular, they found that the reason that some pre-service teachers seem to devalue SSI teaching is a type of (mistaken) belief about how content knowledge, nature of science can relate to SSI – namely that the only relation between the three components is that SSI is a vehicle for teaching the other two. This resonates with the findings about in-service teachers by Tidemand and Nielsen (2017) that SSI is often reduced to an instrument for teaching other parts of the curriculum – most notably content knowledge.

In Chap. 10, Garrido Espeja and Couso (2020) found that, for pre-service teachers, the most challenging aspect about teaching SSI activities was to include the scientific information in a way that facilitated cogent argumentation among students. Indeed, the student teachers involved in Garrido Espeja and Couso's study tended initially to transmit specific information as established truth rather than facilitating that students could dialogically and argumentatively develop their view on the SSI. Further, they found that the participating student teachers had significant difficulties coordinating students' discussions (such difficulties seem to face in-service teachers as well; see e.g. Bryce and Gray 2004). Garrido Espeja and Couso relate these challenges to the teacher students' lack of pedagogical content knowledge as well as the lack of mastery of the scientific content. Interestingly Garrido Espeja and Couso's study also shows that the involved teacher students under careful guidance and scaffolding by teacher educators (the researchers) were able to change this practice and find more cogent ways to include scientific content.

As discussed in Chap. 2, Nielsen (2020), much research on pre-service teachers document that the development of the competence to cogently include socioscientific issues in one's teaching needs to be facilitated systematically (see also Evagorou et al. 2014b). All things being equal, becoming educated as a science teacher does not necessarily entail that one becomes competent to teach socioscientific issues.

12.3 The Embeddedness of SSI-Teaching

The second emergent theme from the chapters in this book pertains to the way SSI-teaching is often embedded in a wider teaching context with a particular pedagogical approach that often will differ from what students and/or teachers are used to. It is a well-known straw man fallacy to state that there is something called *traditional teaching* and that a particular *new* pedagogical approach differs significantly from the traditional approach. That being said, letting students discuss and make own decisions on contentious societal issues *is* different from all variations of teacher-centered teaching (we are *not* saying that the latter is the norm in all classrooms).

Coarsely put, we can expect that in many classrooms, the introduction of socioscientific issues in the science classroom will mark a palpable change in pedagogy (indeed it is well established that the introduction of socioscientific issues is rarely the norm in science teacher practices (see e.g. Lee and Witz 2009). Indeed, full-fledged SSI-teaching will inevitably involve a role in which the teacher guides students' argumentation or decision-making processes (Nielsen 2009) in which the students balance multifarious information and values coming not just from the natural sciences (Nielsen 2010).

The change in practice or difference from the (local) norm that SSI-teaching imposes is often accentuated because the introduction of socioscientific issues often occurs within the context of a wider teaching context that in itself also differs from the (local) norm. This is evident in the contributions by Amos et al. (2020), Friedrichsen et al. (2020) and Davis and Bellocchi (2020) and Mudaly (2020). Amos et al. (2020) outline an educational model to support Socioscientific Inquiry Based Learning (SSIBL) in conjunction with Citizenship Education (CE) – a model which was developed through the European project PARRISE. Here the socioscientific issues primarily serve as relevant scenarios that raise questions prompting an investigation.

12.4 The Necessity of Long-Term Professional Development

The third emergent theme from the chapters in this book pertains to the need for professional development of teachers. Several chapters in this book explicitly proceed from the vantage point that (long term) professional development of teachers is necessary in order to secure the uptake and quality of SSI teaching.

In Chap. 6, Friedrichsen et al. (2020), explore the possibilities of a collaborative professional development setup in which teachers co-design and implement SSI activities. Their work indicates that much can be gained from the process of collaborating on designing SSI-teaching, and that having multiple teachers from the same school participate holds many benefits. In Chap. 8, Cohen et al. (2020), discuss the benefits of having upper secondary school teachers participate in a professional development program that focusses on implementing inquiry-based SSI teaching (SSIBL). Their case study indicates that there is a professional progression or taxonomy, according to which teachers will first have to learn to teach SSI and then progress to learn to teach SSIBL. They further discuss the difficulty with implementing SSIBL in an educational system that does not fully formally legitimize this approach. Having available teaching materials, such as the ones developed for this program, may be a key in increasing the uptake of SSIBL teaching. In Chap. 9, Furman et al. (2020) present a long-term professional development program for in-service Argentinian teachers to support them in implementing SSI in their teaching. Their findings suggest that a long-term program can benefit from developing teachers' competences in a stepwise fashion – starting with implementing teaching activities designed by others and progressing to increasingly co-develop the activities.

The aspect that seems to emerge again and again is that SSI is rarely not included in the curricula; and that even if it is included it is not clear for the teachers how to teach and how to evaluate it (for an overview see Tidemand and Nielsen 2017).

12.5 The Future of Socioscientific Issues in Teacher Education

As the international science education community increasingly turn to the terminology of *competences* (see Ropohl et al. 2018; Rönnebeck et al. 2018), the learning goals associated with SSI teaching are obvious candidates for key competences that flesh out a Vision II (or even Vision III; see Sjöström and Eilks 2017) of scientific literacy. It seems that the community would benefit from a comprehensive overview of what skills and knowledge areas such competences are comprised of in order to establish a roadmap for potential learning goals in the realm of SSI teaching.

The use of the specific models in training, models that will include SSI competences, may help teachers to develop a stronger pedagogical base to support their teaching and learning about SSI. Until now, very few models of SSI professional development are supported by empirical data, and a contribution of this book is that we present different models from different contexts all supported by data and providing a detailed presentation of the PD context. Furthermore, the question of whether long term professional development with in class support (e.g. Bencze et al. 2020; Garrido Espeja and Couso 2020; Friedrichsen et al. 2020) has better outcomes than short term PD (Bayram-Jacobs et al. 2019) still remains. Teacher ownership and co-creation of materials (Friedrichsen et al. 2020; Garrido Espeja and Couso 2020) seems to play a positive role on how teachers uptake SSI teaching, even though some studies offer contrasting evidence (Bayram-Jacobs et al. 2019).

A notable gap in knowledge that this book has unfortunately not covered pertains to the lack of knowledge about assessment of or for student learning in SSI-teaching. Science teachers avoid assessing students' competences related to SSI – expecting that this is done in other disciplines (e.g. Steffen and Hößle 2016). They also tend to devalue SSI-relevant assessment criteria (e.g. Steffen and Hößle 2016) and they instead tend to focus on the science disciplinary content when assessing students (Christenson et al. 2017; Tidemand and Nielsen 2017). A number of authors (Ekborg et al. 2013; Evagorou et al. 2014a; Christenson et al. 2017) have started to focus on assessment of student learning in SSI-teaching, but have also generally argued that there is a significant gap in knowledge about viable assessment practices in this regard (Tidemand and Nielsen 2017). The existence of appropriate student assessment practices is a key factor in determining the uptake of concrete pedagogical approaches by teachers (Harlen 2013). This means that the uptake of SSI teaching is directly challenged by the lack of assessment practices vis à vis SSI teaching.

The chapters in this book are not different from the norm in science education research. Only one chapter of this book – Chap. 10, by Garrido Espeja and Couso (2020) – includes a focus on (formative) assessment in the design of SSI activities

by pre-service teachers. But none of the chapters explore more deeply how student learning in SSI teaching can be assessed (formatively or summatively). Future research is needed to develop knowledge of how the complex learning goals associated with SSI teaching can be made *operational* (Nielsen et al. 2018) for assessment (see also Nielsen and Dolin 2016; Dolin et al. 2017).

Concluding this chapter, we believe that the book has helped in presenting current trends and successful practices in SSI teacher professional development. However, three questions still remain to be answered by the international research community: What are good ways to weave learning to teach SSI into traditional teacher education? What changes are needed to move SSI-research into providing more conclusive findings? What changes in policy and assessment are needed in order to support the uptake of full-fledged SSI-teaching?

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