Chapter 3
Prioritizing Emotion Objects: Toward a Better Understanding of Preservice Science Teachers' Growth in the Learning and Teaching of Socioscientific Issues

Jessica S. C. Leung and Maurice M. W. Cheng

Abstract   Learning of socioscientific issues (SSI) in the first place, making decisions to teach SSI, and deciding how to teach are affective as much as they are cognitive. The literature has identified positive and negative emotions when teachers decide whether and how to teach SSI. Yet, there is no discernable pattern regarding the association between their emotions and their intention to teach SSI. This chapter suggests that emotion objects of preservice science teachers (PSTs) (i.e., what their emotions are about) when they were learning to teach SSI revealed to us such a commitment (or a lack of it). Our cross-case analysis revealed that during their 12 weeks of learning, PSTs who developed a stronger and more sophisticated belief towards SSI teaching demonstrated more specific and diverse emotion objects. For example, they expressed emotions about their own competence to teach, student's learning outcomes, teaching strategies, and political contexts of their teaching, etc. These compared with the PST with less sophisticated belief who had rather generic and all-embracing emotion objects (i.e., "teaching"). We suggest that identifying emotion objects can better help teacher educators to understand the learning of PSTs and are pieces of information that help us to adjust our on-going teacher education.

Keywords Emotion · Preservice science teachers · Socioscientific Issues ·
Intended belief of teaching · Multiple case study

J. S. C. Leung (✉)
Faculty of Education, University of Hong Kong, Pok Fu Lam, Hong Kong
e-mail: leungscj@hku.hk

M. M. W. Cheng
Division of Education, Te Kura Toi Tangata School of Education, University of Waikato, Hamilton, New Zealand
e-mail: maurice.cheng@waikato.ac.nz

3.1   Introduction

"Traditionally, science education has dealt with established and secure knowledge, while contested knowledge, multiple solutions, controversy and ethics have been excluded" (Hodson, 2003, p. 664). It follows that many science teachers see their main task as teaching canonical science, i.e., an emphasis on scientific laws, theories, facts, and principles. It is often emotionally charged for science teachers to make the decision to teach socioscientific issues (SSI) in their science classes—an approach that is remarkably different from the teaching of canonical science for its consideration of the ethical dimensions of science, the moral reasoning, and the emotional development of their students (Zeidler et al., 2002). Although there is a consensus in the literature that teaching beliefs and behaviors are inseparable from emotions, this affective aspect is yet to be explored in teacher education for SSI.

The literature has identified a variety of emotions when teachers consider teaching SSI. In a study of 120 preservice biology teachers (Büssing et al., 2019), the participants held positive emotions about teaching the topic of returning wolves, with enjoyment more frequently reported than fear and anger. The anticipated enjoyment and anger correlated positively and negatively with the desires to teach the topic, respectively. In another study examining 45 preservice elementary and 40 in-service secondary science teachers' emotions about climate change revealed that teachers' anger about climate change and teaching the topic was linked to their perception of climate change as less valid, thereby suggesting the potential for less engagement with the topic (Lombardi & Sinatra, 2013). These findings suggested that positive emotions were more conducive to teaching SSI than negative emotions.

Some studies suggested that negative emotions also contributed to the framing of teaching SSI. In a study involving 30 preservice elementary teachers in a science course, the participants expressed fear, anger, guilt, helplessness, and frustration about the impacts, lack of action, and causes of climate change (Hufnagel, 2015). Hufnagel (2015) argued that these negative emotions were indicative of personal engagement with climate change and PSTs' deeper emotional engagement with the impacts of others, compared to that of human, may influence the framing of their teaching about climate change. This suggested the potential role of negative emotions in promoting PSTs' engagement with climate change and its teaching.

Emotions are at the heart of teaching (Hargreaves, 1998). These studies focused on reporting the valence of teacher emotions (i.e., being positive or negative) and the way that these emotions co-exist with the willingness to use SSI as an approach of their science teaching. Emotions can be described as internal states within an individual *about* something (Deonna & Teroni, 2012). That "something" is called emotion objects, i.e., the specific referents to which emotions are directed. When we examined these studies, we observed that the emotion objects were often about teaching in a rather general sense (Büssing et al., 2019; Hufnagel, 2015; Lombardi & Sinatra, 2013). In view of the mixed findings of PST emotions about teaching discussed above, it would be useful to conceive teaching as a complex activity that is contextualized in a particular sociocultural environment which involves a broad range of

emotion objects. They include national and school curriculums, specific topics/issues under discussion, school and parent expectations, student responses, pedagogical approaches, prior teaching-related experience, the broader sociocultural contexts, and more. Expertise is often manifested in teachers' capability to attend to these factors in their teaching and planning. In order to better understand PST growth and intention to teach SSI, it is essential to be specific about their emotion objects (a.k.a. aboutness).

Contextualized within an initial science teacher education course, this study was set out to examine PSTs' emotions as learners of SSI teaching and as teachers of SSI. Through identifying their emotion objects, we would be able to see what they do and do not attend to and engage in. In fact, we found that PST emotion objects during their learning to teach SSI are related to their growth of teaching SSI, for example, in terms of their confidence and intention to teaching SSI. This chapter reports such a relationship. Also, their emotions about these emotion objects would inform us of the support and course design that PST would need.

3.2 Method

3.2.1 Research Design

This study adopted a multiple case study approach to investigate and compare the emotional expressions of three PSTs during a 12-week science teacher education course (after Yin, 2009). We selected three PSTs who collectively demonstrated varied beliefs about teaching SSI upon course completion. In this way, we are able to identify emotions and their aboutness that associated with different beliefs about teaching SSI.

3.2.2 Context of the Study

School science curriculums in Hong Kong have mentioned science-technology-society-environment (STSE) since 1998 (CDC, 1998). Recent development, however, did not include SSI explicitly (CDC, 2017). We are of the view that SSI is unique in the sense that it contextualizes science learning in ethical dilemmas of the broader society, which is remarkably different from teaching canonical science. Therefore, we envision it is important to support PSTs to develop capabilities in the SSI approach of curriculum planning and teaching (Cheng & Leung, 2022).

The study was contextualized in a compulsory course titled "Nature of Science and Socioscientific Issues" as a part of the five-year science teacher education program. The PSTs enrolled in the course were in the final year of their studies. The course adopted a reflection orientation (Abell & Bryan, 1997) to foster the learning of the

PSTs through reflection from both a learner's perspective and a teacher's perspective. Students were prompted to reflect on components essential for critical engagement with SSI, including nature of science and nature of media (learner perspective). Also, they were asked to reflect on features of SSI, various instructional approaches, and assessment methods of SSI (teacher perspective) (see also Leung et al., 2020). The course ended with a culminating activity of group presentation on their design of an SSI teaching package (see Table 3.1). The course design was shown to shape PSTs' beliefs about teaching SSI by engaging PSTs to reflect on the *why* (e.g., manipulation of readers' thought by news media in Week 6, goals of science education and curriculum designs to achieve these goals in the Week-12 culminating activity), *what* (e.g., limitations of over-reliance on hardcore science and the need to consider dimensions beyond hardcore science to inform judgements on SSI in Weeks 2, 5, and 6), and *how* (e.g., analyzing authentic video footage featuring students learning about SSI in weeks 8 and 9 and choosing SSI topics for teaching through understanding the nature of SSI in Week 5) of teaching SSI (Leung, 2021). This study was conducted in alignment with the Human Research Ethics Committee of the University.

Due to the Covid-19 pandemic, the course was conducted through synchronous online learning, which offered a classroom environment with limited capacity to express one's and perceive others' facial communication (Wang & Reeves, 2007). To maximize social interactions through verbal and non-verbal cues in the virtual classroom, participants were encouraged to turn on their camera and to share their ideas by talking on the microphone.

The course design was shown to shift PSTs' intended beliefs about teaching SSI (Leung, 2021). Beliefs are not always consciously held; they may become explicit through practice. Therefore, instead of probing the PSTs' professed beliefs (i.e., what teachers say) using interview protocols or questionnaires, their intended beliefs (i.e., their intentions through planning) were explored through a post-course task where participants were asked to design an ideal science curriculum. Three cases–Victor, Gordon, and Billy (pseudonyms)–were selected based on their intended teaching beliefs about SSI and return of completed weekly reflective journals among those from whom consent was obtained. They represented *SSI as a vehicle* for knowledge and skill development, *SSI as a goal* to be achieved, and theoretical ideal of SSI, i.e., a *bi-directional* view of considering SSI as both a vehicle and a goal that also accounted for students' emotional development.

3.2.2.1 Victor–SSI as a Vehicle

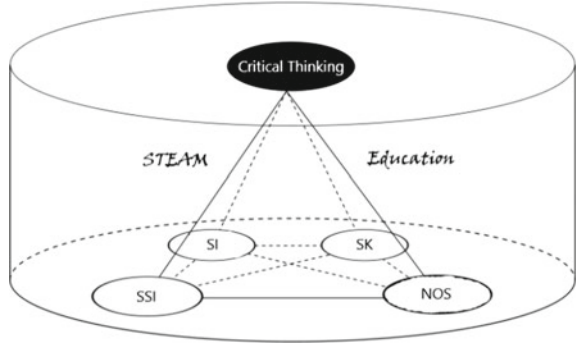Victor's ideal science curriculum was constituted of four key components (see Fig. 3.1).

> The four essential components will be NOS [nature of science], SSI, SK [scientific knowledge], and SI [scientific inquiry]. Like NOS and SSI can *help the students in terms of understanding SK*, and SK and SI can help to the students in terms of understanding the full picture of science… I think the NOS and SSI can work together to the students *having further progress on the critical thinking skills.* (emphasis added)

Table 3.1 Summary of course design

Week	Topics	Key ideas	Class activities
1	Course Overview	What is SSI?	Interactive discussion
2	Understanding Nature of Science	NOS: A philosophical, epistemological, and sociocultural perspectives	Post-box activity
3	Nature of Science—teaching and learning	Approaches to teaching NOS: contextualized vs. decontextualized approach; explicit vs. implicit approach	Mystery tube and other NOS class activities
4	Nature of Science—curriculum and assessment	Representation of NOS in various science curricula; approaches to assessing NOS understanding	Reflective sharing; interactive discussion
5	Nature of Socioscientific Issues	SSI vs. socially-denied science; SSI vs. STSE	Interactive discussion
6	Media literacy	Science news selection; challenges and constraints of journalists; responsibility and trustworthiness of journalists	Be-a-journalist
7	Teaching SSI	Approaches to teaching SSI (e.g., field trip, modeling practice, lab practical, board games, concept mapping)	Jigsaw reading
8 and 9	Video analysis workshop	Classroom observation protocol for socioscientific issue-based instruction; teaching SSI in local context	Video analysis
10	More about teaching SSI	Systems thinking; socioscientific decision-making; perspective taking	Interactive discussion; instructor's sharing of teaching experience
11	Q&A finale	Addressing any questions and concerns raised by student teachers	Interactive discussion
12	Presentation and concluding remarks	Designing and presenting teaching package	Video presentation; peer evaluation

Victor viewed SSI as a vehicle for facilitating students' science content learning and developing their critical thinking skills, thereby suggesting a unidirectional view about teaching SSI.

Fig. 3.1 Victor's ideal
science curriculum

3.2.2.2   Gordon–SSI as a Goal

Gordon's ideal science curriculum was represented by a big tree (see Fig. 3.2), where SSI "act[s] as the *tree trunk* to connect students (*tree leaves*) with different important components in science education curriculum and act as the medium for students to transform the knowledge and skills from each component into daily practices" (emphasis in original). "[T]o transform the knowledge and skills from each component into daily practices" is suggestive of Gordon's positioning of SSI as a goal to be achieved–by making use of the five components represented in the roots [NOS, SK, SI, scientific reasoning skills, and belief in science] to tackle SSI. On further elaboration of his framework, he added "…since SSI contextualizes and simulates the social discussion and debate in classroom, students are encouraged to propose possible solutions to solve different dilemmas or, at least, to develop their

Fig. 3.2   Gordon's ideal science curriculum

stance or make [a] decision on an SSI…" This confirmed his view of perceiving SSI as a goal to develop students' informed judgements on SSI, which was regarded as more sophisticated compared to Victor's view of SSI as a vehicle alone.

3.2.2.3 Billy—A Bidirectional View of SSI

Billy's "science is for life" curriculum was indicative of his bidirectional view about SSI as evidenced in the two-way arrows between SSI and other components (see Fig. 3.3) and his description of the model:

> … SSI provided a context in the lesson with authentic issues for students to more easily be engaged in learning and practice decision making skills through down-to-earth scenarios... NOS derived from the SSI can be used as some general guidelines for reviewing another SSI... the experiences and knowledge accumulated from each cycle will be staggered up… for achieving the scientific literacy through making informed decision[s] and becoming a responsible citizen.
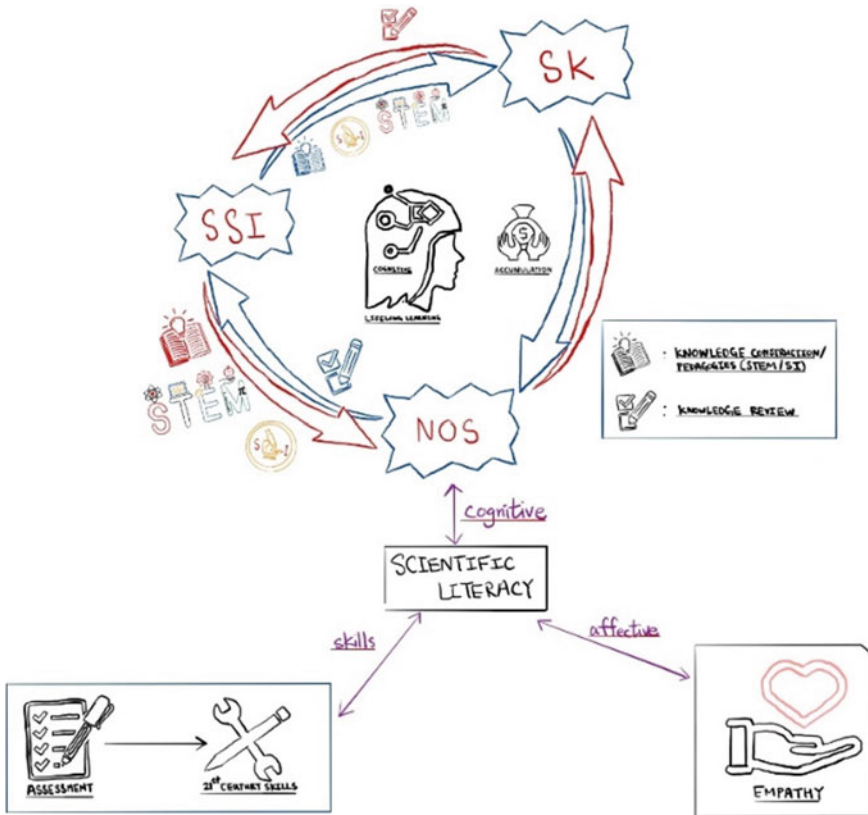

Fig. 3.3 Billy's ideal science curriculum

On the one hand, Billy viewed SSI as a "context" to develop students' decision-making skills and understanding of NOS, and on the other hand, a goal to be achieved with the use of components such as understanding of NOS. Furthermore, his ideal curriculum also emphasized the affective domain:

> The affective domain promotes affective development which refers to the personal growth and internal change to serve the best interest of the society... Students should be empathetic enough by thinking in other perspectives when they formulate their arguments and make their decision…

Billy's bidirectional view about teaching SSI with an emphasis on students' affective development was coherent with the SSI paradigm.

3.2.3   Data Collection

Throughout the course, students kept a weekly journal to record their reflections on the following questions:

1.   What is the take-home message that you have learned this week?
2.   What is/are the feeling(s) that you have experienced in class this week? Please describe and elaborate.
3.   Is there anything that you wish to ask or share with me?

Reflective writing offered us a way to access PST's emotions and thoughts about their learning experience. Although questions 1 and 3 did not ask explicitly about emotions, participants did express their emotions in their responses. This was not surprising because "[r]eflecting on an experience in writing means expressing one's expectations, perceptions, and feelings about that experience" (Levin & Wagner, 2006, p. 234). Therefore, we were able to use their responses in these prompts as our data to identify student emotions of their learning.

3.2.4   Data Analysis

Open and iterative coding was performed for the types and aboutness of all the emotional expressions. Each emotional expression was analyzed for the type of emotion by attending to its semantics and contextualization (Hufnagel & Kelly, 2018). For semantics, emotional expressions in the reflective journals were identified based on emotion words, ambiguous emotional expression, and implied emotional expressions. Emotion words refer to explicit expressions of emotion (e.g., interested, fear). Ambiguous emotional expressions were vague, e.g., the use of broader affective words (e.g., good, like). Implied emotional expressions involved judgments of events or experiences, (e.g., precious, fruitful, awkward). Considering both explicit and implicit expressions of emotion was important for variations in students' abilities

of conveying their emotions clearly (Barrett, 2006). Contextualization cue refers to "any feature of linguistic form that contributes to the signaling of contextual presuppositions" (Gumperz, 1982, p. 131). In PSTs' reflective journal, emotions were not only expressed in the form of content-related words, but also writing conventions such as words that were bolded, colored, capitalized, underlined, carried exclamation marks, or emotion icons (Hufnagel & Kelly, 2018).

When we examined PST emotion objects, there are two key salient categories. They are: (i) learning-related aspects of SSI teaching, including learning experience, concepts/ideas, and people (e.g., peers and instructors); and (ii) teaching-related aspects of SSI, including the *internal* variables that entail self-efficacy of teaching SSI and the *external* variables that refer to the environment that the PST would be teaching, such as student traits and expectations from the school and society (Lee et al., 2006).

3.2.5 Case Reports and Cross-Case Analysis

After developing an emotion profile, including information about the types and aboutness of each emotional expression, detailing what the data revealed about the emotions experienced by each case, we conducted a cross-case matrix analysis (Miles & Huberman, 1994) to reveal similarities and differences among the three participants. This two-step process of case report development and cross-matrix analysis allowed us to characterize the emotional experiences of PSTs in relation to their belief about teaching SSI.

3.3 Results

3.3.1 Victor—About Learning to Teach SSI

The key emotional expression characterizing Victor's learning experience was his enjoyment about the class activities for their pleasantness:

> I *enjoy* the time spent on the discussion so much, we can share and learn from others at the same time to improve our point of view. (Week 7, emphasis added)
>
> I *enjoy* the lesson very much that we can share the ideas among each other and think about what we think are insufficient... (Week 9, emphasis added)

Victor particularly enjoyed the sharing of ideas in small group discussions and his enjoyment was reiterated at the end of the course:

> Overall, I *enjoy* the course so much. The lesson was full of sharing and discussions throughout the lesson, we are able to understand how others think and reflect on our point of view or learn from them... (Week 12, emphasis added)

Notably, his enjoyment was limited to his experience in group discussions only.

3.3.2 Victor—About Teaching SSI

In Week 7, Victor raised a question about teaching SSI:

> May I ask if the school does not allow the teachers to share the view on some specific SSI, how should the teacher do, how should we respond if the students ask about it? (Week 7)

The above question was contextualized within a discussion on whether teachers should disclose their stance in teaching SSI. Victor's question was suggestive of his concern about school culture or expectations, an external variable potentially influencing the teaching of SSI. On the other hand, his emotion about his ability to teach SSI–an internal factor to teaching SSI–was positive:

> In general, the course helps me a lot in terms of understanding NOS and SSI, it made me confident with the future teaching in the practicum. (Week 12)

Despite Victor's increased confidence in his future teaching post course, there was no sign of his intention to teaching SSI. In sum, Victor's emotional expressions about learning to teach SSI and those about teaching SSI tended to be positive.

3.3.3 Gordon—About Learning to Teach SSI

Below was Gordon's reflection in Week 1:

> … I am *inspired* by the in-class discussion. We have shared some of our teaching experiences in discussing the possibility of introducing SSI to the current science curriculum which *inspired* me to review my teaching experience. I will ask myself whether there is any space for me to introduce SSI in my previous teaching so that I could improve my teaching by creating better linkages between the content knowledge and real-life context... (Week 1, emphasis added)

Gordon felt positive about his learning. He was inspired by the idea about "the possibility of introducing SSI to the current science curriculum." The discussion prompted him to reflect on his prior teaching experience for opportunities to incorporate SSI. Notably, Gordon's view about SSI in Week 1 was limited to "creating better linkages between the content knowledge and real-life context" than to position SSI as a goal post course. In Week 11, Gordon continued to express positive emotions about his learning:

> I want to *say thank you* for your efforts in providing a lot of suggestions for us in teaching NOS and SSI in these 11 weeks. I am so *happy* that you can share your valuable teaching experiences and difficulties to us... I will try my best to practice more on teaching SSI and NOS in the future! (Week 11, emphasis added)

Gordon expressed gratitude ("want to say thank you") and happiness ("I am so happy") for the instructor's sharing of various approaches to teaching SSI and her personal experience of teaching SSI. He also expressed that he would "try [his] best to practice more on teaching SSI," suggesting his intention to teach SSI. His emotional expressions directed to learning to teach SSI were not only about class discussions, but were also extended to specific ideas and his instructor.

3.3.4   Gordon—About Teaching SSI

Below are excerpts illustrating Gordon's emotional expressions about external factors to teaching SSI:

> ...As we know a teacher was delisted because she adopted 'inappropriate' information from the media in T&L activities. This promotes a sense of *fear* on how we should prevent ourselves from 'crossing the redline' when we choose different news for students... (Week 6, emphasis added)

> When we discussed whether we should disclose our standpoint, many of us maybe are *scared* to do so because of such political sensitive environment in HK. This is a most significant factor which hinders our 'freedom of speech' in today's T&L environment... (Week 7, emphasis added)

With the deregistration of a teacher in Hong Kong over accusations of a lesson plan spreading pro-independence messages, Gordon expressed fear in response to the changing political environment. Apparently, the red line became an obstacle for PSTs to teach SSI. Gordon's fear was reiterated in his reflection in Week 7, which suggested that it became a taboo for teachers to disclose their standpoints in this "political sensitive environment." Compared to Victor, Gordon seemed to feel more negatively (i.e., fear compared to concern) about external factors to SSI teaching and his emotional expressions were directed to a broader context (i.e., the political environment at a societal level rather than culture or expectations at a school level).

While his emotional expressions toward external variables of teaching SSI were negative, Gordon expressed mixed feelings about his ability to teach SSI:

> I felt more confident in SSI teaching as it provided more examples and pedagogies on SSI teaching. Moreover, our group is planning to implement debate in our design. It gave us a lot of directions on how to make the debate more vibrant... we should carefully design the lesson such that it won't narrow the room for student discussion, so that they can make informed decision[s] on an SSI with in-depth discussion. (Week 9)

Gordon attributed his increase in confidence to the "examples and pedagogies on SSI teaching." His goal for students to "make informed decision[s] on an SSI with in-depth discussion" was consistent with his view of "SSI as a goal" post course. In addition, Gordon expressed some negative emotions about his ability to teach SSI:

> I am certainly saying that I am *more confident* in designing teaching materials as I have different tools to make the SSI lesson more fruitful. However, since we have no experience in teaching SSI in real classroom setting. It is *difficult* to predict the learning outcomes and

student reactions and understand the nature of students. That's why I may feel *doubt* on whether I can design an SSI lesson which really meet[s] the learning needs of students. Nevertheless, I will still try my best to improve my teaching and learn more when I become a service teacher in the future. (Week 10, emphasis added)

While Gordon continued to express that he felt "more confident," he also recognized the *difficulty* to "predict the learning outcomes and student reactions" and expressed *doubt* about his ability to design an SSI lesson that would "meet the learning needs of students" because of his lack of experience in teaching SSI. Notably, his doubtfulness was about student learning (cf. teaching per se). Despite his negative emotional expressions, Gordon still expressed his intention to "try [his] best to improve [his] teaching" and acknowledged the need to "learn more" when becoming an in-service teacher in the future.

3.3.5   Billy—About Learning to Teach SSI

Echoing Victor and Gordon, Billy's emotional expressions toward his learning experience were positive:

I feel *excited* to see all the faces again... Beside from thinking 'what' to learn in the science curriculum, I feel *engaged* since we also need to discuss 'why' we are learning science and whether NOS/ SSI should be emphasized in the curriculum... It is very *fruitful* today. Also *keen* to see you again after 2-3 years! (Week 1, emphasis added)

Similar to Gordon, Billy was able to specify ideas in the group discussion that attributed to his positive emotional expressions, e.g., feeling engaged and satisfied ("fruitful"). Billy's positive emotional expressions, e.g., "excited" and "keen," were also directed to his peers and the instructor, suggesting his social bonding with his peers and instructor that could have important bearing in supporting his learning. Such social bonding could be particularly prominent, given the virtual classroom setting in this course.

3.3.6   Billy—About Teaching SSI

Billy was one of the few who had some SSI teaching experience. Below was an excerpt of his reflection:

… I told my group I have used jerry-built projects for my teaching before. At that time, my mentor told me it may be sensitive to mention this in class as it may hurt [the] feeling[s] of students from China. I told her I just 'wanna deliver the truth to the class, without any biased judgement and standpoint revealed. It just served as a way to deliver my lesson. I insisted doing so. Of course that is two years ago. When I reflect back, the situation of education is changing now, we don't know what will happen tomorrow. Can we still deliver the truth to class? Do we need [to] self-censor before the lesson? (Week 6)

Reflecting on his prior teaching, Billy expressed doubt about the possibility for teachers to "deliver the truth to class" and the need for teachers to self-censor their teaching in response to the changing political environment. In Week 7, Billy expressed "… I think we should stay open for disclosing our standpoint whenever needed. Of course, I will not intend to do so in some sensitive issues, but will stay open for it…" (Week 7). Unlike Victor and Gordon, Billy seemed to have an answer to whether he would disclose his standpoint in teaching SSI–staying open while being cautious about sensitive issues. This suggested his shift from feeling uncertain about the need to self-censor his teaching in Week 6 to feeling certain about disclosing his standpoint in Week 7. In the Week-10 reflection, Billy put down:

> As a preservice teacher, I realized that I can't always teach from a single perspective. I need to prime students to think in a bigger angle with proper guidance and support. Most importantly, we should ask ourselves what the next step is and so what. *How* can we follow up by utilizing their reasoning skills and make informed decision[s]? *How* can we cater students in the class using this mode of teaching? I feel like it will be a long process of trying and learning, and the experiences cannot be learnt solely in the lesson. (Week 10, emphasis added)

Unlike Victor and Gordon, Billy did not reflect on his ability to teach SSI, but expressed his intention of incorporating SSI in his teaching (e.g., "prime students to think in a bigger angle") and his readiness to take up the challenge ahead by acknowledging that it "will be a long process of trying and learning." This echoed Gordon's intention to "learn more" as an in-service teacher in the future. Furthermore, Billy raised a number of how-questions. Taken together, these suggested that Billy went beyond *whether* to teach SSI by appraising his teaching ability to *how* to teach SSI (see Table 3.2 for a result summary).

3.4 Discussion

3.4.1 About Learning-Related Aspects

The three case studies presented above revealed the emotional expressions of three PSTs who experienced a teacher preparation course about SSI: Victor viewing SSI as a vehicle, Gordon viewing SSI as a goal, and Billy holding a bi-directional view about teaching SSI. All the three PSTs exhibited positive emotions, e.g., enjoyment, gratitude, and satisfaction, about the learning-related aspects of SSI teaching. These positive emotional expressions were believed to be supportive for learning. For instance, enjoyment was believed to direct attention to the task at hand, allowing the full use of cognitive resources for supporting his learning (Pekrun et al., 2007). Unlike Victor whose aboutness related to learning was limited to his learning activities, Gordon and Billy also directed their emotional expressions to specific ideas and people (i.e., peers and instructor). Emotional expressions directed toward specific concepts, instead of learning experience alone, may indicate more in-depth engagement in learning.

Table 3.2 Summary of findings

	Victor	Gordon	Billy
Orientation towards SSI	SSI as a mean to content & critical thinking	SSI as an end	SSI as a mean and an end
About learning	Enjoy (discussion) (Wk 7, 9, 12)	Inspired (concept), gratitude & happiness (teacher) (Wk 1, 11)	Satisfied (discussion and/or concept); excited & keen (peers & teacher) (Wk 1)
About teaching (external factors)	Concern (school expectation) (Wk 7)	Fear (political context, Wk 6 & 7); Difficult (to "predict the learning outcomes and the reaction of students") (Wk 10)	Doubtful (political context) (Wk 6) Certain (disclosing standpoint) (Wk 7)
About teaching (internal factors)	More confident (ability to teach; within classrooms) (Wk 7, 12)	More confident (ability to teach) (Wk 9 & 10) Doubtful (about himself to meet the learning needs of students) (Wk 10)	Certain (about whether to teach), less certain (about how to teach) (Wk 10)
Intention to teach SSI	No indication	Yes	Yes

3.4.2 About Teaching-Related Aspects

The three participants' emotional expressions about teaching SSI were directed to both external (e.g., school culture or expectations, the red line) and internal variables (e.g., self-efficacy). For external variables, Victor expressed concern about school culture or expectations, which echoed earlier studies that identified local school culture as an external variable to SSI teaching (McGinnis & Simmons, 1999).

Gordon expressed fear about crossing the red line. His fear echoed findings within the context of social studies about teachers' fear of losing jobs by introducing controversial topics in class (Cornbleth, 2001; Ho et al., 2014). Billy expressed doubt about the possibility of telling the truth and the need of self-censoring. This corroborates with self-censorship that is observed in the teaching of history and civics (Vered et al., 2017). Vered et al. (2017) identified motivations for self-censorship, including fear of sanctions (as observed in Gordon's reflections) and maintaining the nation's positive image (as reflected in Billy's doubtfulness about delivering truth on jerry-built projects in China in his future teaching). Clearly demarcated political and social boundaries were reported to allow more freedom for teachers to discuss controversial topics. Nevertheless, in reality, these boundaries are ambiguous. Teachers may become more conservative with their curriculum decision-making for their heightened sense of uncertainty and insecurity (Ho et al., 2014). Adding to the external variables identified in prior studies, such as instructional time, content coverage,

and limited teaching resources (Gray & Bryce, 2006; Mansour, 2010), our findings identified the "red line" as an external constraint for PSTs to teach SSI, which is possibly applicable to other illiberal democracy societies. While Gordon and Billy expressed fear and doubt in relation to the red line, Victor did not have any emotional expressions directed to this emotion object. It could be that he did not attend to the obvious factors that may impact his actual teaching, or even if he did, he did not worry about political controversies. This might be explained by his viewing of SSI as a vehicle for facilitating students' science content learning and developing their critical thinking skills, unlike Gordon and Billy who recognized SSI as a goal to be achieved.

For internal variables, Victor and Gordon expressed increased confidence in teaching SSI post course. Earlier studies reported teachers' lack of confidence in dealing with SSI in their class (Lee et al., 2006), our findings suggested that a 12-week teacher preparation course adopting a reflection orientation potentially supports PSTs' development of confidence in teaching SSI. Yet such confidence may not be translated to the intention to teach SSI. It is interesting to note that despite Victor's increased confidence, there was no evidence suggesting his intention to teach SSI. On the contrary, other than increased confidence, Gordon also expressed doubt about his ability of designing an SSI lesson for his lack of experience in teaching SSI, making it hard for him to predict student responses. Despite his fear about the red line (external variable) and doubt about his ability (internal variable), he indicated the intention of incorporating SSI in his teaching. Unlike Victor and Gordon, instead of reflecting on his ability to teach SSI, Billy indicated his intention to teach SSI and his readiness to cope with the challenges ahead. This might be explained by his teaching experience of SSI, which was believed to increase feelings of empowerment (Lee & Yang, 2019), thereby shifting his focus from *whether* to teach, to *how* to teach SSI.

Despite their negative emotional expressions towards the external variables to teaching SSI, both Gordon and Billy indicated their intention to teach SSI. This is in line with prior studies suggesting that internal variables are more influential in teachers' decisions to teach SSI (Lee & Witz, 2009; McNeal et al., 2017). Our case study suggested that PSTs' positive emotions about their learning did not necessarily lead to positive emotions toward teaching SSI nor the intention to teach SSI. Prior studies reported that negative emotions about teaching SSI were unfavorable while positive emotions were preferred (e.g., Büssing et al., 2019; Lombardi & Sinatra, 2013). Victor, whose emotional expressions were entirely positive, held a less sophisticated view of teaching SSI compared to his counterparts and did not seem to intend to adopt an SSI approach to teaching. On the contrary, Gordon and Billy, who expressed negative emotions about the external variables and mixed emotions about internal variables to teach SSI, held more sophisticated beliefs about teaching SSI and indicated the intention to teach SSI. These suggested that negative emotions were not necessarily unfavorable. Our case study suggested that negative emotional expressions about teaching-related aspects were associated with more sophisticated teaching beliefs about SSI and the intention to teach SSI. We could not have come up

with this finding if PSTs' emotion objects were not analyzed at this more fine-grained level (e.g., the external and internal variables to teaching SSI as opposed to teaching SSI as a whole).

3.5 Conclusion and Implications

This chapter aims to use three cases to illustrate features of PST emotions when they learn to teach SSI. Although we contextualize the findings in learning to teach SSI, we believe that they are also relevant to teacher learning in general.

While some studies identified PST positive emotions as being more conducive to teaching SSI than negative emotions, other studies suggested that negative emotions relate to engagement, which indicates some readiness to adopt an SSI approach to teaching. This study indicated that PSTs with different intended beliefs of SSI teaching expressed positive and negative emotions, meaning that valence of emotions alone did not sufficiently explain their willingness or their readiness to adopt their own SSI curricular ideals.

Emotion objects seem to be a worthwhile factor to consider when we examine PST learning to teach SSI. We would like to highlight three major findings as we attended to emotion objects. Firstly, we found that their positive emotions *about* their learning did not necessarily lead to positive emotions *about* teaching SSI nor intention to teach SSI. Secondly, PSTs with more informed intended beliefs of SSI teaching referred to more emotion objects. That is, they had a wider range of emotion objects in their reflections. Thirdly, emotion objects of PST who showed less sophisticated understanding tended to be rather generic (e.g., confident about teaching). This compared with more specific emotion objects (e.g., how to teach, how to fit students' need) of more competent PST. The generic/specific emotion objects were likely reflections of their growth (i.e., the depth they engaged in learning to teach SSI and their intended belief of SSI teaching).

When the three PST become full-time science teachers, we are interested to examine their emotion objects and the way that these emotion objects change and evolve along with their SSI teaching practice.

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Jessica S. C. Leung is an Assistant Professor in the Faculty of Education, the University of Hong Kong. Before that she was a Lecturer in the Faculty of Science for the same university. Jessica takes up the dual role of teacher educator and science teacher at the university. She works with preservice secondary science teachers and teaches a general education course on making sense of socioscientific issues for students from all faculties. Her research focuses on supporting teachers and students in dealing with socioscientific issues and understanding the nature of science.

Maurice M. W. Cheng is an Associate Professor in the Division of Education, The University of Waikato. He is interested in science and chemistry education, in particular, student learning of socioscientific issues. His research interests include the roles of visual representations, in particular, drawing, in learning and in research. He was the National Research Coordinator (Science) of TIMSS Hong Kong study 2019. He also serves in the Science Extended Expert Group for OECD's PISA 2024.