Indonesian Pre-Service Science Teachers’ Views on Socio-Scientific Issues-Based Science Learning

Safwatun Nida 1,2*, Vita Ria Mustikasari 1, Ingo Eilks 2

1 Prodi Pendidikan IPA Universitas Negeri Malang, INDONESIA
2 University of Bremen, GERMANY

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Abstract
This study explores the views of Indonesian junior high school pre-service science teachers (PSTs) towards teaching based on socio-scientific issues (SSIs). Questionnaires were analyzed qualitatively and descriptively. The PSTs (N=62) acknowledged that student competencies ranging from personal to socially relevant skills as well as character formation can potentially be developed through SSI-based instruction. The PSTs mentioned several challenges which may hinder implementation of SSI-based instruction. These include the interdisciplinary and controversial nature of SSIs, a lack of familiarity regarding SSIs, the lack of necessary student skills, insufficient teacher expertise, and curriculum constraints. The PSTs viewed SSIs as able to potentially enhance their personal competencies through SSI-based instruction, mostly with regard to pedagogical skills. The relevance of SSI-based instruction was, however, not seen in as positive a light as the participants’ views on the need of character building. The PSTs’ intentions to later implementing SSI-based instruction ranged from medium to high.

Keywords: science education, curriculum, socio-scientific issues, pre-service science teachers

INTRODUCTION
Ever since the 1960s, the goals of school science education in many countries has shifted from a primary focus on preparing the next generation for science-related careers to achieving scientific literacy for all (Eilks, Rauch, Ralle, & Hofstein, 2013). Scientific literacy can be defined as the ability to recognize scientific questions and to utilize knowledge and skills from science. This includes making informed decisions regarding any science and technology related issues or problems in modern life and society. Approaches to achieving scientific literacy found in the literature suggest reorienting science learning along the lines of contexts relevant to everyday life (Childs, Hayes, & O’Dwyer, 2015) or using societal relevant questions (Hofstein, Eilks, & Bybee, 2011; Stuckey, Hofstein, Mamlok-Naaman, & Eilks, 2013). Socially-oriented science education focuses on a broader skill set which reaches beyond the learning of science. Some have suggested that it be organized using socio-scientific issues (SSIs). SSIs are science-related questions that are relevant to life in society and are multifaceted, controversial and open-ended in nature (Sadler, 2011a; Zeidler, 2015).

Knowledge of how to implement SSI-based instruction in Indonesia is limited. It seems that SSI-based science education is rarely implemented in Indonesia (Nida, Rahayu, & Eilks, 2020; Subiantoro, 2017). This study focused on the views of Indonesian pre-service science teachers (PSTs) in junior high school with regard to SSI-based teaching. It explored competencies suggested by the PSTs which should be enhanced through SSI-based instruction. The study inquired into PSTs’ views on the connection of SSI-based pedagogies and student character building. It also asked about the suggested relevance of SSI-based pedagogies for junior high school students. The PSTs were required to suggest potential topics which might be good for carrying out SSI-based instruction in science education. The participants also listed potential challenges in implementing SSI-based learning and discussed their personal willingness to try out the corresponding lessons in the future.
Contribution to the literature

- The findings of this research contribute to understanding potentials and challenges in implementing SSI-based science education as a new pedagogical approach in Indonesia.
- The study explores the connection of SSI-based science education and students’ character formation and inquired into the relevance of SSI-based education for secondary school students.
- The study suggests to thoroughly implement SSI-based education in pre-service science teacher education and continuous professional development in Indonesia.

FRAMEWORK

One of the frameworks for SSI-based science education has been proposed by Sadler (2011b), which was further developed by Presley et al (2013). According to the framework by Sadler (2011b), SSI-based instruction consists of two core aspects, namely: Design Element and Learner Experience. Presley et al (2013) added Teacher Attributes as another core aspect. The Design Element consist of four features: 1) Instruction is built around a compelling issue; 2) the issue is presented first; 3) scaffolding for higher-order practices is provided (e.g. argumentation, reasoning, and decision making); and 4) culminating experience is provided, which could be done through multiple pedagogies, such as role play, debate, service learning, etc. This is in line with another SSI-framework called socio-critical problem oriented approach, developed by Eilks, Marks and others (e.g. Eilks, 2002; Marks, Bertram, & Eilks, 2008; Marks & Eilks, 2009, 2010). Under this framework, teaching has to be started with a societally-relevant, controversial, current, and authentic issue from the society which allows the learning of science content, while at the same time it engages students into group discussions and decision making processes. According to this approach, a fruitful socio-scientific issue must meet some specific criteria. The issue is authentic and relevant, since it is controversially discussed in the media with different points of view, such as newspaper, TV news, podcast, advertisement, etc. It should allow for open debate in the classroom in which arguments from science and technology may play a role. It is suggested that SSI-based science education starts with authentic media leading via science learning into decision making exercises.

Science teaching with the help of SSIs has been suggested as a way to potentially increase student interest and participation in science learning (Morris, 2014). In traditional science education, student interest has often been described as lackluster for many reasons. These include the beliefs that science content is difficult (Turner, Ireson, & Twidle, 2010) or that science is irrelevant (Sjöberg & Schreiner, 2005). The literature suggests that students can be motivated to learn science if they find the contexts provided for science learning to be personally relevant (Bybee & McCrae, 2011). However, what students perceive as relevant is not always in line with what teachers think is important (De Jong & Talanquer, 2015). Therefore, science teaching needs to be made relevant for all students by considering their personal interests and needs for the present and the future (Stuckey et al., 2013). Science learning should start from contexts connected to students’ lives in society, their prior experiences, as well as their interests (Childs et al., 2015). SSIs represent a special form of context, because they are authentic, relevant and controversial in nature (Stolz, Witteck, Marks, & Eilks, 2013). SSI-based education is not merely another form of context-based science education, it aims centrally at promoting general educational skills which enable students to actively participate in a democratic society (Eilks et al., 2013, Eilks, 2015). SSIs can be used as a special form of context which motivates students to learn science. They can also serve as a starting point to practice skills which learners require to become scientifically literate individuals in a contemporary society (Sadler, 2011a, 2011b).

Furthermore, character formation and values education have been acknowledged to be a part of scientific literacy for the 21st century (Choi, Lee, Shin Kim, & Krajcik, 2011; Sjöström & Eilks, 2018). Character formation and values are assumed to be driving forces that serve as general points of reference for individuals to make responsible decisions regarding local or global SSIs (Choi et al., 2011; Lee, Chang, Choi, Kim, & Zeidler, 2012). SSIs have been suggested as a vehicle which can promote character formation and values education for global citizenship (Lee et al., 2013). Science education should therefore be linked to character-building education (Berkowitz & Simmons, 2003). It should also be integrated into citizenship education in order to promote the necessary skills for being responsible citizens (Sperling & Bencze, 2010). Teaching using SSIs is seen as having the potential to enhance students’ moral sensitivity and contribute to their moral development (Fowler, Zeidler, & Sadler, 2009). It also provides students with chances to practice education for responsible citizenry (Zeidler & Nichols, 2009). In the case of Indonesia, the government has explicitly emphasized the need for moral character development through formal and informal education as stated in the Peraturan Presiden Republik Indonesia Nomor 87 Tahun 2017 (2017). In this framework, science education plays an important role in emphasizing character building as a part of formal education, for example...
Research on SSI-based pedagogies is an emerging topic, but its implementation in Indonesia remains limited (Subiantoro, 2017; Nida et al., 2020). Studies exploring pre- and in-service science teachers’ views of SSI-based learning have been published, but most are from outside Indonesia. Lee, Abd-El-Khalick, and Choi (2006) conducted a Korean study examining secondary school teachers’ views on introducing SSI into the science curriculum. The results indicated that the teachers saw a need to address SSIs. However, only a small number of the participants actively used such issues in their own classrooms and the application was sporadic at best. The participants also mentioned several obstacles to teaching with SSIs such as a lack of time and the inaccessibility of relevant materials. Similar results were reported for Turkey by Kara (2012), who explored the perception of SSIs in the curriculum among biology teacher trainees.

In Indonesia, the number of studies examining science teachers’ views regarding SSI-based science education is very limited. Subiantoro (2017) explored Indonesian senior high school biology teachers’ views on SSI-based education. The findings reveal that before participating in the study, teachers had limited knowledge and experience regarding SSI-based learning. After being trained, their knowledge on SSI-based instruction had expanded and their views regarding the benefits and challenges of such an approach had changed. Similar results were recently found for Indonesian junior high school science teachers (Nida et al., 2020). This latest study covered teachers’ views on SSI-based learning. Despite several challenges to implementation mentioned by the teachers, the participants expressed positive views on SSI-based instruction. They believed that SSI could contribute to students’ skill set development and aid in character formation. Most of the teachers were also interested in implementing SSIs in their own classes and considered some potential science topics to incorporate SSI-based education.

Teachers are the key to curriculum change (Anderson & Helms, 2001). This holds true for in-service teachers. It is even truer for prospective teachers, since future teachers play a central role in enacting and spreading instructional innovation which they learn about in their teacher education programs (Davis, Petish, & Smithey, 2006). Inspired by the study previously done by Nida et al. (2020), we conducted a similar research focusing the pre-service junior high school teachers. The current paper details a study of PSTs in Indonesia with regard to the use of SSIs in science education. We examined the participants’ views with respect to the potential benefits and challenges of SSI-based instruction to enhance skills and character formation. We also inquired into the relevance of learning about SSIs and investigated suggested topics for implementing SSI-based education, as well as the student teachers’ intension to implement SSI-based instruction later when they become a science teacher.

### Method and Sample

The study is based in a questionnaire adapted from Nida et al. (2020), with one multiple choice, three Likert and five open-ended items. At the beginning of the questionnaire, a definition and an example of SSI-based education is presented. This provides all the respondents with the same definition of what SSI-based education means. As a part of the questionnaire, the PSTs were asked about their knowledge of and familiarity with SSI-based education and any sources of information that they had used so far. An overview of the questionnaire with the different questions and foci (challenges, promotion of competencies/skills, character formation, relevance, potential topics, and intention of implementation) is provided in Table 1.

A total of 62 PSTs from Indonesia took part in the study. All of them were in the seventh semester of their university science teacher education program at a public university in East Java. There were 57 (91.9%) of the participants who were female and 5 (8.1%) who were male. This is not an unusual distribution in science teacher programs in Indonesia. All participants took part in the study voluntarily.

The Likert and multiple-choice items were subjected to descriptive statistics. The Likert items were scored on a scale from 0-4 (0 not at all; 4 to a very great extent). Mean values were calculated, with higher values through the enactment of an SSI-based pedagogy to support character formation.

### Table 1. Description of the questionnaire

| Item | Question Focus | Type |
|------|----------------|------|
| 1    | Challenges     | Open-ended |
| 2    | Promotion of competencies/skills | Open-ended |
| 3    | Character formation | Likert type |
| 4    | Potential topics for SSI-based education | Multiple-select |
| 5    | Intention      | Likert type |

- **Item 1**: Potential challenges to implement SSI-based education
- **Item 2**: Promoters’ competencies or skills potentially enhanced through SSI-based education
- **Item 3**: Teachers’ competencies or skills potentially enhanced through SSI-based education
- **Item 4**: Contribution of SSI-based education to learners’ character formation
- **Item 5**: Intention to implement SSI education when teaching in a school internship

| Questions and Foci | Type   |
|--------------------|--------|
| Potential challenges | Open-ended |
| Relevance | Likert type |
| Identification | Open-ended |
| Intention | Likert type |

The study voluntarily.
The majority of the participants in the study stated that they were not familiar with SSI-based science education (72.6%). Only 17 out of 62 respondents reported having read/heard/known about the topic. Most of these people had been introduced to SSI-based education through either journal articles or colleagues. None of them had received knowledge on SSI-based education during their teacher education courses.

**Challenges in Implementing SSI-based Learning**

Six categories of challenges in implementing SSI-based instruction could be identified (Table 2). The two most common challenges were related to the multidisciplinary character and controversial nature of SSIs. The other problems mentioned included teachers’ lack of familiarity with the topic, too little expertise in implementing SSI-based education, an estimated lack of student competencies, and challenges related to matching up or integrating SSIs into the science curriculum.

**Competencies**

The PSTs suggested several competencies that might be developed through SSI-based education, not only for the learners but also for the teachers. Student competencies mentioned by at least 10% of the PSTs included creativity, scientific reasoning, scientific literacy, scientific inquiry, content knowledge, the nature of science, and decision-making skills.

Aside from considering learner competencies that can be enhanced by SSIs, the PSTs also mentioned competencies that can potentially be developed among teachers. The most commonly mentioned ones fell into eight categories. These include designing innovative contextual learning, attaining wider knowledge, increasing teaching skills/classroom organization, gaining multidisciplinary knowledge, adding teaching skills, promoting creativity, maintaining neutrality, and developing interdisciplinary knowledge.
utilizing learning sources, and bettering information and communication technology (ICT) skills (see Table 4).

Table 3. PSTs’ views on competencies which learners can potentially develop (% = PSTs mentioning)

| No | Category                          | Description                                                                 | Examples                                                                                     | %    |
|----|----------------------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|------|
| 1  | Problem solving                  | Any response related to problem solving skills                              | The students learn to solve a problem scientifically and also consider societal needs.       | 43.5 |
| 2  | Critical thinking                | Any response about reflexive and critical thinking                          | Students can enhance their critical thinking skills; the students can reflect upon information regarding the SSI so that they can make an informed choice or decision. | 41.9 |
| 3  | Higher order thinking skills     | Any response related to higher order thinking skills based on Bloom’s taxonomy | Higher order thinking skills; the ability to analyze the problem within society.            | 27.4 |
| 4  | Communication                    | Any response about communication skills                                      | The ability to convey ideas, criticize, answers, and ask questions; the ability to present data using tables, charts, etc.; the ability to ask/answer questions, or to get involved in a discussion. | 25.8 |
| 5  | Character                        | Any response related to character formation                                  | The ability to show positive attitudes regarding the SSI such as open-mindedness, appreciating different opinions, enhancing positive attitudes and building character. | 17.7 |
| 6  | Multidisciplinary nature         | Any response related to interconnection science-technology-society-environment or related to multidisciplinary nature of SSIs. | Connecting what the students learn at school with society; implementing scientific knowledge in society. | 14.5 |
| 7  | Collaboration                    | Any response related to collaboration either within the community or society at large | The students know how to work together with society to solve a problem using a win-win solution to the controversy. | 11.3 |
| 8  | Curiosity                        | Any response related to curiosity                                            | Increase learners’ curiosity and interest in learning science.                              | 11.3 |

Table 4. PSTs’ views on competencies teachers potentially develop (% = PSTs mentioning)

| No | Category                                | Description                                                                 | Examples                                                                                     | %    |
|----|-----------------------------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|------|
| 1  | Designing innovative contextualized learning | Any response related to the ability in context-based learning by utilizing SSIs and integrating SSIs with the curriculum | Choosing suitable issues for science topics; the ability to analyze societal problems and integrate them with learning activity by providing real life examples/contexts; the ability to integrate science/technology and society and make it a learning activity; the ability to enhance students awareness about societal issues; the ability to design science learning based on real-life problems. | 46.8 |
| 2  | Wider knowledge                         | Any response about enhancing knowledge                                      | Teachers can gain a wider range of knowledge; they have up-to-date information.             | 21.0 |
| 3  | Teaching skills/classroom organization  | Any response related to abilities in teaching or organizing the classroom   | The ability to organize discussion and fruitful debate; the ability to help students think of and propose ideas to solve the problems faced within society; skills in directing the discussion so that students can take a position regarding the issue; the ability to utilize the issue in the discussion so that the students can analyze the problems; the ability to direct students in thinking critically regarding the issue; the ability to simplify the complexity of the SSI so that the students can follow the instructions easily; the ability to motivate students in discussions; the ability to choose suitable teaching models for SSI-based learning. | 22.6 |
| 4  | Multidisciplinary knowledge             | Any response about inter- and multidisciplinary knowledge                   | The ability to relate/connect science with other disciplines.                               | 16.1 |
| 5  | Creativity                              | Any response about creativity                                               | Creativity in presenting the issue to be an interesting topic for the students to discuss. | 9.7  |
| 6  | Neutrality                              | Any response about the teachers’ neutral position                          | The ability to be neutral to the different positions, so that the teachers’ personal beliefs do not interfere with students to finding a position; the ability to be open and facilitate students presenting different positions in dealing with the SSI | 6.5  |
| 7  | Utilizing learning resources            | Any response related to providing learning resources for students           | The teachers’ ability to provide students with access to learning resources which support this approach; providing students with suitable media for learning. | 4.8  |
| 8  | ICT                                     | Any response about the ability in utilizing ICT                            | The ability to develop and utilize ICT-based media for teaching; the ability to access information through ICT-based media. | 4.8  |
The PSTs' views regarding SSI-based education as a contributor to character growth and its relevance for the students were scored from 0 to 4. Zero was rated as "not at all". A value of four meant "to a very great extent". All of the PSTs perceived SSI-based education positively. Most of them thought that SSI-based education can contribute to building learners' character to very great extent. The mean value for this item was 3.42 (Table 5). Most of the PSTs saw SSI-based learning as being relevant to the students. However, SSI relevance for students did not score as positively as character building did. The mean value for relevance was 2.82 (Table 5). Table 5 also shows the comparison between the PSTs' single answers on character formation and how relevant SSI-based education is.

The reasons for PSTs' positive views on character formation fall into six categories (Table 6). These categories represent aspects of character that can potentially be enhanced or expanded. These include student awareness, open-mindedness, real world examples/contexts to strengthen character formation, responsibility in decision-making or taking a position, problem solving, and appreciation of values and ethics.

Character Formation and Relevance

The PSTs' responses to the relevance of SSI-based learning for students were classified into six categories (Table 7). The participants who had positive views indicated that SSI is relevant for students because it is often connected to daily life. They viewed SSI as interrelating science / technology and environment / society. SSI can possibly enhance the multidimensionality of skills / competencies. Such topics are also controversial in nature and are currently being debated in society at large. The respondents who saw SSI-based education as less relevant suggested the controversial nature of SSI could also be a negative aspect. One reason for this is that pros and cons can arise which make a topic difficult to handle. Another reason mentioned was that this approach cannot be applied to all topics in the science curriculum.

PSTs Intention to Implement SSI-based Education

The PSTs' intentions of implementing SSI-based education was also scored on a scale from zero to four. Intention was defined as a participant's willingness to implement SSI-based education should they be asked later in the teaching internship program. The mean value of the PSTs' intentions was generally positive with a value of 2.76 (Table 8). This was less positive than the mean values found for the contribution of SSI-based...
learning towards character formation (3.42) and SSI relevance (2.82) (see Table 5). The PSTs’ willingness to implement SSI was less positive than the other categories. However, we should note that none of the PSTs replied negatively to implementing SSI-based education. The majority said that they would implement SSI to some or to a great extent. Some PSTs even said that they would do so to a very great extent.

Potential Topics to Incorporate SSIs

The participants named several topics which they considered to be helpful for incorporating SSIs into teaching practice (Table 9). There are ten topics in the lower secondary school science curriculum in Indonesia which were suggested by at least one-third of the PSTs. The topics are mostly related to environment or technology.

| Table 7. PSTs’ answers concerning relevance (% = PSTs mentioning) |
|---------------------------------------------------------------|
| No     | Category                                      | Description                                                                 | Examples                                                                 | %     |
|-------|-----------------------------------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------|-------|
| 1     | Real life contexts / issues / problems        | Any response about SSIs being real life contexts or problems faced by society that can be observed by the students, interest them, and can be used to provoke discussion | SSI-based learning is about the problems currently faced by society; it is not like the textbook; this approach is based on exploration of their environment by the students; students are directed to think about the issue so that they can be more actively involved in the discussion; the issue is very close to students’ lives and that makes them more interested. | 43.5  |
| 2     | Interrelatedness of the issue with science/ technology/ environment/ society | Any response about the interrelatedness of the SSI with science/technology and environment/society that enhances students’ knowledge | Students might connect the scientific and environmental issue; the issue can be used to discuss other aspects such as economics, culture, science, etc. under one topic and is suitable for integrated science learning; students can analyze the issue through multiple perspectives that the students provide and that brings wider knowledge. | 30.6  |
| 3     | Enhances multiple dimensions of competencies  | Any response related to SSI’s role in enhancing multiple dimension of students competencies, either thinking skills, problem solving skills, critical thinking skills, cognitive, affective, psychomotor, etc. | Students might enhance their cognitive, affective, psychomotor skills; students might enhance their higher order thinking skills, which are needed for their professional work in the future; this approach can be used to strengthen character formation; students can increase their critical thinking skills; students learn to solve problems scientifically. | 16.1  |
| 4     | Controversial nature                         | Any response related to the controversial nature of SSIs                    | It is the controversial nature that I think will not work (for the students); there will be pros and cons and it is difficult to get a win-win solution; the controversial nature can make students more aware of the issues and make them try to analyze and discuss it. | 8.1   |
| 5     | Currently being under debate                 | Any response related to SSIs as being current topics of discussion in society | The issue is currently being discussed by society; the issue is not new for the students. | 6.5   |
| 6     | Not all content can be taught using SSI-based education | Any response related to unsuitability for the whole curriculum | Not all material can be adapted to this approach; not all topics are suitable for SSI-based learning. | 4.8   |

Table 8. PSTs’ willingness to implement SSI-based education

| Aspect               | N   | Score* | Sum | Mean value | Standard deviation |
|----------------------|-----|--------|-----|-------------|-------------------|
| Intention            | 62  | 0      | 28  | 21          | 13                | 171              | 2.76             | 0.78             |

*0: not at all, 1: to a small extent, 2: to some extent, 3: to a great extent, 4: to a very great extent

| Table 9. Potential science topics for SSI-based instruction |
|------------------------------------------------------------|
| No     | Topic                                                      | %     |
|-------|------------------------------------------------------------|-------|
| 1     | Environmental pollution                                     | 82.3  |
| 2     | Global warming                                             | 80.6  |
| 3     | Food biotechnology                                         | 71.0  |
| 4     | Green technology                                           | 66.1  |
| 5     | Addictive and addictive                                    | 62.9  |
| 6     | Civilization and environment                               | 48.4  |
| 7     | Interaction of living things and environment               | 46.8  |
| 8     | Electricity and electrical technology in the society        | 40.3  |
| 9     | Heredity                                                   | 37.1  |
| 10    | Energy in life systems                                     | 33.9  |

DISCUSSION AND CONCLUSION

SSI-based education was relatively unknown among the Indonesian PSTs in this sample. They had limited knowledge and experience about utilizing SSIs to teach science. All of the participants had had a course on science-technology-society. However, most of them had no experience prior to this study with approaches based
in authentic and controversial SSIs as a basis for science education. Theoretical justifications and conceptual ideas on the inclusion of SSIs in science based education are needed in science teacher education for later implementation (Sadler, 2011a). This also seems to be the case for Indonesia. In a study by Nida et al. (2020), practicing teachers described students’ lack of competency in dealing with SSIs as the largest expected challenge in implementing SSI-based education. Among the PSTs, the multidisciplinary and controversial nature of SSIs was listed as the largest challenge to teaching, since the units incorporate a variety of societal factors ranging from politics to economics to ethics (Sadler, 2011a). This was, however, also mentioned by many in-service teachers in Indonesia in the study by Nida et al. (2020). This was also paralleled in a Thailand study published by Pitipornpatin, Yutakom and Sadler (2016), in which PSTs tended to prefer uncontroversial issues for students to learn science. The PSTs in this study said that the controversial nature of SSI is not familiar to students. This avoidance of controversial issues might not just be due to teachers’ views of their students. Teachers often do not address controversial science-related issues because they themselves do not have a clear position (Lee et al., 2006).

The findings above suggest that teacher education needs to more thoroughly incorporate not only the learning of science, but also about science and its interrelatedness to other disciplines. Teacher trainees also need to learn about scenarios and pedagogies for effectively dealing with controversies in education, for example structuring discussions or role-playing. Both learning about multidisciplinary SSIs and covering how to deal with controversies are needed, if we intend to lower the barriers for effectively implementing SSI-based education. This will remain a challenging task for teachers, as Owens, Sadler and Zeidler (2017) suggest:

“Introducing students to relevant and contentious issues, helping them contextualize science ideas and practices toward the resolution of the issue, and tasking them with creating effective arguments and evaluating those of their peers is critical for promoting the kind of civil discourse that democracy requires, but it can be a daunting task for teachers” (p. 47-48)

Although the PSTs from this sample listed several challenges in implementing SSI-based education, they also acknowledged that many competencies might be promoted among both students and teachers. The first three competencies mostly acknowledged by the PSTs were problem-solving, critical thinking, and higher-order thinking. These three skills can be generalized into higher-order thinking skills that can be defined in term of transfer (the ability to use the knowledge in a more complex ways), critical thinking (reasonable reflective thinking focused on deciding what to believe or do), and problem-solving skills (the ability to identify and solve problems in life), as suggested by Brookhart (2010). Following Holbrook and Rannikmae (2007), the skills promoted by societally-oriented science education by the PSTs cover both the individual and societal domain. In the individual domain, intellectual skills, such as problem-solving, critical thinking or communication skills are believed to be enhanced by SSI-based learning. In the societal domain, understanding the interlinkage of science-technology-society and collaboration skills might be fostered. A few of the PSTs also acknowledged advantages for the nature of science domain by promoting inquiry or scientific investigation skills, scientific reasoning, or understanding the nature of science. Most of the skills mentioned by the PSTs were also in line with the those acknowledged by the in-service teachers in the previous study by Nida et al. (2020), although with slightly different order.

The PSTs also recognized several competencies that teachers might develop if SSIs are used in teaching. The most frequent responses were related to pedagogical skills such as designing innovative contextual learning, classroom organization and teaching skills, and utilizing various learning resources in teaching. This is also similar with the in-service science teachers’ responses about the teachers’ skills that are potentially enhanced (Nida et al., 2020). Most of the skills the in-service science teachers mentioned were related to pedagogy. Everyday issues which frequently appear in the news or media, commonly about environment, energy, and resources (e.g. SSIs) have all been suggested as daily life contexts to relate science to students’ daily life (Childs et al., 2015). SSIs therefore may affect learner motivation, orientation, topic illustration, and material application as suggested by De Jong (2008). SSIs seen to provide a motivational function for students, because they are strongly related to one’s personal and societal life. Teachers also utilize SSIs as contexts for their students to learn science concepts, although it is clear that not all traditional science content can be covered with SSI-based education. The PSTs, however, did acknowledge that SSI-based learning requires them to acquire a wider range of knowledge and skills, such as multidisciplinary knowledge and the ability to develop and utilize ICT-based media for teaching. This has also been suggested by Morris (2014), Evagorou (2011), and Presley et al. (2013). Additionally, better skills at forming networks of students, teachers, experts and other members of societal groups might be needed (Chen, Seow, So, Toh, & Looi, 2010). Less often mentioned, but also necessary, is the development of a stance of neutrality regarding different positions. This ensures that teachers’ personal beliefs do not interfere inadequately with the students’ positions.

A very important point for the PSTs was the potential role of SSI-based education in influencing students’ character formation. This was valued more highly than the relevance of students to learning about SSIs. One reason might be in the explicit focus of character education in the official Indonesian educational policy.
(Peraturan Presiden Republik Indonesia Nomor 87 Tahun 2017, 2017). Generally, it has been suggested that SSI-based education could play a role in developing character and imbuing values as global citizens (Lee, et al., 2013), such as in making responsible decisions and taking action on global issues (Lee et al., 2012). SSI-based education was seen to contribute to certain aspects of character formation, such as awareness, openness-mindedness, as well as responsibility. These aspects of characters were also the three most acknowledged characters by in-service science teachers (Nida et al., 2020).

Because SSIs are viewed positively in regard to building character and being relevant to learners, they are also desirable to most teachers. The participants in this study tended to want to employ SSI-based education in the future. Whether this will lead to implementation of SSI-based education must be viewed with caution, since it faces many hindering factors. This is especially true for the question of whether or not junior high school students have sufficient skills for dealing with controversial issues. Missing skills were also reported in a study published by Kara (2012) in Turkey, where PSTs were concerned that their students were not mature enough to make judgments regarding SSIs. Ekborg, Ottander, and Silfver (2013) also reported that teachers tend to think that school students are too young and have too little prior knowledge and experience in handling SSIs. One controversial belief among teachers about the level of skills and knowledge necessary for understanding controversial SSIs can be found in a study examining teachers’ views regarding teaching climate change in Germany (Feierabend, Jokmin, & Eilks, 2011). All this must be considered, however, to be less a question of students’ skills and more an issue of adequate pedagogies and teachers’ investment in their pupils’ skills development.

This study is somewhat limited by its sample size and its focus on only one group of PSTs from Eastern Java. However, the results may help us to better understand Indonesian PSTs’ views regarding the challenges and potential of SSI-based education. The study suggests that SSI-based education needs to be more thoroughly inserted into PSTs teacher pre-service education and continuous professional development. To implement this, the development and dissemination of examples, resources, and support structures are needed to overcome some of the expected difficulties (Mamlok-Naaman, Eilks, Bodner, & Hofstein, 2018). The program needs to provide PSTs with examples of how SSIs can be incorporated into science class using issues relevant to the Indonesian context. Then they can experience the corresponding practices themselves in teaching and during their teacher education seminars. The examples could start with the topics mentioned by PSTs or in-service teachers (Nida et al., 2020) which are believed to have potential, such as environment pollution, global warming, food biotechnology, green technology, etc.

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