ENHANCING PROBLEM-SOLVING SKILLS AMONG EARLY CHILDHOOD PRESERVICE TEACHERS THROUGH SOCIOSCIENTIFIC INQUIRY APPROACH

Hidayah Mohd Fadzil
Faculty of Education
University of Malaya
hidayahfadzil@um.edu.my

ABSTRACT

The purpose of this study is to examined early childhood preservice teachers' problem-solving skills through socioscientific inquiry approach. The study involved the researcher working independently on in-class research project with students in solving the problems related to socio-scientific issues (SSI) in early childhood education. SSI represents important social issues and problems which are conceptually related to science in social dimension. The study involved 28 third-year university students in early childhood education program. Inquiry-based problem solving strategies has been used to guide the students in their research on SSI. Data were collected through classroom observation, individual interviews, survey and students' written reports. Findings show that socioscientific inquiry approach can enhanced preservice teachers' articulation of ideas, closing the gap between theory and practical, and provide structured way to problem-solving. When students are engaged in the learning process, they experience a sense of agency and responsibility for their learning. Students can evaluate and reflect on their own learning when they have been part of the learning process and play an active role in the planning and identification of main learning objectives. Questioning and searching for answers are extremely important parts of inquiry learning and through this process, the students described that knowledge can be generated meaningfully. This study promotes innovations in teaching and learning and reorganization of the course that encourage student engagement and as a new strategy in fostering students' socio-scientific reasoning through inquiry learning.

Field of Research: *Socio-scientific issue, inquiry-based learning, early childhood education, health education.*

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1. Introduction

Scientific literacy refers to the ability to obtain, comprehend, and apply knowledge about science and technology to engage in a discussion and make decision related to science or technology. According to Miller (2012), scientific literacy reflects the knowledge of individual to understand scientific concepts and scientific way of thinking and apply it for individual and social purposes. A citizen with an understanding of those basic constructs would be able to make sense of new and emerging science issues years after the ending of their own formal schooling. Scientific literacy has become an internationally well-recognized contemporary educational goal. According to Holbrook and Rannikmae (2017) scientific literate society are viewed in two primary roots which are those that advocate a central role in 'doing' science as a career path and those who see scientific literacy in the context of society usefulness that enable them to make decisions on scientific issues. Roberts (2007) also discussed scientific literacy in terms of two visions. The first vision aims to foster content in the scientific disciplines and the second vision aims in enhancing student's science-in-society oriented understanding to function as life-long and responsible participants in their everyday lives. Modern society is becoming increasingly complex due to the advancement of science and technology. Numerous socioscientific issues (SSI) are emerging due to the result of science and technology production. Thus, society should be able to apply the scientific information underlies the issues and to reflect it in order to make decision related to SSI (Sadler et al., 2006).

SSI are defined as controversial, socially relevant issues within science curricula (Sadler et al., 2006). SSI exposes students to view science in a realistic way, including knowledge and ethics in making decision about societal issues that relate to science (Sadler et al., 2006; Siribunnam, Nuangchalerm & Jansawang, 2014). SSI are different from other scientific issues in that they are of many aspects and solutions. SSI are open-ended, ill-structured and arguable problems or issues (Sadler et al., 2017). Thus, the SSI has been chosen in this context to engage the preservice teachers with real issues that are happening in our society. The preservice teachers are encouraged to understand complex early childhood issues and make a decision according to their scientific knowledge, that can create a richer and meaningful experience for them, as suggested by Zeidler, Applebaum and Sadler (2011) and Zeidler and Nichols (2009).

Presently, socioscientific issues and socioscientific issue-based instruction are receiving attention in science education and researchers are extensively carrying out studies to find out the effectiveness of this approach (Sadler et al., 2017). In order to make an informed decision on socio-scientific issues, socioscientific inquiry approach has been selected in this particular study as a pedagogical approach that invites students to explore academic content by consistently posing, investigating, and answering questions (Towns & Sweetland, 2008). Socioscientific inquiry approach is an instructional strategy that integrates science content, culture and society while at the same time provides opportunities for the application of knowledge and ethical reasoning in decision making process (Sadler et al., 2017; Eastwood et al. 2012). Preservice teachers in this research are given the opportunity to engage in reasoning and debating. They are also given the opportunity to interact among themselves, explore scientific ideas and real data gathered from their investigation, while at the same time negotiates social aspects of the problems or issues. Furthermore, Drayton & Falk (2001) proposed that inquiry in the classroom has the ability to create scientifically literate individuals.

Research on socioscientific inquiry has often focused on its application in science education, but the approach is equally well-suited to the teaching of the humanities such as in early childhood education, as suggested by Arslan (2010) and Snow-Renner and Lauer (2005). One of the essence of inquiry is problem solving. Problem solving not only involve cognitive ability but includes other aspects such as attitudes and values. One of the main purpose of education is to improve criticizing thinking, logical responding and mainly to develop problem solving abilities of the students (Lavole, 1993; Sadler et al., 2017). Through problem-solving the preservice teachers could learn new knowledge by facing the problems to be solved, instead of burdened contents. The preservice teachers must observe, understand facts, analyze and interpret, find solutions and perform applications that lead to a holistic understanding of concepts. Thus, effective teaching needs to embrace knowledge and other skills, as well as provide multiple opportunities for the preservice teachers to use these skills and apply them across many experiences. The importance of having an excellent problem solving skills at bachelor degree level have also been emphasize in Malaysian Qualification Framework (MQF) (MQA, 2008). Domain number 4 clearly stated that individuals should show techniques and capabilities to search and use data to make decision, having considered social, scientific and relevant ethical issues. In addition, graduates of teacher education should be capable to communicate with a range of stakeholders involved in the process of educating children. Typically, teacher education has focused on providing preservice teacher with a set of theoretical knowledge that is arguably relevant to the practice of teaching (Edwards & Hammer, 2006).

Although developing problem solving skills is often accepted as a desirable goal in many educational settings, there is little evidence that students are graduated as better problem solvers. Thus, the students can solve routine problems, but they cannot adapt their prior knowledge for the solution of new problems (Koray et al., 2008; Hollingworth & McLoughlin, 2001). Moreover, according to Snow-Renner and Lauer (2005), one of the key elements in supporting teacher learning is through an inquiry-based teaching and learning that is well defined and well structured. Therefore, the

introduction to socioscientific inquiry in teaching and learning might be an appropriate approach to engage the preservice teachers actively in pursuing problem solving that involve them in scientific practices such as collecting and interpreting scientific data and building evidence-based explanation. Moreover, not all of the preservice teachers from Bachelor of Early Childhood Education pursue science stream in secondary school thus they are not familiar with the steps in conducting scientific investigation that integrated the elements of inquiry. In addition to that, teachers are one of the main sources for improving the problem-solving skills of children and learning problem-solving skills at an early age will lay a sound basis for children and for the world (Arslan, 2010). Ceylan, Yıldız-Bıçakçı, Gürsoy and Aral (2009) stated that the preschool teacher plays a major role in the development of children during preschool years. This claim is in line with Bingham (1998) who explicated that teachers play an important role in showing children that they have the ability and ways and means to deal with problems that arise in their environment. The methods used by teachers to interpret events and situations and the problem-solving styles of the teachers have a significant impact on the cognitive schema of children (Arslan, 2010). Considering that teachers having effective problem-solving skills will help their students to learn these skills, it is important for the pre-service teachers to receive this kind of practices (Arslan, 2010). Although this study is grounded by the general importance of problem solving skills learning that occurs between the interactions of teachers and children, it is not a study of the transference of problem-solving skills to children. Instead, the purpose of this study is to explore and understand the problem-solving skills of early childhood preservice teachers through an inquiry approach which is motivated by socio-scientific issues. This study focuses on the following research question: What are the early childhood preservice teachers' experiences in using socioscientific inquiry approach in problem solving?

2. Methodology

This study employed mixed-method methodology. It required the researcher working independently on in-class research project for 12 weeks. The aim of the study was to explore the problem-solving skills of early childhood preservice teachers through socio-scientific inquiry approach.

2.1 Participant of the study

The study was designed for the use in a course associated with the Bachelor of Early Childhood Education at a university in Kuala Lumpur, Malaysia. The course, Health and Safety, focuses on the issues regarding children's development: the health and safety components among children. The course exposed the preservice teachers to a variety of health problems that arise from negligence in maintaining health and safety among children. In the past, this course was conducted using a lecture and discussion format in which preservice teachers were lectured on a range of health and safety related issues and they are expected to complete a simple assignment on common childhood illnesses and presented it at the end of the course.

The participants of this study were 3rd year students enrolled in Bachelor Degree of Early Childhood Education. The 28 preservice teachers ranged in age from 23 to 25 years old. They have already been awarded with Diploma in Early Childhood Education before pursuing their bachelor degree and have prior experiences teaching in preschool during teaching practicum. This study organized preservice teachers to work in a group of five which they conducted researches on the selected socioscientific issues concerning early childhood. This task was considered as part of their continuous assessment with weightage score of 30 percents.

2.2 Implementation of the study

At the beginning of the study, the preservice teachers were given time to decide on the socioscientific issues (SSI) that they wanted to investigate and presented it during the third week of the course to decide on the suitability of the topic. The SSI selected are childhood obesity, pedophilia, childhood immunization, consumption of genetically modified food (GMF) and the use of electronic gadget on children. In respond to the selected socioscientific issues, students were

required to conduct scientific investigations that are based on the Alberta inquiry model (refer Figure 1). The Alberta inquiry model (Alberta Learning, 2004) was integrated to guide the preservice teachers in their inquiry processes due to the appropriateness of the model to the preservice teachers' level of understanding. The model provides explicit instructions on the skills and strategies that need to be apply in each phase of the process, as the model incorporates a step-by-step phase that are easy to follow. There are six major phases that are integral to learning and evaluation (planning, retrieving, processing, creating, sharing, and evaluating) and then a seventh central piece (or phase) that integrates reflection which continually operates throughout the process. The researcher explained the inquiry model during the introduction class at the beginning of the semester and guided the preservice teachers during the course duration.

All the information regarding the SSI and inquiry-based learning was posted to the course e-learning portal (refer Figure 2). At the end of this course, the preservice teachers were instructed to share their findings through presentation and to submit their research report.
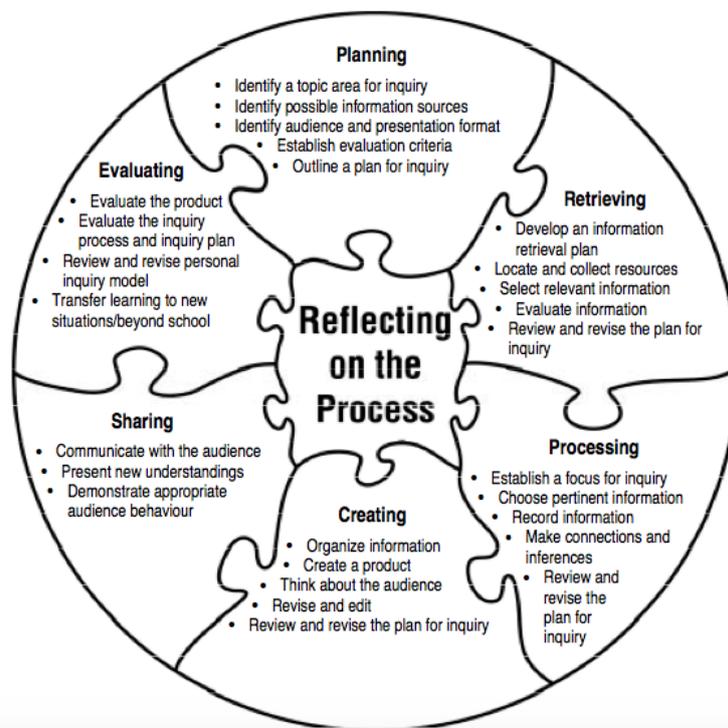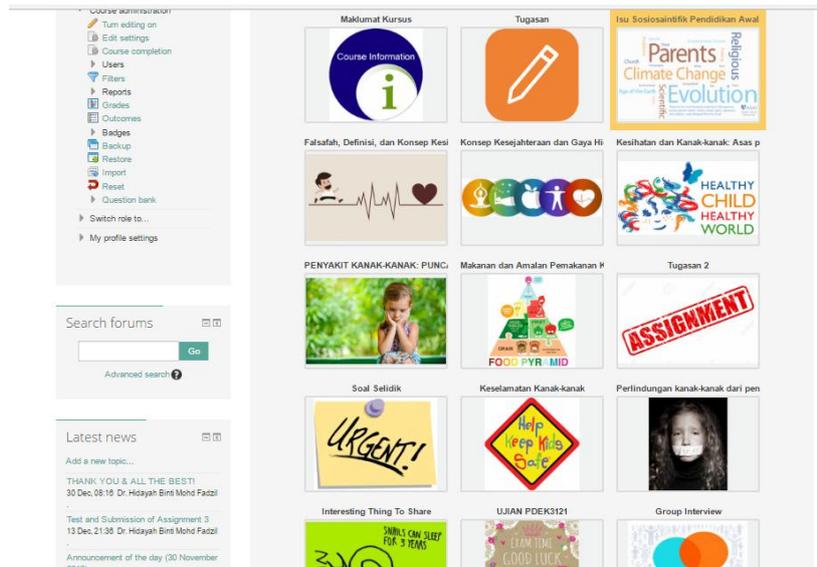

Figure 1. Alberta inquiry learning model

Figure 2. Snapshot of the e-learning platform for Health & Safety course

2.3 Data collection techniques and data analysis

Data were collected through classroom observation, individual interviews, survey and analysis of document which were the students' written reports. The questionnaire, in particular, contained 18 statements linked to a five-points Likert scale namely: strongly disagree [1], disagree [2], not sure [3], agree [4] and strongly agree [5]. The questionnaire was not piloted because it offers primarily limited descriptive data to be used in this particular setting and because of that the data should not be generalized to other settings. However, the questionnaire has been reviewed by two experts in the field of science education and health education. Therefore, this study adapted similar procedure in validating questionnaire from previous studies which involved an in-class research project setting. (e.g. Edwards & Hammer, 2006).

Data arising from the responses of the questionnaire were calculated as mean scores and the standard deviation for each item determined. The students' written reports and presentations were analyzed by using a problem-solving skills rubric. The interview data was transcribed verbatim. It was subsequently analyzed using qualitative research analysis techniques of open and axial coding in order to categorize and develop themes from information that emerged from the interpreted data (Strauss & Corbin, 1998). This paper reports the findings from five quantitative questions and qualitative questions that revolved around the early childhood preservice teachers' experiences of applying the socioscientific inquiry approach in solving problems related to their field. Their responses are the core of this study's findings.

Before the commencement of the study, the researcher provided a thorough explanation on the purpose of research to the preservice teachers. All participants volunteered to take part in the study and were assured of their confidentiality and privacy. They were also required to fill an informed consent form as proof of their acceptance and availability for the interview.

3. Findings and Discussions

For quantitative data, the high mean scores suggest that early childhood education preservice teachers perceived socioscientific inquiry approach as an appropriate approach to be implemented in their teaching and learning of this course (5=strongly agree). The following table (Table 1) illustrates the mean scores and standard deviation for the items.

Table 1
Findings for five quantitative questions aimed to determine the extent to which participation in the socioscientific inquiry approach supported students' problem-solving skills

Questions	Mean	(SD)
1. In solving problem related to SSI, I need to find the information from reliable sources	4.43	0.50
2. In investigating SSI, I need to understand, analyze and make the best decision based on the information gathered from various sources	4.29	0.46
3. My decision on SSI will be more relevant if I can argue and justify it Scientifically	4.50	0.51
4. Problem solving using inquiry approach is relevant to be used in understanding current issues in my field	4.11	0.69
5. I feel more confident to solve problems related to SSI in early childhood situations after I conducted this research	4.43	0.50

The responses from semi-structured interviews further illuminated these quantitative findings. A comprehensive thematic analysis revealed three major themes. These are, socioscientific inquiry approach (i) enhanced preservice teachers' articulation of ideas, (ii) closing the gap between theory and practical, and (iii) provide structured way to problem-solving.

(i) socioscientific inquiry approach enhanced preservice teachers' articulation of ideas

This theme explained the preservice teachers' communication skills which were one of the requisite competency for scientific literacy for 21st century citizens. It included the ability to articulate ideas by using variety of verbal and visual representation to deliver the key ideas from the relevant concepts efficiently. In this study, the preservice teachers involved in oral and written presentation, which were through their group presentation and submission of written report. The preservice teachers understanding of the SSI was reflected during this tasks. They have presented their findings by using software such as Microsoft PowerPoint and Prezi, sharing videos from YouTube and even conducted a role-play of the issues under study.

Most of the preservice teachers could answer the questions posed to them during the presentation and proposed relevant solution to the problems in SSI. For example, the group who conducted investigation on the topic of pedophilia suggested that pedophiles should be clinically and psychologically treated because pedophilia is a psychiatric disorder in which an adult or older adolescent experiences a primary or exclusive sexual attraction to prepubescent children. The preservice teachers suggested that pedophiles should not only be punished, but they were also entitled to received appropriate treatment or therapy. The therapy should integrate psychological and sexological, as well as pharmaceutical approaches. This example indicated that preservice teacher who can research more deeply into their SSI will often be able to come up with new ideas and better ways in solving problem. The following excerpt depicts the practice conducted by this group during the investigation:

> In our group, we worked together to find as many information related to our topic. We compiled all the input and conducted a discussion to establish a focus for our research. We attended seminars related to the issue of pedophilia to attain more knowledge. We all played our parts in accomplishing this research (Wanyi, ln.261-262)

Aikenhead (2006) explained that SSI are often complex, and therefore difficult to understand. Thus, group work provided the preservice teachers with a platform where they can engage in verbal behaviors that promote active thinking and learning. As preschool teachers communicated in their group discussions, they can confirm the received information, assimilate and accommodate the new information, and challenged their own ideas on SSI (Desrochers et al., 2007; Guiliodori et al., 2006). Habitually, when the preservice teachers engaged in a discussion, they verbalized the ideas that were beyond the boundaries of their knowledge. This triggered the preservice teachers to review and re-examine their understanding continuously and at the end they were able to draw an informed conclusion on the SSI under study.

An extensive body of literature also indicated that writing activities can enhance students learning and understanding in science (for e.g. Rivard & Straw, 2000) and the finding of this study concurred with the previous literature. Most of the preservice teachers were able to transform rudimentary ideas on SSI into coherent, structured knowledge by following the Alberta inquiry model in their investigation. This study also suggested that writing can enhanced the preservice teachers reasoning skills, promote continuous reflection on scientific content and demand them to organize their ideas rationally. Writing also engaged the preservice teachers in generating new knowledge on SSI, as explicated in the following excerpt:

> We comprehended the information because we made a lot of effort to investigated the topic and prepared the written report. Moreover, this socioscientific issue was relevant to us as a future preschool educator. (Yih, ln. 270-271)

Therefore, this study has indicated that the implementation of socioscientific inquiry approach can be valuable to enhance preservice teachers' communication skills and understanding. At the same time, it can also motivate the preservice teachers to understand the relevance of the controversial scientific problems in their everyday life.

ii) Relevancy of socioscientific inquiry approach in closing the gap between theory and practical

Connecting students to scientific concept in meaningful way has historically been a challenge in education (Falk et al., 2004). Nevertheless, employing socioscientific issues in the learning experiences have the potential to be pedagogically meaningful for preservice teachers to developed conceptual understanding and connected their experience to learning. This theme was concerned with the manner in which the preservice teachers described their participation in the socioscientific inquiry approach as relevant in bridging the gap between theory and practical. In this theme, the gap between theory and practical can be bridged by focusing on two aspects which are (i) the incorporation of knowledge on SSI into teaching and learning practices, and (ii) ability to connect new knowledge with other courses in early childhood education.

Findings from these themes saw the preservice teachers describing their experience as realistic in nature, as SSI was drawn from real world issues that children were faced with daily. Thus, the preservice teachers emphasized the relevancy to incorporate the knowledge gained from the investigation into their teaching and learning practices, as mentioned in the following excerpts:

> The knowledge from readings became much more meaningful when you could relate it into a real-life situation. I will never forget what I have learned during this course and I will certainly use the knowledge in my teaching practice later (Kika, ln.12)

> This study makes me aware of the issues that I might not have considered before, for example the existence of anti-vaccine movement in our country. I will use the knowledge to create awareness among my future students and their parents (Jye, ln.73-75)

Preservice teachers in this study also admitted that they connected the new knowledge that they have gained throughout the course with information from other courses in early childhood education, such as in special education and educational technology. For some preservice teachers, this theme saw them describing their increased engagement of the roles they had to play in solving the problem regarding SSI, for example:

> For instance, in the issue of pedophilia…we can design a technological application, such as digital stories in order to create awareness among the children. I can incorporate this knowledge in my educational technology course next semester (Ann, ln.231-234)

> We can increased our knowledge and understanding of SSI…Furthermore, I can relate the information with things I learned in other courses, such as child psychology (Khai,ln.115)

However, further investigation is required to shed more light on how this approach can support preservice teachers' understandings of the relationship between theory and practice.

iii) Socioscientific inquiry approach provide systematic way to problem-solving

This theme concerned with the manner in which the preservice teachers described how their participation in the socioscientific inquiry learning approach had increased their understanding of the issue by using systematic scientific procedures in problem solving. The finding shows that when the students were engaged in the learning process, they experienced a sense of agency and responsibility for their learning efforts. This finding confirmed the result from previous studies that when students are invited to take part in the learning process from the initial stage until the end of the process, it will produce a greater engagement from the students and possibly increase their intrinsic motivation to learn (Aikenhead, 2006; Ryan & Deci, 2000). Specifically, the students could evaluate and reflect on their own learning experience when they have been part of the learning process and play an active role in the planning and identification of the main learning objectives.

The used of Alberta inquiry model enhanced preservice teachers' decision making with respect to problem-solving. Results from this study were promising, as appropriate guidance can have a positive impact on students' socioscientific reasoning and decision making.

A common view amongst the preservice teachers are presented in the following quotes:

> Our investigation was more organized and we know the structure of what to do first… (Wanyi, ln.321)

> I have save a lot of time rather than me jumbled up everything. It is more organized (Kika, ln.187)

Active participation in learning facilitated the preservice teachers to synthesize gathered information and brought them in scenarios that required continuous informed decision makings regarding the problems, and therefore they progressively developed an in-depth understanding of SSI. The studies presented thus far provide evidence that socioscientific inquiry approach had motivated the preservice teachers to learn more from the course which did not occur during their experience with didactic teaching.

4. Conclusion

In the light of the findings, this study promoted innovations in teaching and learning and the reorganization of Health and Safety course that encouraged the students' engagements. It is a new strategy in fostering students' socioscientific reasoning through inquiry learning. Moreover, not all preservice teachers in early childhood education are familiar with the steps in conducting scientific investigation that were integrated as elements of inquiry. The findings reported here indicated that this approach enabled the preservice teachers (i) to enhance their articulation of ideas, (ii) to bridge the gap between theory and practical, and (iii) to conduct problem-solving in a structured and systematic way. The proposed study could help lecturers to organize the content of their course and to provide a relevant and cumulative framework for effective learnings. An appropriate teaching and learning should also provide the preservice teachers with different ways of viewing the world, communicating about it, and successfully coping with the questions and issues of daily living. Questioning and searching for answers are extremely important parts of inquiry and through this process, knowledge is generated effectively. Many studies had emphasized the relation between socioscientific issues and problem-solving skills. Since scientifically literate citizens are necessary in such a world that is continually improving in technology and scientific knowledge, teaching and learning should focus on SSI more than before. Despite the inherent limitation of this study due to its small scale and the lack of generalizability (which is not the underlying aim of this study), the findings of this research, to an extent, indicate the need for an alternative and complementary practice to the education of the preservice teachers. To date, there are not much studies conducted to explore the effectiveness of using socioscientific inquiry approach for teachers education, and particularly for early childhood education. Whilst, socioscientific inquiry approach may be considered as a useful pedagogical approach in teacher education, further investigation is needed in order to determine how this approach works to support early childhood preservice teachers in the scientific problem-solving process. This study will also provide grounds for further investigations in other areas of interest in early childhood education.

Acknowledgement

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