Exploring early childhood preservice teachers' problem-solving skills through socioscientific inquiry approach

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Abstract

Developing problem solving skills is often accepted as a desirable goal in many educational settings. However, there is little evidence to support that students are better problem solvers after graduating. The students can solve routine problems but they confronted difficulties when adapting their prior knowledge for the solution of new problems. The purpose of this study is to explore early childhood preservice teachers' problem-solving skills through socioscientific inquiry approach. The study involved the researcher working independently on an 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 learning approach has been employed to guide the students in their research on SSI. Data were collected through questionnaire, classroom observation, individual interviews and students' written reports. Data arising from the questionnaire were analyzed using descriptive statistics. The qualitative data were analyzed using open and axial coding in order to categorize and develop themes from information that emerged from the interpreted data. The most significant finding is that when students are engaged in the inquiry-based learning process, they will experience a sense of agency and responsibility for their learning. The students described that knowledge can be generated more meaningfully than in other perceived passive mode of learning. The finding also supported the result from previous studies that socioscientific inquiry learning helps to motivate and increases the students' interest in learning the course. It can be concluded that this study promotes innovations in teaching and learning and the reorganization of a course that encourages student engagement. Consequently, this study argues for a new strategy in fostering preservice teachers' socio-scientific reasoning through inquiry learning.

Keywords: Socio-scientific issue, inquiry-based learning, early childhood education, health education.

Introduction

Modern society is becoming increasingly complex due to the advancement of science and technology. The impact of science and technology in the world today is massive. Many controversial issues emerged in our society due to the result of science and technology development and these issues may influence individuals' scientific reasoning (Sadler et al., 2006). According to Miller (2012), scientific literacy refers to the ability of an individual to use information about science and technology in making informed decision. It reflects the knowledge of the individual to understand basic scientific concepts. A person 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. However, science in school

has long been taught and learned as a mono-methodological branch of knowledge (McFarlane, 2013, Fadzil & Saat, 2014). This attitude needs to change through the practice of embracing more student-centered approaches. According to McFarlane (2013), in order to enhance students' interest and understanding, there is a need for a more involved and project-based approach that provides students with the opportunities to engage with science. This statement is also supported by Nuangchalerm (2010) that stated that teaching and learning should engage students in an inquiry approach that involves students in pursuing authentic problem-solving, rather than information and definition giving.

Socio-scientific issues (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 are related to science. Society and their representatives in particular should be able to apply the scientific information that underlies the investigated issues and to make thoughtful decisions with the aim to engage socioscientific issues. Thus, the SSI have been chosen in this context to engage the pre-service teachers with real issues that are happening in our society. They were encouraged to understand complex society issues and make a decision according to their scientific knowledge. Following Zeidler, Applebaum and Sadler (2011) and Zeidler and Nichols (2009), these can create a richer and meaningful experience for the preservice teachers.

Inquiry-based learning has been selected in this study due to the essence of inquiry which is problem solving. Problem solving is often used synonymously with inquiry and science process skill reasoning (Helgeson, 1994). Problem solving does not only involve cognitive ability but includes other aspects such as attitudes and values. Inquiry-based learning is a pedagogical approach that emphasizes student-centered engagement with real problems. The approach motivates the students to pursue active decision-making processes. It also invites students to explore academic content by consistently posing, investigating, and answering questions. Also, known simply as 'inquiry,' this approach puts students' questions at the center of the curriculum, and places just as much value on the component skills of research as it does on knowledge and understanding content (Towns & Sweetland, 2008). The process of teaching and learning through inquiry-based is appropriate for students from preschool through graduate school (Towns & Sweetland, 2008). Previous studies in inquiry-based learning approach have often

focused its application in science and mathematics education. Nevertheless, 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). Moreover, Drayton and Falk (2001) have stated that inquiry approach can create scientifically literate individuals. Thus, the term socioscientific inquiry approach in this paper represents one approach that is designed to stimulate deeper interest and knowledge related to science.

In this study, the preservice teachers were required to observe and understand facts which led to analysis and interpretation of information. The inquiry process in not complete until the teachers are able to find solutions and perform the relevant applications. Consequently, the acquisition and practice of this skill led to a holistic understanding of concepts in SSI. The importance of having an excellent problem-solving skill at bachelor degree level has 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 after having considered social, scientific and relevant ethical issues. Although developing problem solving skills is often accepted as a desirable goal in many educational settings, there is little evidence that students are better problem solvers after graduating. As a result, 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). Not all the preservice teachers from a Bachelor of Early Childhood Education pursue science stream in school. Thus, they are not familiar with the steps in conducting scientific investigation that integrates the elements of inquiry. However, the lack of formal training in scientific study should not be a deterrence: 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 and revision of an inquiry-based teaching and learning approach might be an appropriate approach. This approach engages the preservice teachers to pursue problem solving actively and involved them in scientific practices regardless of their specific background. Agreeing with the philosophy behind SSI, scientific skills such as collecting and interpreting scientific data and building evidence-based explanation could become a necessity skill sets for the future teachers in order to fulfill their role more effectively.

Teachers are one of the main sources for improving the problem-solving skills of children. Consequently, 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. 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 (Bingham, 1998). 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 preservice teachers to receive this kind of practices beforehand (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' responses to using socioscientific inquiry approach in problem solving?

Methodology

Participants of the study

The findings emerged during the investigation of preservice teachers' responses to their participation in socioscientific inquiry learning approach. 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

preservice teachers have not been exposed to the authentic problem-solving technique in this course.

This study employed mixed-method methodology and required the researcher working independently on in-class research project for 12 weeks. The preservice teachers participating in the course were 3rd year students enrolled in Bachelor Degree of Early Childhood education. The 28 preservice teachers (10 male and 18 female) 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. Particularly, this study organized preschool 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.

Implementation of the study

At the beginning of the study, the preschool teachers were given authority to decide on the socioscientific issues they wanted to investigate and presented it during the third week of the course. The researcher commented on the suitability of the topic during this presentation. The SSI selected were 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. The Alberta inquiry model (Alberta Learning, 2004) was integrated to guide the preservice teachers in their inquiry processes (refer Figure 1) 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 are applied by the students in each phase of the process. Referring to the model consistently provided a guide to the preservice teachers during the investigation, as the model incorporates a step-by-step phase that are easy to be followed by them. There are six major phases that are integral to learning and evaluation, 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.

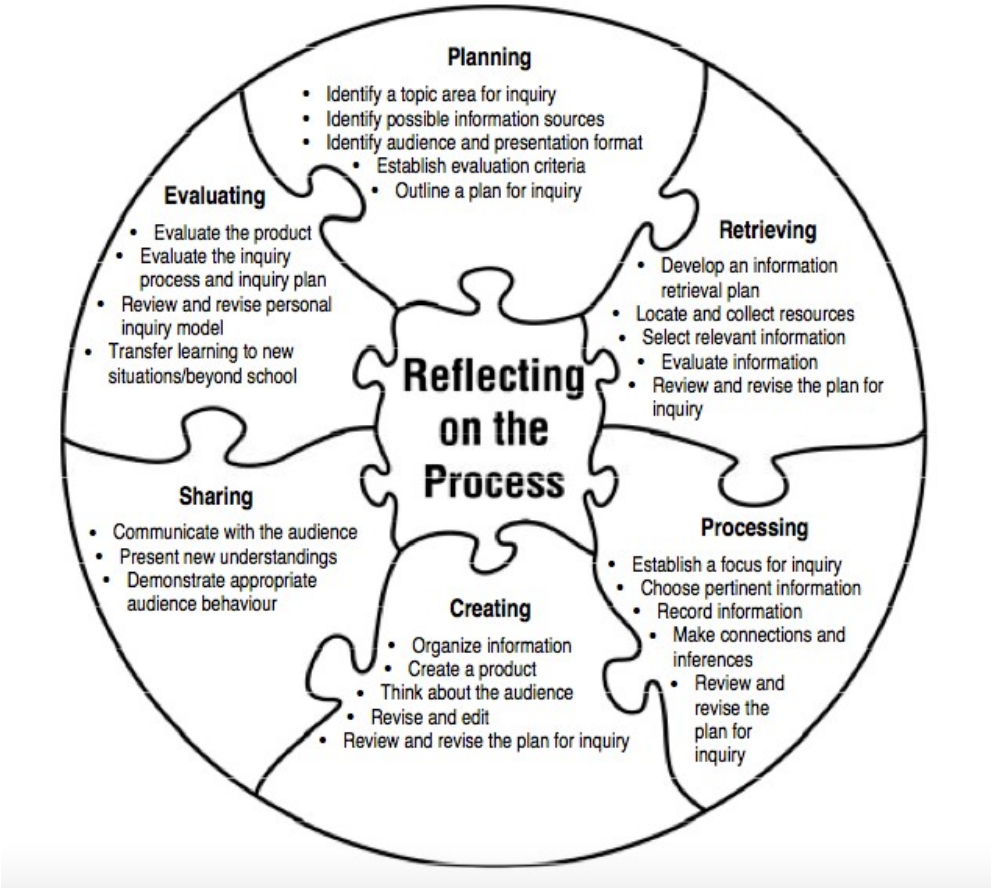

Figure 1. The Alberta Inquiry Model (Alberta Learning, 2004)

All of 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.

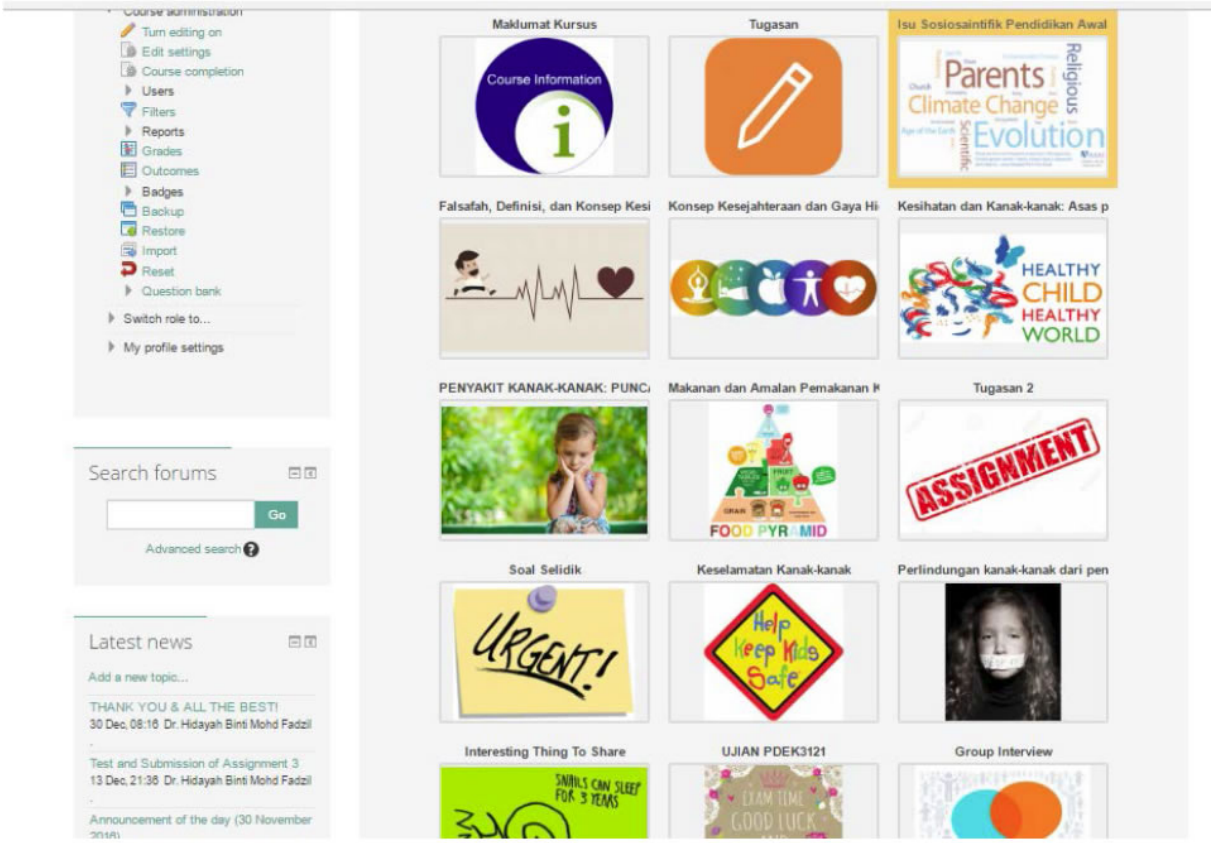

Figure 2. Snapshot of the e-learning platform for Health & Safety course

Data collection method and data analysis

Data regarding the students' perceptions were collected continuously on different stages: i) during classroom observations, ii) during presentations, iii) from semi-structured interviews with the students, and iv) from the assessment of the written reports and administration of questionnaire at the end of the study (n=28). The questionnaire, in particular, contained 18 statements linked to a five-point 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. Therefore, this study adapted similar procedure 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 were determined. The students' written reports and presentations were

analyzed by using a problem-solving skills rubric which involve the criteria stated in Table 1.

Table 1. Description of criteria in assessing preservice teachers' problem-solving skills

No.	Criteria	Description
1.	Identification of problem related to socioscientific issues	Problem or issue to be addressed is clearly identified and explained. Students clearly state the related socioscientific issue
2.	Significance and relevance of issue	Problem identified is relevant and specific to content area. Student appropriately identifies problem that is not too broad or narrow
3.	Gathering of information	Multiple sources of appropriate and relevant information are identified and used (for e.g. interview, survey, document analysis)
4.	Integration of scientific knowledge	Student integrates and applies knowledge gained from this subject to the current issue with new information gained throughout investigation
5.	Interpreting and analysis of information	Student provides a logical interpretation of the findings based on scientific evidence
6.	Presentation of findings	Presentation of the findings is clear and presented in a logical manner
7.	Conclusion	Clearly solve the problem and offer alternative solutions to tackle the socioscientific issue
8.	Reference	Skilled selection and synthesis of reading materials drawn from a wide range of sources including critical evaluation of and appropriate quotations from materials

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. Their responses are the core of this study's findings.

Ethical considerations

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.

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 2) illustrates the mean scores and standard deviation for the items.

Table 2. 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. The use of inquiry approach helps me in investigating socioscientific issues in a more structured and deliberate manner	4.29	0.54
2. The application of inquiry approach to understand socioscientific issues in early childhood is more meaningful as compared to conventional teaching technique such as lecture	4.40	0.74
3. Socioscientific inquiry learning approach requires me to conduct research in a more scientific way	4.31	0.50
4. Problem solving using inquiry approach is relevant to be used in understanding current issues in my field	4.43	0.50

5. I feel more confident to solve problems related to socioscientific issues in early childhood situations	4.11	0.68

The responses from semi-structured interviews further illuminated these quantitative findings. A comprehensive thematic analysis revealed three major themes. These are: (i) inquiry approach generated meaningful learning, (ii) SSI increased motivation and interest in learning the course and (iii) socioscientific inquiry approach assisted in the acquisition of other important skills that are needed for undergraduate students.

(i) Socioscientific inquiry approach generated meaningful learning

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 have played an active role in the planning and identification of the main learning objectives. Without a doubt, questioning and searching for answers are extremely important parts of inquiry learning. Through this process, the students described that knowledge can be generated meaningfully. Meaningful learning occurs when these preservice teachers can engage with the learning directly and attach more meaning to it. As a result, the learning process make more sense to them. Howland et al. (2012) characterized meaningful learning as the learning that being active, constructive, authentic and cooperative.

One of the preservice teacher explained the situation as follows:

> We have learned a lot from the research in socioscientific issue as compared to the assignments given from other courses that we have taken previously. They (the lecturers) just assigned us with a topic and we needed to present it

> during the lesson. We just searched the internet for the information. However, when we were asked to do a research in socioscientific issue, we gained a lot of knowledge and better understanding….in-depth understanding…better than just taking the information from the internet (Yih, ln. 191-193)

From this research, students also admitted that they took more responsibility of their role in learning as a group. This learning experience had also motivated the preservice teacher in exploring the relevant concepts in SSI and put forward their own strategies for dealing with the issue. The following excerpt depicts the positive impacts:

> 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 to attain more knowledge on the issue of pedophilia. We all played our parts in accomplishing this research (Wanyi, ln.261-262)

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. Subsequently, the students progressively developed an in-depth understanding of SSI. Table 3 outlines preservice teachers' actions for each week in relation to the six phases of inquiry learning model by Alberta Learning (2004).

Table 3. Preservice teachers' actions for each week in relation to the six phases of inquiry learning model by Alberta Learning (2004).

Week	Action	Observation based on inquiry phase (Alberta Learning, 2004)
1	Introduction to the socioscientific inquiry learning approach and the formation of groups among preservice teachers	<u>Planning phase</u> Preservice teachers determined what is to be investigated: • identified an appropriate topic area in SSI for inquiry • found issues and problems that are significant and relevant to the SSI • formulated research questions and research aims * The SSI selected are childhood obesity, pedophilia,
2	Exploration and identification of SSI in early childhood	

	topics by preservice teachers	childhood immunization, consumption of genetically modified food (GMF) and the use of electronic gadget on children.
3	Preliminary presentations of the chosen topics for SSI research	
4 to 9	Investigation are conducted by the preservice teachers in groups	Retrieving phase Preservice teachers managed to gather information from multiple sources such as review of literature, interview with experts: e.g. doctors who specialized in childhood immunization, attended seminar on pedophilia and conducted small survey on respected SSI. Processing phases Preservice teachers displayed great ability to integrate and apply knowledge gained from their investigation with the SSI. Creating phase: Preservice teachers organized the gathered information and provided logical interpretation of the findings that were based on scientific explanation. Additionally, they made informed decisions in solving the problem arise from SSI.
10.	Presentation of ideas by preservice teachers Assessment of the preservice teachers through the presentation of evaluation rubric	Sharing phase Most of the preservice teachers could deliver key ideas from the scientific concept efficiently and effectively and manifested their understanding through presentation, written reports and interview session. Evaluating phase The preservice teachers evaluated their findings, made conclusions and offered solutions to tackle the SSI.
11.	Final report submission	Preservice teachers submitted the written report.
12.	The preservice teachers participated in semi structured interviews and questionnaire	Preservice teachers answered the questionnaire online and took part in interview session.

(ii) SSI increase motivation and interest in learning the course

This theme referred to the preservice teachers' responses which expressed how their participations in the study had increased their motivations and interests. Even though preservice teachers admitted that they "did not had much interest in science", (Jye, ln. 21) and that "as an art stream student, I did not know much about scientific concept" (Yih, ln. 14), they had displayed adapting abilities to comprehend scientific information that underlay the investigated socioscientific issues. This can be observed during group presentation sessions and through their written reports. During the interview, both of the preservice teachers admitted that the SSI had motivated them to learn more from the course which did not occur during their experience with didactic teaching. This is stated in the following interview excerpts:

> I do not prefer learning in a one-way lecture approach because the information gained is very limited. Through inquiry approach I built my own understanding regarding childhood obesity. The knowledge from readings became more meaningful when I linked it into real life context (Jye, ln.82)
> This approach is more relevant in comparison to information I got from lectures…It made you aware of issues that you might not have considered, for example the long-term effect of consuming genetically modified food for children (Khai, ln.135-137)

One of the preservice teacher reflected her previous experience in learning similar course during her diploma study;

> We had learned this subject before, but like what Khai said, we only learned basic things. Safety in class, safety on outside, safety in playground and all that stuff. Imagine that we had already learned three years of diploma. Every class that we attended here (for bachelor degree) more or less was related. This is one interesting subject (Health and Safety) where we can you know, conduct like a mini project. And I have never heard of GMO. (Kika, ln.140-142)

This finding concurred with previous studies (for e.g. Aikenhead, 2006; Ekborg at al., 2009; Sadler, 2006; Zeidler, 2014) which found that students are extremely interested in working with socioscientific issues.

(iii) The approach assists in the acquisition of other important skills needed for undergraduate students

The findings indicated that socioscientific inquiry approach also enhanced the preservice teachers acquisition of other important skills such as communication skills, group work and skills in doing scientific research. SSI are said to be vehicles, not only for raising students' interests in science, but also for strengthening generic skills such as team-work, problem-solving and technology literacy. (Jarman & McClune, 2007; Lindahl et al., 2011; Ratcliffe & Grace, 2003).

Communication skills are one of the requisite competency for scientific literacy for 21st century citizens which include the ability to articulate ideas by using variety of verbal representation (oral presentation and written report) and visual representation (such as the use of video, roleplay, and multimedia presentation) to deliver the key ideas from the relevant concepts efficiently. During the interview, the preservice teacher admitted that she has learned "the skills to communicate and socialize with the kindergarten teachers and parents that took part in the investigation" (Jye, ln.261).

In the present study, the findings also revealed that group work enhanced the socioscientific inquiry approach in terms of complexity, inquiry, and multiple perspectives. In group activities, the preservice teachers displayed a variety of ways to explain the SSI, made connections between theory and real-life situation, drew conclusions, and found solutions and strategies to overcome the negative effect of the issues. Group members reasoned together, negotiated together, evaluated claims and evidences and ultimately reached a consensus on the nature of the problem (Galton, Hargreaves, & Pell, 2009). Group activities were seen more effective since preservice teachers were more willing to be vocal, and they felt comfortable expressing ideas because there is no "right" answer. Furthermore, they were able to interrelate values with complex conceptual issues. In this way, they learned to build qualified arguments and enhanced their problem-solving skills. The discussions were more varied, generative and exploratory (Tal & Kedmi, 2006). Therefore, the responses of the participants indicated that group work is believed to be an effective method to be implemented in this study.

Preservice teachers admitted that this study had helped to enhance their skills in doing research as they are required to submit their project paper during the final semester of their bachelor degree. These skills included the skill in recognising research problems, knowing current work in field, finding information off the internet, and finding information from different sources. Additionally, the learning

process required the participants to analyze critically the gathered information which they later must document and report the outcome of their study. The following excerpts were taken from the interview sessions with the preservice teachers:

> I am extremely interested with the inquiry approach because it gave me an initial exposure on how to conduct my own research for my project (Ann, ln.490)
> I view this assignment as a training for my project paper (Ami, ln.297)

Individual who can research more deeply into their field are often able to come up with new ideas and better ways in solving problem. Therefore, the implementation of socioscientific inquiry approach has been proven to assist the preservice teachers in developing their communication skills and ability to work cooperatively with others as an outcome of their interactions with the different stakeholders. These experiences had contributed holistically in developing their general skills in conducting a systematic investigation.

Conclusion

In the light of the findings, this study promotes 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' socio-scientific problem-solving skills 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 generate a meaningful learning experience, (ii) to increase motivation and interest in learning the course, and (iii) to assist in the acquisition of other important skills needed for undergraduate students. The proposed study could help lecturers to organize the content of their course and provide a relevant and cumulative framework for effective learnings. An appropriate teaching and learning should also provide students 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 as part of the teachers' training generally, and particularly in its relation to early childhood education. Whilst, socioscientific inquiry approach may be considered as a useful pedagogical approach in the teachers' education, further investigation is needed in order to determine how this approach works to support preservice teachers in the scientific problem-solving process.

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