TEACHERS’ OWNERSHIP TOWARDS USING SOCIO-SCIENTIFIC ISSUES FOR AN ACTIVE INFORMED CITIZENRY

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Abstract
Socio-scientific Issues are potentially a useful teaching area for enhancing learning. These can motivationally promote socially embedded nature of science topics through controversial issues, thus promoting students’ argumentation skills, decision making skills, societal values, personal development as well as economic considerations. With the growing intention to develop active and informed citizenry worldwide, socio-scientific issues have the potential to promote very meaningful educational skills among the students, suggesting teacher ownership of a social scientific relationship is an important field to study and seek ways to promote. This study is intended to serve the purpose to seek teacher opinions and conceptualizations in this specific area with a view to understanding their ownership towards using socio-scientific issues to promote an active informed citizenry.

Keywords: Classroom Discourse, Socioscientific Issues, Teacher Preparation.

1 INTRODUCTION
Relating science education to social aspects, especially where these are familiar, or of interest to students, is seen as an important development in education [1]. To address this interrelationship within science education and society, the inclusion of socio-scientific issues is potentially a useful teaching approach [2]. Over the years, socio-scientific issues has been shown to meaningfully incorporate important interdisciplinary learning skills, such as argumentation [3], decision making [4], tackling ethical dilemmas [1] and character development [5]. In fact, a further significance of SSI can be suggested as arising through involving students in putting forward informed opinions [6]. Such opinions, potentially leading to beliefs, are based on an appropriate conceptualization of the related science, seeking to resolve issues incorporating a range of society factors, seeing this form of enhanced scientific literacy as promoting a more active and informed citizenry.

The idea of active informed citizenry can be conceptualised as a group of scientifically literate, actively participating citizens, who are willing to engage in scientifically influenced, personal, national and global activities. The concept of active informed citizenry, as derived from the literature, is to provide an all-embracing umbrella, which seeks to promote expected outcomes from science education such as the use of scientific knowledge and beliefs in situations requiring individual, social, national and/or global participation [7]–[9]. The literature emphasises that SSI needs to foster these outcomes, although the concept of an active informed citizenry can also be conceived as going beyond the literature focus, suggesting that students’ participation need not be limited to individual gains, but in addition, preparing students to seek to embrace the involvement of the wider citizenry to engage in such issues focusing at the local, national and/or global level, thus establishing ‘an informed citizenship’ [10], ‘active engaged citizens’ [11], or even global citizens [12], seeing the collective use of the term ‘citizens’ as ‘citizenry’ who recognise and participate in social responsibilities [13].

In implementing SSI to achieve the goal of promoting an active and informed citizenry, teacher ownership of this is hypothesised as a key aspect among teachers. In fact, teacher ownership is a growing area of importance since it incorporates how the improvisation of teaching is implemented by the teachers influencing students’ learning [14]. The teacher ownership concept is further clarified as the ability to internalise the teaching concepts as intended, delivered as expected and shared with others [15].

To explore the feasibility of promoting an active informed citizenry through science education in the actual classroom situation, the study puts forward the following research question;

1 How far are teachers aspiring to using socio-scientific issues towards promoting active informed citizenry?
2 METHODOLOGY

The study was conducted as a basic interpretive study using a qualitative approach, which is commonly employed to serve the purpose of understanding a phenomenon by analysing the data collected from participants [16].

In order to obtain maximum variation in responses, 10 volunteering Estonian teachers were chosen as the target population, purposefully chosen to identify and select potentially ‘information-rich cases, related to the phenomenon of interest’ [17] In this case, the study related to the extent of teacher involvement in implementing socio-scientific issues in the classroom. The teachers were categorised in four groups according to their teaching experience and prior or current engagement in in-service courses.

a) Highly experienced teachers having prior involvement in in-service course (number of teachers: 3),
b) Teachers who recently completed pre-service courses (number of teachers: 3),
c) Recently graduated teachers (number of teachers: 2), and
d) Experienced teachers without any involvements in projects or in-service courses (number of teachers: 2).

Teachers were interviewed for approximately 30 minutes using a semi-structured interview guideline, based on open-ended questions. The questions were aligned with the Estonian curriculum and 4 categories (validated by science education experts) were established, helping the interviewer to conceptualise the teacher’s teaching perspective. The four categories of questions were:

1 How to develop students’ decision making abilities within a socio-scientific situation, which enables them to gain content knowledge and also participate in the decision making process?
2 How to establish students’ values which enable them to acknowledge the need for self-determination?
3 How to ensure a student’s personal growth with respect to cognitive, dispositions and psychomotor aspects?
4 How to enhance individual, local, national and global economic concerns among students through science education, including career orientation, society cohesion, sense of community and the ability to interact with others?

Collected data was transcribed and inductive data analysis was carried out in two steps:

a) summarising the comments made, and
b) interpreting teachers’ responses (within the four teacher groups).

The validity of this approach was established through consultation with a science education expert who have been involved in teacher development programmes and the reliability of this study has been established by transcribing the data and crosschecking with the participants.

3 RESULTS AND DISCUSSION

3.1 Developing students’ decision making abilities in a socio-scientific situation

The teachers’ understanding of making ‘competent decisions’ was almost similar in all cases. The teachers tended to interpret ‘competent decision making in everyday life’ as dealing with any situation where science has a role. Examples mentioned were (a) choice of clothing according to heat conductivity (in physics), (b) the need for vaccination (in biology), (c) limiting production of gases e.g. CFCs (chlorofluorohydrocarbons) (re-global warming in chemistry), (d) refugee crisis (in geography).

3.1.1 Summary of teachers’ comments

Teachers acknowledged that through decision making about a controversial topic, students developed the skills to resolve an issue in a democratic way. They valued each other’s opinions and through a valid argumentation process, based on scientific evidence, the students came to a conclusion.
Teachers stressed that in the discussions, the students might not reach a resolution expected by the teacher. For example, while discussing the use of animals to produce insulin for diabetic patients, one teacher experienced that the students came to a conclusion that it was not worthy to bear the burden of expenses spent for the older generation.

During SSI, the teachers played the role of a facilitator, rather than as an instructor, and thus did not directing the students to reach the expected conclusion. In facilitated the discussion, the teachers made available sufficient sources of information in order to enable the students to make better decisions.

3.1.2 Interpreting teachers’ responses

3.1.2.1 Highly experienced teachers having prior involvement in in-service course:

a) The highly experienced teachers believed that students needed to understand the nature of science to make competent decisions, suggesting students should use the knowledge gained from SSI learning in their everyday life activities, such as turning of the lights, water taps, garbage sorting. In addition, they should have the skills to use technological equipment to make their lives easier, while recognising the need to strike a balance and not harm the environment.

b) The teachers mentioned that making use of the media and out of school learning activities aided the promotion of decision making through socio-scientific issues.

c) Teachers believed that a teacher’s willingness was a key factor for promoting informed decision making through a socio-scientific issue, stressing that aspects such as curriculum overload, time management and lack of resource were not a problem when the teacher was well prepared.

d) In their experience, the teachers found that students were able to argue, often passionately, over a controversial topic and could come to a resolution in a democratic way, after weighing logic considerations and the strength of arguments. Nevertheless, they mentioned that developing these skills might take more than just one year of any course.

e) Those teachers involved in several projects, stressed that a democratic debate, during decision making on a socio-scientific issue, was a major skill to develop among students. Involvement in several projects and trainings enabled their perception to emphasise on students’ decision making skill, rather than just focusing on content knowledge.

f) The teachers believed that to make decisions in a democratic way, student participation was important and teachers needed to provide guidance so that all students were able to put forward their opinions.

3.1.2.2 Teachers who recently completed pre-service professional development courses:

a) Teachers with two or three years teaching experience and having attended several in-service courses pointed out that competent decision making was acquired when students had the skills to make decisions using skills such as argumentation, cooperation, teamwork, communication, critical thinking and social skills.

b) These teachers highly emphasised that the teaching approach has to be student centred and monologue teaching would not be very helpful to promote decision making.

c) These teachers recognised that especially in biology classes the students came across a number of topics, which could be controversial, such as having plants inside the house at night-time, vaccination and species protection.

d) Making a meaningful decision in a democratic way was seen as only possible through a valid group discussion according to these teachers and the teachers’ willingness and preparedness were seen as key factors in promoting informed decision making.

3.1.2.3 Recently graduated teachers:

a) These teachers were found to have no experience in teaching about socio-scientific issues. Nevertheless, such teachers saw possibilities and recognised the importance of using socio-scientific issues for promoting decision making.

b) These teachers hypothesised that the theories and practices now (for examples, using waves like Wi-Fi or microwaves) might not have any visible demerits at present, but they recognised
the necessity to introduce to students, with examples, where previous theories might be proved wrong and thus preparing students to be open-minded and able to counter theories. The teachers agreed strongly, when asked whether socio-scientific issue could be a vehicle to promote informed decision making and they believed being open-mindedness was the key to making better decisions.

c) Freshly graduated teachers, in this case having one-month experience in teaching physics, believed that, in physics classes, there were not so many socio-scientific issues on which to hold discussions and linking everyday life with physics topics might make the topic even harder for students to understand.

3.1.2.4 Experienced teachers without any involvements in projects or in-service courses:

a) Teachers with more than 5 years’ experience, but no involvements in projects or in-service/pre-service courses held a range of different beliefs. Their interpretation of making competent decisions was to guide students to be able to use their knowledge for the benefit of their future, including everyday tasks e.g. choosing the appropriate dress for the weather or knowing when the egg is hard when being boiled.

b) These teachers found using the Chernobyl nuclear explosion as a controversial issue in every five years of a student’s study period where the contents and the individual task was provided to make an essay on the historical, economic, environmental issue and come up with an informed decision, along with the examination on the contents. While these teachers acknowledged that this exercise did not include decision making in a democratic way, the teachers mentioned that in other lessons, issues like whether or not to ban plastic bags, should there be any regulation on sugar consumption, if the traffic regulations are too strict, the teachers promoted informed decision making among the students through raising a controversial issue.

3.2 Establishing student values

While discussing a socio-scientific issue, the teachers noted the diverse values of the students. The teachers were aware that some students might not be expressing their opinions, so the teachers formed the teams in a way that every student was required to provide input to the discussion.

3.2.1 Summary of teachers’ comments

a) The teachers recognised that the students’ values mostly come from their personal experiences, beliefs, anecdotes from their personal lives and practices of their communities.

b) Teachers often mentioned that the values were recognised when the students start an argument with “in my opinion/in my family/I know someone, etc.” and the teachers also stressed that the students spoke very passionately and emotionally when their values were being expressed.

3.2.2 Interpreting teachers’ responses

3.2.2.1 Highly experienced teachers having prior involvement in in-service course:

a) Teachers stressed that teachers should be very willing to help students to trigger and be aware of their values and through a constructive discussion, shape their values for smooth integration to the society.

b) To prepare the students as better citizens in future, the teacher recognised the role of the teacher to involve the students to compare and analyse their values so that the students were prepared for less disappointments, setbacks and more tolerance to controversial issues.

3.2.2.2 Teachers who recently completed pre-service courses:

a) These teachers recognised that there are many ethical dilemmas where the students’ personal values play a major role during a discussion. They believed that it is very important that students have different values, because that made the discussion more constructive and the teacher played a role of a facilitator, not instructing right or wrong. Through a valid argumentation, the students recognised, weighed and established their values themselves.

b) Teachers recognised genetically modified food, vaccination, drugs, alcoholism were some of the topics in biology class where students came across different individual values. Cloning, abortion
and AIDS were some of the controversial topics mentioned by the teachers while they mentioned religious values played a role in the students’ argumentation. The teachers identified the religious value of a student when the student mentioned, ‘it’s God’s decision’ or ‘we can’t be God to decide a human can live or not’.

c) However, the teachers also mentioned that the Estonian law has regulation when an abortion can be taken place, and the teacher was also optimistic that the students could argue about the laws and the betterment of laws as well through an effective argumentation which the teachers recognised as a quality of a good citizen.

d) Teachers believed that they had to be respectful when the students have conflicts in their values and could not reach to a resolution, in which case the teacher had to be friendlier and support the students to acknowledge the logical aspects of an issue.

3.2.2.3 Recently graduated teachers:

The fresh graduate teachers had less teaching experience and they did not have enough opportunity to bring controversial topics in the class. Therefore, the teachers could not give examples how the students’ values were established through a controversial issue.

3.2.2.4 Experienced teachers without any involvements in projects or in-service courses:

a) Teachers mentioned while teaching Chernobyl and fossil fuel, e-substances as controversial issues, the students’ values were recognisable. In teaching the Chernobyl, the teachers recognised that the students while writing individual paper on the topic, bring out several aspects from their personal values and preferences, and the teacher also identified that the essay represented the student’s personal values through how the student described the issue.

b) The teachers recognised that the values the students grow from their families were visible when the teacher talks about driving speed, traffic, using mobile phone while driving. For example, if a student was brought up in a family where speed driving was normal and safe driving was frowned upon, in that case the teacher tried to show the speed of reaction and the possible consequences without pointing out which is right and which is wrong.

3.3 Enabling personal growth of the students

Even though, personal growth has been explained differently in several literatures, [18] categorised personal development in four key points - responsive to service learning, cognitive, emotional, behavioural engagement, reflection on society, self, service, conceptualization of diversity.

3.3.1 Summarised comments

Teachers had mixed ideas regarding promoting personal growth through socio-scientific issues, especially when broken down to the abovementioned sub-categories.

3.3.2 Interpreting teachers’ responses

3.3.2.1 Highly experienced teachers having prior involvement in in-service course:

The teachers mentioned that it is highly likely that the students started the responsible engagement towards self, society and world from their home, which made them a part of big community. For example, placement of an internet router, plants inside the bedroom at night-time, talking about vaccination at home, healthy menu for family members etc.

3.3.2.2 Teachers who recently completed pre-service courses:

Teachers mentioned that there were some activities that showed that the students really are achieving the personal developments, like the project of Temera where a lot of organisations of Estonia engage in environmental activities and the teacher mentioned that through discussing controversial issues, it is possible to make the students environmentally aware to take part in the project.

3.3.2.3 Recently graduated teachers:

Teachers believed that to engage students in service learning, community engagement might be difficult for the teachers since the teachers only actively connected to the students during the class hours. It would be quite impossible to monitor for the teachers if the students were in fact actively
participating in the society, also the teachers mentioned that the students had limited activities in their age.

3.3.2.4 Experienced teachers without any involvements in projects or in-service courses:
Teachers mentioned that after a valid discussion in a controversial issue, the students were more passionate to work on the subject and therefore more active in those issues, like protecting the diversity, acting towards a healthy lifestyle, taking part in social causes etc. For an example, the students tried to make people aware about the sugar consumption by displaying bottles of soft drinks and the amount of sugar in a glass and providing information how much calories these drinks contain and how to consume this amount with physical activities.

3.4 Enhancing individual, local, national and global economic concerns among students through science education

3.4.1 Summarised comments
Teachers had mixed opinion regarding the possibility of individual, local, national and global economic concerns among students through a controversial issue.

3.4.2 Interpreting teachers’ responses
While some teachers recognised the importance of enhancing individual, local, national and global economic concerns among students as a goal of whole science education but cannot be particularly achieved through socio-scientific issues, other teachers saw some possibilities to utilise controversial issues to produce a better labour force, develop future good employees, aware about global economy and specially promote skills that would be helpful for the students to take part in economic activities in future.

3.4.2.1 Highly experienced teachers having prior involvement in in-service course:
Teachers believed that introducing careers is very possible and also important while discussing an issue. Some teachers mentioned that while they discuss an issue through a role-play, the students had an idea about several career opportunities.

3.4.2.2 Teachers who recently completed pre-service courses:
Teachers stressed the point that while discussing a controversial issue, the students learnt certain skills like team work, decision making, communication, cooperation, leadership, presentation, time management, information validation, which the teacher believed made the students better future employees.

3.4.2.3 Recently graduated teachers:
Teachers anticipated that even though the role of socio-scientific issues haven’t been established yet to enhance individual, local, national and global economic concerns among students, there are fair chances and opportunities to explore.

3.4.2.4 Experienced teachers without any involvements in projects or in-service courses:
Teachers mentioned that some controversial topics raised awareness about global economy like genetically modified food, refugee crisis etc.

4 CONCLUSIONS
The study is conducted in the Estonian context, where the curriculum is competence-based. The data revealed that the teachers are willing to develop students’ competences in terms of using scientific knowledge in reaching decisions in scientifically influenced social issues. However, in-service courses and teaching experience seems to play a more significant role in guiding teachers to take ownership to incorporate SSI in their teaching as a step towards promoting an active and informed citizenry.
REFERENCES


