Inquiry in the Context of Socioscientific Issues: A case Study

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Abstract

The skills and knowledge of science can be developed through inquiry approaches, specifically those that focus on socioscientific issues (SSI) [1,2]. SSI are controversial scientific topics with ethical, moral or economic implications that can be used as a context for learning [1]. This paper presents a qualitative case study following a teacher as he facilitated a series of inquiry lessons in the context of SSI with a class of 19 lower secondary school students (aged 14-15). Data collection involved classroom observations, questionnaires, interview and secondary documentation. Thematic analysis was carried out on all data based on the method of Braun & Clarke [3]. The SSI contexts chosen by the teacher for the inquiry were highly relevant and contemporary and resulted in the development of a range of skills and knowledge in the students. Students developed their ability to explain the science, demonstrating their knowledge within the context of the SSI and distinguish between arguments based on science or other considerations.

Keywords: *Socio-scientific issues, inquiry;*

Introduction

Inquiry as a pedagogical approach is widely supported by educationalists as an effective method of teaching both skills of inquiry and content knowledge of science [1]. Broadly speaking inquiry based instruction is where students engage in hands-on activities in a student-centred way, with students involved in active-construction of learning [4]. The teacher acts as a facilitator rather than knowledge provider. Socio-scientific issues (SSI) are social issues with conceptual and procedural connections to science [2]. However, SSI are more than simply "real life" contexts; they are scientific issues with ethical, moral or economic implications [2]. SSI are controversial. This means that they involve a number of conflicting scientific, social or moral viewpoints, which may conflict with the students' own views; this makes them personally relevant to the students [5,6]. Because of the conflicting viewpoints and understandings of the SSI, a concrete conclusion cannot usually be reached even after thorough examination of evidence [6]. These contemporary and personally relevant SSI can be used to provide contexts for inquiry based learning in which students engage in dialogue, discussion and debate [5,2].

Methodology

This study is a qualitative case study following a teacher through six, 40 minute lessons with a class of 19 students (aged 14-15). The students took part in a guided inquiry in the context of two distinct but related SSI. The teacher (given the pseudonym of Mr. Baker) has been teaching for 25 years and is experienced in embedding teaching through inquiry into his everyday lessons. The researcher carried out lesson observations and an in-depth, open interview with the teacher at the end of the six lessons. Secondary documentation relating to the student experience was also gathered , which included a short, open response student questionnaire and student work. Analysis of this data was carried out qualitatively using thematic analysis based on Braun and Clarke [3]. Validity of findings was considered through triangulation between data sources and member checking of the themes before finalization [7].

Findings and discussion

The table below outlines the two themes identified from analysis of the questionnaire, interview transcript and secondary documentation. The sub-themes are displayed in order of importance, indicated by the number of coded references to the sub-theme, from highest to lowest.

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Table 1: Themes and sub-themes

Theme	Sub-themes
Skills	Explain scientifically
	Work together
	Research
	Distinguish arguments based on science
	Evaluate solutions
	Present information
Knowledge	Recall and apply scientific knowledge
	Implications of scientific knowledge for society (and the environment)

SSI context and teaching approach

In this case study, context was a key factor driving the student inquiry. The first five lessons, entitled "The Transport Problem" were situated within a local context, making the inquiry particularly relevant to the students. Mr. Baker described his reasons for choosing this context:

"It was looking at an issue that would be relevant to the students, that they could tap into fairly rapidly, and it was the idea of local congestion when getting into school in the morning. Many of them would be familiar with this because they come from the local community and towns."

Mr. Baker introduced the SSI by displaying a PowerPoint slide showing a traffic jam in the local area, without further explanation. It was evident to the researcher that the students were immediately interested and comments such as "that's where I live" could be heard. The students were then asked to work in groups to discuss the problem and develop short and long term solutions to The Transport Problem. Following this, the students presented their solutions, still as part of a group, to the rest of the class. Finally, the students were asked to critique their solutions by coming up with the pros and cons of each solution.

The final lesson was entitled "Letters to Trump" and was based on a SSI set in a global context. The SSI was climate change or more specifically climate change denial. Mr. Baker introduced the topic by reading aloud a series of climate change denying "tweets" from current President of the USA, President Trump. As with the introduction to the previous SSI, the students immediately showed interest and whispering of "Trump", "Donald Trump" could be heard in the classroom before the teacher revealed the author of the "tweets". The students were then asked to prepare a letter to President Trump to "inform him of the difference between climate change and global warming" and that the "best ones will be sent to the Whitehouse." At interview, Mr. Baker explained how he and the students collaborated on the outcome of this inquiry:

"I handed out a series of his [Trump's] tweets and they [the students] were absolutely incensed. I did it with a couple of classes and some of the students got really annoyed about it and asked 'can we not write to him and put him right'. I said 'yeah, go for it'. That was the trigger scenario for that activity."

Mr. Baker also described just how contemporary the SSI context was:

"It was fortunate at the time and it just tied in nicely that Trump had just released a series of tweets about global warming and climate change, saying that the whole thing was a very expensive hoax...The circumstances that set up the lesson were unique in that it happened at a time when Trump had been very vocal on a particular topic"

Figure 1 below gives an overview of the student inquiry, focussing on the skills and knowledge developed. The skills and knowledge sub-themes are shown in *italics*.
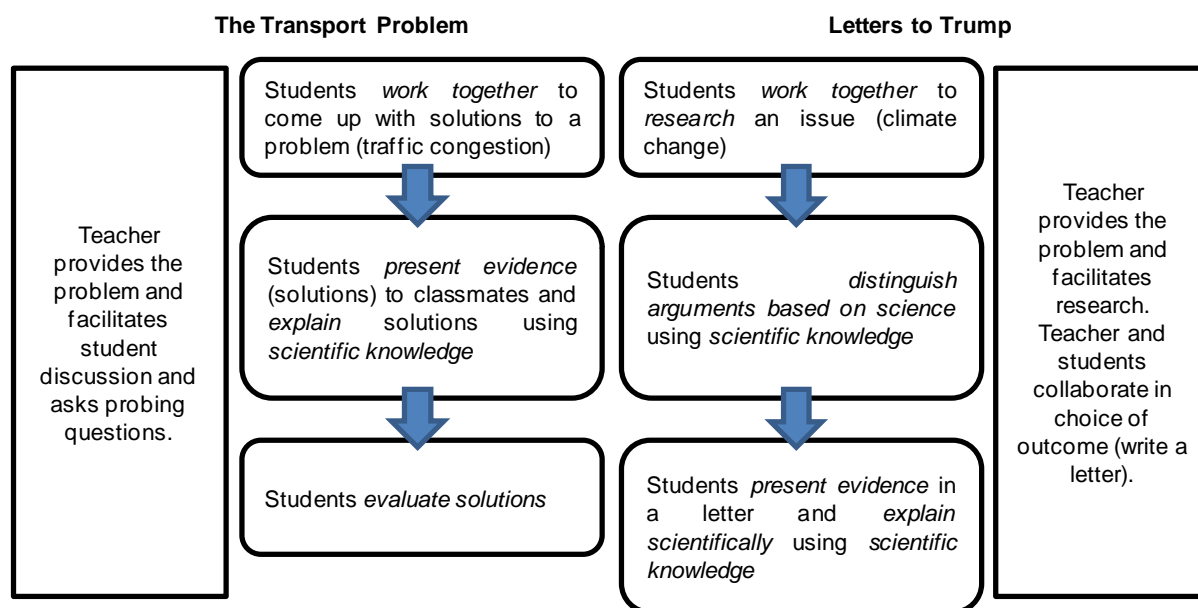
The Transport Problem   **Letters to Trump**

Teacher provides the problem and facilitates student discussion and asks probing questions.

Students *work together* to come up with solutions to a problem (traffic congestion)

Students *present evidence* (solutions) to classmates and *explain* solutions using *scientific knowledge*

Students *evaluate solutions*

Students *work together* to *research* an issue (climate change)

Students *distinguish arguments based on science* using *scientific knowledge*

Students *present evidence* in a letter and *explain scientifically* using *scientific knowledge*

Teacher provides the problem and facilitates research. Teacher and students collaborate in choice of outcome (write a letter).

Figure 1: Overview of lessons "The Transport Problem" and "Letters to Trump"

Development of skills and knowledge

Students developed the ability to explain the science behind the SSI using their scientific knowledge. They demonstrated this when writing about their group's long and short term solutions for The Transport problem:

"The bridge would reduce traffic and accidents. The bridge will take 5-7 years and employ 100s of workers. If the limit of cars is cut in half it will reduce fuel gases beng released into the atmosphere and traffic and accidents will be reduced too."

The example quote above goes beyond simply *presenting evidence* and gives scientific explanation. In particular, the extract "If the limit of cars is cut in half it will reduce fuel gases being released into the atmosphere and traffic accidents will be reduced" links the solution to the problem and shows the student's use of *scientific knowledge* as they demonstrate their knowledge of the effect of greenhouse gases. The explanations and knowledge demonstrated clearly link the science with the societal implications, e.g. increasing employment locally.

During the latter lessons, the students' demonstrated the sub-theme *explain scientifically* in their letters to President Trump. The students used their own words to explain the science at a level that was appropriate to their age and demonstrated their scientific knowledge. Of the two knowledge sub-themes, *implications of scientific knowledge for society* is the larger (Table 1). This means that when giving explanations, students were more likely to relate their scientific knowledge to society or the environment than not to. This is likely because of the particularly engaging SSI contexts explored in these lessons.

Students also developed the ability to *distinguish arguments based on science*. This skill is highly context specific and was only observed in the final lesson exploring climate change denial. The students asserted that President Trump's beliefs on climate change were based on considerations other than scientific evidence. One student stated:

"I learned that sometimes people in power are there because they have negative views on things that people don't want to make an effort about.."

This student believes that Trump's view on climate change is borne out of lack of willingness to "make an effort" to combat it.

Another student stated:

"I learned that a lot of the things president elect Donald Trump says is not fact. There is a lot of evidence of climate change everywhere. Most websites have hard facts about climate change that contradict Donald Trump"

The student believes that President Trump's views are not based on science but on other considerations.

Conclusions

This case study followed a teacher as he facilitated inquiry in the context of SSI with his class. The first SSI context was a familiar, local issue and as such it was highly relevant to the students and therefore engaging. The students were asked to devise solutions and subsequently critique them, showing the students that science does not always provide a neat solution even having taken account of available evidence. The second SSI based on climate change denial, was truly controversial, and conflicted with the students' own viewpoints. Through this SSI based inquiry the students developed the ability to distinguish scientific arguments from arguments based on other considerations such as political and economic. The students were able to explore the conflicting views through their own research and draw their own conclusions.

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