

PRE-SERVICE TEACHERS' CONCEPTIONS OF THE INTEGRATION OF SOCIOSCIENTIFIC ISSUES IN LIFE SCIENCES TEACHING

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Abstract

Debates have been going on regarding what the goals of science education are and how those goals could be achieved. Developing scientific literacy in learners has gained traction over the years among other goals. It has been documented that by engaging learners in socioscientific issues (SSIs) in the science classrooms learners acquire complex competencies and skills necessary for scientific literacy. Learners also get motivated to learn science and take up careers in science. The current paper reports findings from a qualitative case study which sought to determine pre-service teachers' conceptions of the integration of SSIs in Life Sciences teaching and learning. A total of 50 third year pre-service teachers enrolled for a Life Sciences methodology course at a South African University, were selected to participate. After covering a theme on SSIs in Life Sciences teaching and learning, the participants were asked to document their conceptions of SSIs and how argumentation could be used to teach SSIs in specific Life Sciences topics. Their submissions were subjected to content analysis. Two themes emerged: 1. Teachers' conceptions of the integration of specific SSIs when teaching controversial concepts in Life Sciences; and 2. Teachers' conceptions of argumentation as a suitable strategy in addressing SSIs in some Life Sciences topics. In addition to the previously found benefits of integrating SSIs such as developing learners' critical thinking skills, ability to make negotiations, and developing learners to make informed decisions, the pre-service teachers brought in a new angle. They showed how failure to teach SSIs could impact on the livelihood of humans as related to SSIs associated with the current COVID-19 pandemic and other diseases humans are grappling with such as cancer. Some brought in the role of SSIs in teaching the nature of science, an area neglected in many Life Sciences classrooms. Other participants mentioned how argumentation as a teaching strategy equips learners with life skills such as abilities to raise their opinions and stance in a world where most young people are failing to take criticism or challenges positively thereby resorting to suicide as an easy way out of challenging situations. The pre-service teachers' conceptions were based on real life experiences considering that they were also still young. There were some who did not conceptualise integrating SSIs in the positive manner as they argued that addressing such issues in the classroom would be intrusive. These findings have implications for both pre-and in-service teacher professional development.

Keywords: *Argumentation, life sciences, pre-service teachers, socioscientific issues, teachers' conceptions.*

1. Introduction

There have been debates regarding what the goals of science education are and how those goals could be achieved. Because of such interrogative discussions, the need to develop scientific literacy in learners has gained traction over the years among other goals. The argument is that scientifically literate learners are capable of confronting, negotiating, and making decisions on the everyday issues and challenges in their daily lives that relate to science (Roberts, 2007). Learners become informed citizens who can engage in scientific discourses beyond the school level. Such capabilities are more important in the 21st century citizens considering that there is a flood of information on scientific and technological discoveries and research which is in the public domain. Previous studies have documented that by engaging learners in the teaching and learning of socioscientific issues (SSIs) in the science classrooms they acquire complex competencies and skills necessary for scientific literacy (Hancock, Friedrichen, Kinslow, & Sadler, 2019; Sadler, 2011). Addressing SSIs when teaching controversial science topics provides a well-suited approach for developing science literacy (Hancock et al., 2019). Because of

scientific literacy, learners would interrogate the many issues raised in the media which impact on their lives and make informed choices.

There has been a myriad of benefits that come with the integration of SSIs in the science teaching and learning. These benefits include engagement of learners in debates, dialogues, discussion, and argumentation (Zeidler, 2014); equipping learners with knowledge and skills to make claims and justifications with reasons and evidence (Zeidler, 2014); interrogation of controversial issues (Janasoff, 2010); contextualising science learning within a challenging social and political background (Hancock et al., 2019); equipping learners with skills to make well-informed decisions (Han-Tosunoglu & Lederman, 2016); and motivating learners to continue learning science and take up careers in science (Relela & Mavuru, 2021). Considering that teachers are the main role players in the integration of SSIs for these benefits to be realised, the current study sought to determine pre-service teachers' conceptions of the integration of SSIs in Life Sciences teaching and learning.

2. Literature

The underlying objective and principle of science education for the next generation remains and will always be aimed at promoting science literacy, which provides learners with the ability to critically evaluate and debate scientific issues, along with the processes and logical thinking skills vital to substantiated decision-making (Association for Science Teacher Education, 2013; National Research Council [NRC], 2012). The research to date strongly suggests that the socioscientific issues have had profound implications for the betterment of science literacy in learners within the field of science education over the last two decades (Zeidler, Herman, & Sadler, 2019). SSIs are personally relevant, controversial, ill-structured problems that require scientific evidence-based reasoning to inform decision-making on such topics (Zeidler, 2014).

As underscored by Sadler (2009) the incorporation of SSIs in science teaching and learning has the potential to promote moral reasoning and learners' personal engagement with conflicting perspectives on issues relevant to their pattern of life and society in which they live in. This insinuates that learners explicitly bring their own experiences and perspective to the learning situation, thereby creating the potential to bridge the gap between school science and the learners' worlds (Bossér et al., 2015). The above scholars underlined that using social interactions and argumentation, science learners are given the opportunity to take a stance on issues related to science and society, while at the same time challenging learners to explore their own values and attitudes and those of others.

The ability to discuss controversial topics, in a logical manner while being respectful of learners' beliefs and sensitive to their emotional states, forms a cornerstone of democracy (Sutherland & L'Abbe, 2019). Chikoko, Gilmour and Harber (2011) underscored that true democracy strives to increase interest in science teaching and learning and to facilitate active citizenship, in which individuals can make wise and informed choices and, as such, learners are required to behave in a democratic manner in their daily lives. However, the above scholars propound that due to lack of adequate content knowledge, South African Life Sciences teachers are not capable of managing the discussion of controversial topics in their classrooms (Chikoko et al., 2011).

Religious and cultural dissatisfactions are not the only stumbling blocks impacting the teaching and learning of controversial topics, but the teachers' inability to address the socioscientific issues surrounding such topics also play a major role (Sutherland & L'Abbe, 2019). As defined by Kus (2015), the overriding objective of the inclusion of socioscientific controversial topics in the science curriculum is to enrich learners in gaining values and skills necessary to become informed citizens. Whilst argumentation has been suggested as a suitable strategy in developing scientific literacy in learners (Zeidler, 2014), teachers have indicated their inability to create learning environments conducive for debate and argumentation in their classrooms (Relela & Mavuru, 2021).

3. Methodology

The study adopted a qualitative interpretive paradigm and employed a qualitative case study design. The interpretive qualitative approach allowed the researcher to make sense of the participants' justification or rebuttal of the importance of integrating specific SSIs and use of argumentation as a teaching strategy when teaching controversial concepts in Life Sciences. After covering a theme on SSIs in Life Sciences teaching and learning, the participants were asked to document their conceptions of SSIs and how argumentation could be used to teach SSIs in specific Life Sciences topics. This was a task given to them in the module Methodology and Practicum for Life Sciences, a course that prepared them for classroom practices and experiences. Through a qualitative case study (Creswell, 2014), the participants' conceptions of the integration of SSIs could be deduced.

3.1. Selection of participants

A total of 50 third year pre-service teachers were selected to participate in the study. These students, herein referred to as pre-service teachers were enrolled for a Life Sciences Methodology course at a South African University.

3.2. Data collection and analysis

After covering a theme on SSIs in Life Sciences teaching and learning, each pre-service teacher was tasked to document own conceptions of the integration of SSIs when teaching Life Sciences and evaluate the suitability of argumentation as a teaching strategy. The specifications of the task were that each participant should work independently; and should be honest as this would have a bearing on the approaches to be used when developing the next cohort of pre-service teachers. Each participant's submission was subjected to content analysis where the researcher carefully reviewed the conceptions to identify pertinent information from non-pertinent information and to make sure the information was organised into categories related to the research question (Bowen, 2009).

4. Research findings

Two themes emerged from the content analysis of data: 1. Teachers' conceptions of the integration of specific SSIs when teaching controversial concepts in Life Sciences; and 2. Teachers' conceptions of argumentation as a suitable strategy in addressing SSIs in some Life Sciences topics. Findings are presented under each theme.

4.1. Theme 1: Teachers' conceptions of the integration of specific SSIs when teaching controversial concepts in Life Sciences

The pre-service teachers indicated that the teaching of SSIs in Life Sciences is important because learners should not blindly believe and follow everything that science says. Rather learners need to have an open view and be able to make decisions based on not only science but the applicability of such knowledge in their daily lives. They justified this when they pointed out that controversial concepts in biology have the extra feature of needing some moral reasoning or the appraisal of ethical considerations in the process of making decisions about how to best resolve challenges. Examples were given of such practices in the classrooms. This included the teaching of the lungs and respiration or kidneys and the excretory system where SSIs arising from substance abuse e.g. drugs, alcohol and more may be brought up. The participants were adamant that by teaching such real-life situations promotes awareness to the learners and the community at large on the importance of living healthy lifestyles. With such knowledge, learners are empowered to make informed decisions based on evidence. The pre-service teachers argued that by only teaching the Life Sciences concepts without addressing SSIs, it defeats the objective of making concepts relevant and applicable to learners' lives.

The pre-service teachers pointed out that the integration of SSI and Life sciences equips learners with moral reasoning skills as they engage with concepts that have relevance and a bearing in solving some of the social influences they encounter in their lives as the youths. Issues of COVID-19 pandemic and the inflow of different information which includes conspiracy theories surrounding the causes of the disease and the effects of vaccinations, were some of the current SSIs that were mentioned. The participants strongly felt that Life Sciences teachers cannot afford to ignore the discussion of such issues when teaching concepts on microorganisms, diseases, and immunity. Discussions of such SSIs allows the learners to take interest in investigating and studying the given controversial issues and then evaluate the authenticity of the different views before they make their own moral decision based on reasoning.

The analysis of data showed the pre-service teachers conceived the teaching of SSIs in Life Sciences as crucial to stimulating learners' interest in exploring the Life Sciences concepts being learned. Based on the school teaching experiences they had during the year, pre-service teachers indicated that learners become actively engaged and participate more during lessons. They indicated that a typical constructivist learning environment is created when the teacher engages learners in such classroom discussions. As such, learners are better able to relate concepts and construct their own knowledge not only based on textbook content but also on their experiences. The participants identified critical thinking, analytical reasoning, moral and ethical reasoning, and meaningful communication as some of the skills learners are likely to develop because of engaging in robust discussions of SSIs in the topics they learn in class.

The participants conceptualised the integration of SSIs as an essential part of teaching controversial topics in Life Sciences. They pointed out that the knowledge learners acquire from such classrooms will no longer be one dimensional but multi-dimensional. Another example given was that of the issue of global warming and its effects on the lives of both living organisms and the environment.

They indicated that learners are most likely to pay attention in class when concepts such as the impact of humans on the environment are taught because learners have witnessed the effects of global warming in their everyday lives, where floods and droughts are a constant occurrence within their communities. The learners would share their ideas on the topic based on their experiences, which brings more meaning and relevance to the Life Sciences concepts learned.

Pre-service teachers pointed out that the teaching of SSIs promotes the integration of concepts from different subject areas a concept one participant referred to as cross-disciplinary discussion. One participant explained how SSIs creates open mindedness in learners when she gave an example of herself: Cleo (pseudonym): As a university student I have developed a more critical approach to knowledge as well as the ability to apply critical questioning to religious beliefs and scientific knowledge due to the integration of SSIs.

This is in line with one of the Life Sciences specific aims which stipulates that learners should understand “the applications of Life Sciences in everyday life, as well as understanding the history of scientific discoveries and the relationship between indigenous knowledge and science” (Department of Basic Education, 2011, p. 13). The participants indicated that by integrating SSIs when teaching controversial topics teachers are addressing this aim.

4.2. Theme 2: Teachers’ conceptions of argumentation as a suitable strategy in addressing SSIs in some Life Sciences topics

The pre-service teachers indicated that engaging learners in argumentation when integrating SSIs in controversial Life Sciences concepts is important. They pointed out that essential skills such as critical thinking, collaboration, communication and listening skills are developed. Debates and discussions were conceptualised as crucial aspects of argumentation which encourage cooperation and permits learners to rely on and learn from each other. Learners share opinions and ideas and validate them based on evidence provided by individuals who justify and back their claims during the argumentation process. In the participants’ view and experiences, learners learn better from each other and increase their knowledge banks. During such discussions, learners can think critically and creatively providing new ideals and solutions to an issue. They gave an example of the debating about nuclear power plants as a source of energy and its impact on the environment, which allows learners to participate in the scientific and societal discussions.

An important issue was raised that by implementing argumentation in one’s lesson, a teacher opens doors for learners who would not normally raise an argument out of the blue, hence facilitating social interaction and active participation. They indicated that for successful use of argumentation in the Life Sciences classroom, a teacher needs to be well equipped to maintain classroom control and offer guidance where needed. As such the teacher should be more knowledgeable than learners about issues under discussion.

The pre-service teachers viewed argumentation in the positive way as they pointed out that during argumentation learners get an opportunity to challenge each other’s viewpoints and their knowledge thereby learning from one another. In this way learners are able to judge their ideas based on those that have been provided by their peers. They suggested that teachers need to be careful and be prepared before using argumentation in their lessons. They specifically identified the need for teachers to be more conversant with the content of the topic under discussion but should also research about the possible claims, rebuttals, evidence etc. The teacher should identify topics that will foster a debate in the classroom. The participants viewed the arguments learners make as based on the evidence from the observations learners make, their experiences, realities in their communities, which are therefore essential in hence SSIs are an essential part of the argumentation process. The participants pointed out that the use of argumentation in addressing SSIs in some Life Sciences concepts will go a long way in minimising learner development of misconceptions.

There were some reservations raised by a few of the pre-service teachers with regards to the use of argumentation when integrating SSIs in Life Sciences teaching. They pointed out that SSIs by their very nature are sensitive issues hence addressing them using argumentation will make it worse as learners will raise aspects that are offensive to some cultural practices and beliefs. According to these teachers SSIs should not be addressed in the science classrooms as this will be very intrusive.

5. Discussions, conclusions, and recommendations

The pre-service teachers showed that they were aware of the need to address SSIs when teaching controversial concepts in Life Sciences. They also showed appreciation of the role of argumentation as a teaching strategy that allows learners to articulate their different opinions and opportunity to share their beliefs, experiences, and challenges they encounter in their communities. Some participants indicated that

the Curriculum and Assessment Policy Statement is silent on how teachers can tackle such issues in the classrooms. This is also confirmed by previous studies (e.g. Mnguni, 2018) who posited that the curriculum is unable to guide Life Sciences teachers to select scientifically reliable sources of information on how to address those topics during the teaching and learning process. In the current study, teachers attested that argumentation requires teachers who are not only knowledgeable about the content and SSIs being discussed, but that the teacher needs to be skilfully equipped in terms of classroom management. Such important issues raised questions on the viability of addressing SSIs issues in the South African classroom context where there are higher learner teacher ratios and ill-discipline has become a concern these classrooms.

In conclusion, the recent cohort of graduate teachers have been taught how the SSIs in some controversial Life Sciences topics can be addressed and how the process of argumentation can be implemented in the classrooms. The same cannot however be said about the teachers who received their training some years ago. As such, there is need to provide in-service teacher development targeted at teaching and addressing SSIs in some Life Sciences topics. This is more important than before because of the surge of controversial issues because of the COVID-19 pandemic and the information flood due to social media.

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