



PBL Intervention Using a Socioscientific Issue in a Biology Didactics Course

Cristina Sousa^{1,2}

¹Faculty of Sciences, University of Porto, Portugal (cristinacsousa@hotmail.com)

²Present address: FP-I3ID, University Fernando Pessoa, Portugal

Abstract

Socioscientific issues (SSI) are “societal issues that have a scientific component as well as ethical, political, or religious dimensions” [1]. Problem-Based Learning (PBL) has been described to promote several skills, such as questioning, communication, argumentation and cooperation [2]. PBL is adequate to teach about SSI at different levels [3] and we hypothesize that can also promote effective learning in future teachers. Participants included a total of 10 students enrolled in a biology and geology didactics curricular unit of a university master’s program in biology and geology teaching (n = 10 voluntary participants, corresponding to the total number of students enrolled, 3 males and 7 females). Students, working in small-groups, were presented with a SSI problem about the consequences of introduction of invasive plants in ecosystems. Students working in small-groups (three or four elements), started by reading the problem-situation, identifying the themes they already knew, discussing (comparing and contrasting) individual prior ideas, thinking about questions and identifying what they needed to research and performed the investigation, and finally presenting a possible solution to the problem-situation. Students were also asked to identify the controversial issue addressed in the problem and if they classify it as a SSI. A brief pre-posttest questionnaire was designed based on the literature on the subject [1] and content validity of the open items were checked by two experts. Students were able to distinguish between controversial issues in which society denies science, controversial issues within the scientific community and socioscientific issues. After the PBL unit preservice teachers were able to identify the advantages of the inclusion of SSI in the curricula. In conclusion, the applicability, and potentialities of this PBL using SSI in preservice teachers/Master students are discussed.

Keywords: *Problem-Based Learning, Socioscientific issue, Biology didactics.*

1. Introduction

Socioscientific issues (SSI) are “societal issues that have a scientific component as well as ethical, political, or religious dimensions” [1]. It has been described that several teachers do not use SSI due to small recognition of their potential for teaching, lack of available classroom resources, and teachers’ insufficient knowledge of science subject matter and lack of confidence in being able to promote discussion [4].

Problem-Based Learning (PBL) has been described to promote several skills, such as questioning, communication, argumentation and cooperation [2]. PBL is adequate to teach about SSI at different levels [3] and we hypothesize that can also promote effective learning in future teachers.

One of the focuses of our PBL unit is the introduction of invasive species and its impact in the extinction of native species, which constitutes one SSI ([1], [5]) and it is an example of a controversial issue informed by societally accepted science [1]. The proposed problem requires Biology Didactics course’s students to consider scientific issues of social significance that includes the evaluation of several concepts and considerations in order to arrive at an informed solution, therefore constitutes one SSI [6].

For a better understanding of the social impacts of this SSI, the problem-situation included information that the introduction of invasive species in ecosystems causes disruption of their equilibrium, in some cases facilitating fire, and with high costs, such as extinction of native species and costs of eradication of invasive plants, of around 30 billion dollar per year in the United States [7].

The research questions addressed in this study are:

- (1) Which scientific issues do preservice teachers consider controversial and/or SSI?
- (2) Which controversial issues do preservice teachers anticipate having more difficulty to teach in the future? And why?



In exposing Biology Didactics course's students to the resources designed, it is intended to show their potential for teaching, to promote and develop their prior knowledge about the science themes and show an effective way to promote a discussion that they can use in their future profession.

2. Methods

2.1. Participants

Participants included a total of 10 students of a Biology Didactics course ($n = 10$ voluntary participants, corresponding to the total number of students enrolled in the discipline, 3 males and 7 females) enrolled in the first year of a university master's program in biology and geology teaching (required for middle and secondary biology and geology teaching certification, in Portugal).

2.2. Intervention

This study included a teaching intervention: a PBL session (120 minutes), by the author, within a Biology Didactics course, that was conducted in the first weeks of the academic year 2018/2019, using a SSI, such as the introduction of invasive plants in ecosystems and teaching about ecological concepts in this context.

Didactics students working in small-groups (three or four elements), started by reading the problem-situation, identifying the themes they already knew, discussing (comparing and contrasting) individual prior ideas, thinking about questions and identifying what they needed to research and performed the investigation, and finally suggested a possible solution to the problem-situation.

Additionally, at the end of the PBL session, students were also asked to identify the controversial issue addressed in the problem and if they classify it as one SSI.

2.3. Data collection and analysis

Data sources were a questionnaire and field notes of classroom observations.

3. Results & Discussion

Each group presented a different solution to the class and all the solutions were discussed.

Before the PBL unit, preservice teachers identified as controversial issues (in parenthesis we present the frequency of responses by preservice teachers) as:

- 1) the ones that society denies science – evolution (7), stem cells (1), origin of life (1), vaccination (5), alternative medicines (2), reproductive biology/areas of species reproduction (1), climate change (2), Earth structure (1), religious beliefs (1), creationism (1), astronomical issues (1);
- 2) the ones that are controversial within the scientific community - hereditary of acquired characteristics (2), climatic changes (1) and human role in climatic changes (1), use of animal models in research (2), back matter (1), cloning (1), studies using stem cells (1), human genetic engineering (1), vaccination (2) and none identified (1);
- 3) SSI - bioethics (2), genetic therapy (1), euthanasia (1), use of some scientific findings (1), environmental education (1), racial and equity issues (1), creationism as part of Biology classes (1), health (1), nutrition (1), abortion (1), extraterrestrial life (1) and none identified (2).

As introduction to the PBL session, Biology Didactics students were presented with the classification of controversial issues and SSI in [1], and then after the unit were asked again to identify SSI (in parenthesis we present the number of students' responses): euthanasia (2), abortion (2), research funding (1), any progressive issue (1), vaccination (1), invasive species control (3), global warming due to human action (3), hunting (1), sexuality (1), existence of races (1), gender issues (1), discussion between evolution and creationism (2) and none identified (2).

We highlight the effectivity of the unit, since after the unit, students were able to identify some issues that were not mentioned before the unit as SSI, such as: the research funding decisions, the control of invasive species, vaccination and the human action in global warming. However, we consider that this short length unit was not effective in changing some uninformed opinions, since some preservice teachers still identify vaccination (2 preservice teachers) and climatic change (1 preservice teacher) as controversial issues within the scientific community.

Students when asked in the questionnaire, which scientific controversial issues should be included in middle and high school, considered after the PBL unit (in parenthesis we present the frequency of responses by students): SSI and the ones that society denies science (1), SSI (3), the ones that are controversial within the scientific community (1), the ones that society denies science (1), the ones that society denies science and the ones that are controversial within the scientific community (1) and all (2).



After the PBL unit students were able to identify the advantages of the inclusion of SSI. Some examples of responses include: “Will enable students to become more knowledgeable about these issues, to be more critical and to make informed decisions in society if necessary” (student 1) and “Train students and citizens (well) informed so they can critically analyze information” (student 2). While before the unit the advantage commonly referred was “To increase students’ curiosity about the themes”.

Students showed informed opinions about the role of students’ beliefs in the teaching-learning process and were able to reflect and anticipate the subjects they think will be more difficult to teach in their future. The subject most frequently identified, before and after the unit, was evolution (4 out of 10 students), and one example of reasons mentioned is “evolution is a subject that clashes with many religious beliefs”. Other subjects were (in parenthesis we present the frequency of responses by students): bioethics (1), gender issues (1), vaccination (1), abortion (1), religion-related issues (2).

The fact that some students considered vaccination and climatic change as controversial issues within the scientific community, suggests that in future studies and applications an extra session is required to include a longer final discussion in order to include a higher number of scientific controversial issues, focusing in the ones previously identified by the students.

4. Conclusion

Since Biology Didactics courses are usually focused on the practice of teaching rather than science context our teaching proposal is innovative.

Teacher education should be a priority in developing students’ scientific literacy since they are the ones who profit at the end and our proposal of using PBL through SSI has shown to be effective.

References

- [1] Borgerding, L. A. & Dagistan, M. (2018) Preservice science teachers’ concerns and approaches for teaching socioscientific and controversial issues, *Journal of Science Teacher Education*, 29:4, 283-306, DOI: 10.1080/1046560X.2018.1440860
- [2] Wilder, S. (2015). Impact of problem-based learning on academic achievement in high school: a systematic review. *Educational Review*, 67(4), 414-435.
- [3] Hernández-Ramos, J.; Perna, J.; Cáceres-Jensen, L.; Rodríguez-Becerra, J. (2021). The Effects of Using Socio-Scientific Issues and Technology in Problem-Based Learning: A Systematic Review. *Educ. Sci.* 11, 640. <https://doi.org/10.3390/educsci11100640>
- [4] Tidemand, S., & Nielsen, J. A. (2017). The role of socioscientific issues in biology teaching: from the perspective of teachers. *International Journal of Science Education*, 39(1), 44-61.
- [5] Sousa, C., & Chagas, I. (2018). Using Nature of Science enriched-PBL in pre-service science teacher education. In Pixel (Ed.), *New perspectives in science education 7th edition.*, 2018 (pp. 592-595): Libreriauniversitaria.it edition, Pixel.
- [6] Sadler, T. D. (2004). Informal Reasoning Regarding Socioscientific Issues: A Critical Review of Research. *Journal of Research in Science Teaching*, 41, 513–536
- [7] Nijhuis, M. (2013). How Climate Change is Helping Invasive Species Take Over: Longer seasons and warmer weather have combined to be a game-changer in the plant wars. Available online: <https://www.smithsonianmag.com/science-nature/how-climate-change-is-helping-invasive-species-take-over-180947630/>.