SCIENTIFIC MODELLING OF SOCIALLY ACUTE QUESTIONS TO PROMOTE CITIZENSHIP ACTION WITH PRESERVICE EARLY CHILDHOOD TEACHERS

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This paper studies the impact of modelling practice through multiple models. It was carried out in a training programme of collective activism based on scientific practices with preservice early childhood teachers at Málaga University (Spain) during 2021/22. The programme has 4 phases: 1) inquiry, 2) action planning, 3) action and 4) evaluation and reflection. Eleven activist projects were carried out on controversial local issues, selected by 11 teams of 4 or 5 students. The students' answers to two open-ended questions on the assessment of the modelling activity for the development of their activist project are analysed using a system of categories created inductively. According to most students, modelling has had a positive effect on the realisation of their activist projects, not only helping them acquire knowledge but also enabling them to become aware of their views and develop competences to carry out the project. The most difficult part was to identify and/or relate the multiple problem factors in the model and to delimit the project to be represented. However, the quality of the work improved compared to previous years when modelling was not considered.

Keywords: Modelling, Activism, Socially acute questions

INTRODUCTION AND THEORETICAL FRAMEWORK

The complex and important health, social justice and environmental issues affecting society encourage science education to analyse these issues and to take citizen action (García-Bermúdez et al., 2022; Hodson, 2011). These problems are introduced as Socially Acute Questions (SAQ) when they involve topical controversies disseminated in the media and social networks (Bencze et al., 2020; Legardez & Simonneaux, 2006). Analyses of SAQs are complex because they refer to networks of relationships involving multiple stakeholders and require knowledge not only from science and technology but also from other disciplines (Bencze et al., 2020; Sharma, 2020). When SAQs are used, we believe that activism equips students with knowledge, skills and feelings to become competent citizens capable of making decisions and contributing to resolving such issues. In particular, the collective activism approach based on scientific practices on SAQ can be used to develop critical thinking, the ability to model, inquire, argue and act in society (Cebrián-Robles et al., n.d.).

Of all the processes enacted in the collective activism approach based on scientific practices, modelling is the one that makes it possible to visualise (Ke et al., 2021), the factors to be taken into account in the SAQ in order to understand its complexity, investigate its causes and consequences, as well as to facilitate scenarios of possible solutions. Although modelling already has a long history in science education research (Gilbert & Justi, 2016), more research is needed to study whether SAQ modelling serves as a reasoning tool (Desfriches-Doria, 2021; Hipkins, 2022). One of the most widely used models for SAQ analysis is controversy mapping, as it allows the representation of its actants and their relationships in a dynamic model. This model captures public discussions on technoscientific issues by making specific properties visible that can be used to support decision-making and evaluate solutions (Hervé, 2014). According to Desfriches-Doria (2021), modelling through controversy mapping allows students to become aware of their point of view, which evolves during the study of the controversy. However, Ke et al. (2021) argue that complex problems like SAQs require using multiple models, such as mechanistic, systemic, mathematical, and socioscientific models, to understand and analyse them thoroughly. The controversy map, identified by these authors as a socioscientific model, is one tool that brings together different factors to be represented and analysed. However, incorporating multiple models for SAQ inquiry and activism requires further

research to study to what extent multiple models, including the controversy map, and other models, such as those focused on cause-consequence analysis or solution proposals, facilitate analysis and action on SAQs in science education.

AIM AND RESEARCH QUESTIONS

This paper studies the assessment of preservice early childhood teachers (PECT) on the practice of modelling using multiple models carried out in a collective activism training programme based on scientific practices (from now on, "activism training programme"). To this end, the following research questions are posed: 1) In the opinion of the PECTs, how has the theoretical and practical part of modelling helped them to design the models of their activist projects? and 2) What difficulties have they had with modelling in their activist projects?

RESEARCH METHOD AND DESIGN

This work has been carried out with 50 PECT, grouped in 11 teams of 4 or 5 students, in a science teaching subject at the University of Málaga (Spain) during the academic year 2021/22. For this purpose, an activism training programme was carried out in 4 phases (Cebrián-Robles et al., 2023): 1) inquiry, 2) action planning, 3) action and 4) evaluation and reflection. The part related to modelling is mainly shown. The inquiry phase begins with a presentation of what activism is, project examples are shown and analysed by the students, and each team chooses a problem related to an SAQ in the environment close to the early childhood education centre where they will do their internship the following year. Each team creates a controversy map as a model to build initial ideas in the team about the SAQ, followed by a modelling training in which, among others, multiple models are explained based on the example of Ke et al. (2021) on the SAQ of COVID-19. An activity is carried out, which consists of creating a model that represents the solution scenarios to address each team's SAQ (examples in figure 1). First, the model is planned by identifying and describing factors (scientific, social, economic, political, ethical, religious, etc.) that come into play in the solution scenarios. Then, the models are represented in each team. Next, an adaptation of modelling by Gilbert and Justi (2016) is shown in SAQs so that each of the models can be tested and evaluated. Afterwards, other cause-consequence, mechanistic and systemic models are made that help to understand SAQs from a technoscientific point of view and modify its initial controversy map. At the end of the modelling activities, students are asked to evaluate them. Subsequently, the inquiry is continued, and the action on the SAQ is planned and carried out by creating and disseminating videos on social networks.

A)

B)

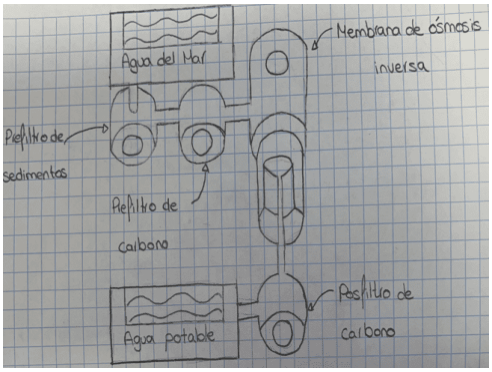

Figure 1. Two examples, A and B, of scenario-solution models from two groups on local water SAQ.

Data collection was done through two open questions at the end of the course: 1) How has the theoretical and practical part of modelling helped you design your activist project models? and 2) What difficulties have you had with modelling in your activist project? The answers were categorised by an inductive method, analysing the allusions made to the activist project or references to modelling itself.

RESULTS

Modelling has helped the activist project for 38 PECT (76%), who indicated that it facilitated: 1) acquiring or clarifying knowledge for the activist project (15 PECT, 30%), 2) the overall project construction process (8 PECT, 16%), 3) understanding and identifying the real problems and controversies of the activist project (6 PECT, 12%), 4) assessing errors in the project (6 PECT, 12%), 5) finding solutions (5 PECT, 10%), 6)

repeating and asking questions (5 PECT, 10%) and 7) knowing the feasibility of the project (5 PECT, 10%). However, 26 PECT (52%) indicated different reasons for the difficulty of the activist project when modelling. The most repeated difficulties were: 1) identifying and/or relating the multiple factors, variables or aspects of the problem in the model (11 PECT, 22%); and 2) delimiting the project and identifying and/or selecting the factors in the model (7 PECT, 14%).

DISCUSSION OF FINDINGS AND IMPLICATIONS

Modelling has had a positive effect on most students in their activist projects. Their responses indicate that it has helped them to (a) gain knowledge about SAQs and about the modelling process itself; (b) understand other points of view on the controversy, as indicated by Desfriches-Doria (2021); (c) facilitate the development of skills such as identifying problem factors; d) improve project evaluation skills, since testing and evaluating models is fundamental in modelling (Gilbert & Justi, 2016); e) evaluate the project; f) improve the search for solutions, for example, by breaking with the dualistic nature of reality, detected by Hervé (2014), when models are improved; g) encourage questioning, a habit that promotes critical thinking.

The experience of the activity, as well as the assessments of PECT, indicate that modelling carried out in activist projects requires time for modelling practice and requires an effort to understand, for example, the differentiation between testing and evaluating models (Gilbert & Justi, 2016). Nevertheless, the quality of the final papers improved in understanding and depth of analysis compared to previous years when modelling was not used, and the models integrated into activist websites and videos. In the future, it is desired to know the argumentation processes and how they help the PECT in the modelling to develop its projects.

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