

Preservice primary teachers' argumentative skills during their participation in a role play on nuclear energy

Isabel María Cruz Lorite^{1a}, Maria Evagorou², Daniel Cebrián Robles^{1b}, María del Carmen Acebal Expósito^{1c}

¹Department of Didactics of Mathematics, Social Sciences and Experimental Sciences.

University of Malaga. ^a imclorite@uma.es; ^b dcebrian@uma.es; ^c mcebal@uma.es

²Department of Education. University of Nicosia. evagorou.m@unic.ac.cy

RESUMEN: Este trabajo muestra los resultados preliminares de un estudio acerca del uso del juego de rol sobre un problema sociocientífico para la puesta en práctica de las habilidades argumentativas de profesorado de primaria en formación inicial. El problema tratado fue el pacto realizado por el Gobierno español y algunas empresas energéticas para el cierre del parque nuclear español entre 2025 y 2035. Se analizó la estructura y el tema de los argumentos utilizados durante la escenificación. Los resultados muestran que los participantes utilizan gran cantidad y variedad de pruebas y en menor medida formulan conclusiones y justificaciones. La mayor parte de los argumentos fueron sobre temas ambientales, seguidos por los económicos y los sociales. Finalmente, el juego de rol parece ser adecuado para la práctica del uso de pruebas, aunque queda pendiente el análisis de la calidad de las mismas.

PALABRAS CLAVE: Juego de rol, argumentación, problemas sociocientíficos, profesorado de primaria en formación inicial.

ABSTRACT: This work presents preliminary results of a study on the use of role play on a socioscientific issue for the practice of argumentative skills of preservice primary teachers. The socioscientific issue addressed was the agreement of the Spanish Government and some energy companies for the closure of all Spanish nuclear power plants between 2025 and 2035. The structure and topics of the arguments used during the role-playing discussion were analysed. The results show that the participants use a large amount and variety of evidence and, to a lesser extent, formulate conclusions and justifications. Most of the arguments were on environmental topics, followed by the financial topics and social topics. Finally, the role play seems to be very adequate for the practice of the use of evidence, although the analysis of their quality remains to be done.

KEYWORDS: Role play, argumentation, socioscientific issues, preservice primary teachers.

INTRODUCTION

The nuclear energy is a noteworthy problem to be tackled with preservice teachers as it can be considered a socioscientific issue (SSI). According to Evagorou et al. (2020), SSI are ill-structured problems that involve moral, ethical and financial aspects, lack clear solutions, and emerge as a science-society nexus with a degree of uncertainty. Nuclear energy is a scientific issue that has had an impact on world history at technological, economic, military-industrial, political, social, environmental and cultural levels (Solbes & Torres, 2018). Such contexts allow the use of evidence in decision-making, an essential

aspect of learning and developing scientific argumentation (Bravo-Torija & Jiménez-Aleixandre, 2018). Preservice teachers' engagement with socioscientific issues, and especially how they discuss and provide evidence is still relatively unexplored (Evagorou et al., 2020). Furthermore, how to support preservice teachers in their effort to understand and talk about SSI is still explored.

Role-playing games are appropriate teaching strategies to address these SSI. They allow to bring social debates into the science classroom and create consensual knowledge-building processes (Belova et al., 2013). Preservice teachers can put themselves in the point of view of others in a role play, which helps them establish scaffolding postures and broaden their comprehension of the opposing viewpoints and counterarguments to the topic at hand (Drumond-Vieira et al., 2015). This work examines the extent to which role play promotes the development of scientific arguments and the use of evidence, justifications and conclusions during an experience with preservice primary teachers (PPTs).

METHODOLOGY

Participants

Four role plays were carried out in two groups of PPTs studying the subject Science Teaching in the 3rd year of the Degree in Primary Education at the University of Malaga. This work only analyses one role play in which 28 PPTs between 20 and 21 years old participated. In general, their background was in social sciences and humanities and most of them had last studied science in secondary education.

Learning context

The role play was based on a real agreement of the Spanish Government and some energy companies for the closure of all nuclear power stations in Spain between 2025 and 2035 (RTVE, 2019). To prepare the activity, the PPTs were organised into eleven small groups, each consisting of between 2 and 4 students, defending different roles. Five of the roles were against the agreement (that means in favour of the use of nuclear energy): government politician, manager of a nuclear cemetery, nuclear scientist, manager of a nuclear plant and worker from a nuclear plant; and five roles were in favour of the agreement (that means against the use of nuclear energy): ecologist, renewable energy scientist, member of the public, solar energy entrepreneur and politician from the opposition. The last group had the role of the presenters and producers. One student was the spokesperson in each of these small groups, and the rest were the advisory team, with different tasks during the role play's preparation and staging. The role play lasted 41 minutes and was divided into three parts. The presentation round took place in the first part, in which each spokesperson had 3 minutes to provide their initial arguments. During the presentation round, the advisory teams had to take notes on the initial arguments made by the other roles. In the second part, there was a five-minute break, during which the spokespersons had to discuss with their advisory teams what counterarguments to use in the third part of the staging. Finally, in the third part, the debate took place, in which each group had to attempt to counter each other's arguments. The program presenters and producers had the task of moderating the debate and taking notes on the most relevant points of the discussion for a summary at the end of the debate. They were also to use some technological application to show on the classroom projector brief comments that the participant could send during the debate from their mobile phones. More details about the design and the development of the role play can be consulted in Cruz-Lorite et al. (2020).

Data collection and analysis

The role play was video recorded and this video recording was transcribed. The PPTs' argumentation skills were analysed through two aspects: the structure and the topics of the arguments.

The structure of the arguments

The analysis of the structure of the arguments was based on an adaptation of the Toulmin model (Toulmin, 1958) developed by Jiménez-Aleixandre (2010), considering as essential elements of arguments the evidence, the justifications and the conclusions. The evidence 'is the observation, fact, experiment, sign, sample or reason intended to show that a statement is true or false' (Jiménez-Aleixandre, 2010, p. 20). The justification is 'the element which relates the conclusion or explanation with the evidences' (Jiménez-Aleixandre, 2010, p. 75). Finally, the conclusion 'is the statement of knowledge that is intended to be proved or refuted' (Jiménez-Aleixandre, 2010, p. 70). Furthermore, the arguments were analysed regarding the number of elements they included. They could be complete (if they included evidence, justification and conclusion) or incomplete (if they did not include at least one of the aforementioned elements).

The topics of the arguments

An open coding was carried out to analyse the topics of the arguments. As a result, fourteen sub-categories were extracted, grouped in four categories: financial, environmental, social and others (Table 1).

Table 1. Framework for the analysis of the topics of the arguments. In the description, 'type of energy' refers to the different ways of producing electricity from different sources (e.g. solar energy, wind energy or nuclear energy)

| CATEGORY | SUB-CATEGORY | DESCRIPTION |
|---------------|----------------------------|---|
| Environmental | Pollution | About how a certain type of energy affects the environment. |
| | Health | About health aspects related to the use of a certain type of energy. |
| | Resources depletion | About the reserves of natural resources or their consumption pace. |
| | Waste and waste management | About waste generated by a certain type of energy and its management. |
| | Safety | About the safety of a certain type of energy. |
| Financial | Continuous production | About aspects related to maintaining a continuous electricity production with a certain type of energy. |
| | Employment | About aspects related to the employment provided by a certain type of energy. |
| | Production costs | About the costs of electricity production of a certain type of energy. |
| | Saving money | About the economic savings and taxes associated with the use of a certain type of energy. |
| | Viability | About practical/economic viability of the use of a certain type of energy. |
| Social | Ear money | About the incomes for towns, cities, countries, etc. |
| | Necessity | About why we need to use a certain type of energy or other services (e.g. nuclear cemetery) |
| Others | Unknown topic | It is not possible to know what is exactly the topic they talk about. |

The data were analysed with the qualitative analysis software Atlas.ti v.9. An example of the analysis of an argument is shown below (the authors have added information in square brackets for a better understanding of the analysis and the quotations):

Member of the public: ‘I think it would be much easier if the resources offered to us, for example solar panels, were more viable [conclusion], because not everybody has access to install solar panels in their house and get their energy through it [evidence]. Therefore, we are in favour of renewable and non-polluting energies. They should be more accessible, because there are not enough resources to obtain it [justification]’. Complete argument; topic: viability (financial).

Reliability analysis

For data analysis, first, two of the authors conducted several rounds of analysis, on the one hand, to test the adequacy of the framework for analysing the structure of the arguments and, on the other hand, to extract the categories to form the framework for analysing the topics of the arguments. These rounds consisted of two rounds of analysis of the first role play and one round of analysis of the second role play (three rounds in all). Then, we proceeded to the reliability analysis of both developed frameworks, in which three of the authors of this work participated. A sample of 25 % of the transcript of the third role play was selected for the reliability analysis, including 28 utterances (an utterance is an intervention made by a participant). The authors independently analysed each utterance, identifying evidence, justifications and conclusions and the topics on which they were about. The percentages of agreement were higher than 75 % for all the categories analysed. Disagreements were resolved through discussion among the authors.

RESULTS

In Table 2 can be seen the results about the structure of the arguments analysis. The PPTs use a large amount of evidence in their arguments. However, they formulate conclusions to a lesser extent, and the justifications are the least present elements in their arguments. These elements were presented as complete (32) or incomplete arguments (41). Often, an argument includes more than one evidence, justification and/or conclusion, which is why the total number of elements (172) is higher than the total number of arguments (73).

Table 2. Results of the analysis of the structure of the arguments used by the PPTs.

| | N | % |
|---------------|-----|--------|
| Evidence | 76 | 44,19 |
| Justification | 41 | 23,84 |
| Conclusion | 55 | 31,98 |
| Total | 172 | 100,00 |

With respect to the incomplete arguments, the most common types of structures were:

1. Only conclusion or evidence. The PPTs provide a conclusion without further evidence or justification. For example, the ecologist’s advisor said: ‘As far as geological formations [repositories] are concerned, it is very bad to group this [nuclear waste] together on land [conclusion]’. In this case, there is no further evidence about why burying nuclear waste is a bad measure.
2. Conclusion and evidence without justification. The PPTs provide evidence and conclusion, but without a justification that satisfactory links both elements. For example, the manager of a nuclear plant said: ‘With regard to clean energies, for example, solar or wind energy they often depend on meteorological factors [conclusion]. For example, solar energy would not be produced at night and wind

energy depends on the wind, while nuclear power plants create a lot of energy [evidence]’. In this case, it is not justified how the evidence on the amount of energy provided by nuclear energy explains the conclusion that nuclear energy does not depend on meteorological factors.

3. Evidence and justification without conclusion. The PPTs provide evidence and justification, but the conclusion is not explicitly stated. For example, the worker from a nuclear plant said: ‘Furthermore, nuclear energy costs us money because of its production, but we have to consider that with solar energy, among other renewable energies, we’re being taxed [evidence] for something that is supposed to belong to all of us and we should all benefit from. So, why are we questioning this? [justification]’. In this case, it is not clear what is being questioned and to what conclusion this reasoning is ultimately directed.

Table 3. Results of the analysis of the topics of the arguments used by the PPTs. The number of topics is higher than the number of complete and incomplete arguments because often an argument was about more than one topic.

| CATEGORY | SUB-CATEGORY | N | | % | |
|---------------|----------------------------|-----|-----|--------|--------|
| Environmental | Pollution | 1 | 57 | 0,99 | 56,44 |
| | Health | 17 | | 16,83 | |
| | Resources depletion | 7 | | 6,93 | |
| | Safety | 13 | | 12,87 | |
| | Waste and waste management | 19 | | 18,81 | |
| Financial | Continuous production | 9 | 39 | 8,91 | 38,61 |
| | Ear money | 1 | | 0,99 | |
| | Employment | 12 | | 11,88 | |
| | Production costs | 2 | | 1,98 | |
| | Saving money | 14 | | 13,86 | |
| Social | Viability | 1 | 4 | 0,99 | 3,96 |
| | Necessity | 1 | | 0,99 | |
| | Resettle | 3 | | 2,97 | |
| Others | Unknown topic | 1 | 1 | 0,99 | 0,99 |
| Total | | 101 | 101 | 100,00 | 100,00 |

Regarding the analysis of the topics, there is a clear presence of arguments on environmental issues (Table 3). Waste and waste management is the sub-category with the highest number of contributions. The discussion on social issues was very limited and focused on aspects related to the benefits that nuclear energy would have for repopulating depopulated areas of Spain.

CONCLUSIONS

Given the dynamism and dialectical structuring of role-playing games, this teaching strategy can be considered as a perfect setting to bring scientific evidence into play. This work has highlighted the high number of evidence that PPTs presented in their arguments, over and above other elements such as conclusions and justifications. Implications from this study concern continuing the analysis to explore in detail the quality, relevance, and consistency of this evidence concerning the arguments, given that the use of evidence is,

according to Bravo-Torija and Jiménez-Aleixandre (2018), a central feature of knowledge evaluation and, therefore, of argumentation.

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