New Perspectives in Science Education

Arguments expressed by university students according to their scientific background on the banning of single-use plastics

María José Cano-Iglesias[1], Antonio Joaquín Franco-Mariscal[2], María del Mar López-Fernández[2], José Manuel Hierrezuelo-Osorio[2], Ángel Blanco-López[2]

[1,2] University of Málaga, Málaga, Spain

ABSTRACT

This paper analyses the competence in argumentation about the socio-scientific issue of plastics of students with different scientific backgrounds: 35 students in the fourth year of the Degree in Mechanical Engineering and 43 students in the Master's Degree in Secondary Education Teaching of scientific specialities at the University of Málaga (Málaga, Spain). The activity proposes to argue about the appropriateness of the ban on single-use plastics after attending as listeners to a short debate by two students, one for and one against the issue.

OBJETIVE

This paper studies the arguments provided by university students with different scientific backgrounds on the issue of banning single-use plastics. Environmental, economic and health aspects, among others, are present in this issue.

METHOD

PARTICIPANTS

EU	Undergraduates of the 4nd year of Degree in Mechanical Engineering of University of Málaga	**N=35**
SG	Chemical and Biological Graduated in training in a Master's Degree of University of Málaga	**N=43**

ACTIVITY

PHASE 1 → **PHASE 2** → **PHASE 3**

Instruction on argumentation.
A training session: argumentation in the scientific area ➡ Toulmin's model.

Debate about the problem.
The participants listened to a 15-minute debate on the issue conducted in the classroom by three students.

Making a decision on the problem.
After the debate, the students made a reasoned decision on the issue: **"The European Union has recently published a regulation to ban single-use plastics; do you support or oppose this ban?»**

DATA ANALYSIS

- ➡ The arguments offered were analysed according to Toulmin's model.
- ➡ Rubric:

Conclusion		
0: No conclusion provided	1: Hesitation in reaching a conclusion	2: An adequate and accurate conclusion is provided

Evidence				
Number of evidence				
0 (No evidence)	1	2	3	4
Type of evidence				
Economic	0 (No evidence)	1	2	
Chemical	0 (No evidence)	1	2	
Environmental risk	0 (No evidence)	1	2	
Health risk	0 (No evidence)	1	2	
Legislative	0 (No evidence)	1	2	
Social awareness	0 (No evidence)	1	2	

Justification		
0: No justification provided	1: A justification that does not link evidence to conclusion is provided	2: A justification linking evidence to conclusion is provided

- ➡ The Mann-Whitney U test was performed to determine the possible existence of statistically significant differences.

RESULTS

- ➡ 75.6% of the students favoured the plastic ban. No differences were observed regarding the scientific background of the participants.
- ➡ All students drew a conclusion in the level 2 of the rubric.
- ➡ Not all students justified the conclusion adequately, but listed a series of evidence only, this being more pronounced in science graduates.
- ➡ They based their conclusions on were qualitatively similar type of evidence, with minor differences being found depending on the student profile.
- ➡ Thus, the difference in the social awareness evidence, chemical evidence and health risks, which science graduates used more, was striking, while engineering students notably used economic evidence.

	Conclusion	**Justification**	**Evidences**						
			Economic	**Chemical**	**Environmental risk**	**Health risk**	**Legislative**	**Social awareness**	**Total number of evidence**
Average EU	2.00	1.60	0.29	0.34	0.66	0.17	0.11	0.26	1.83
Average SG	2.00	1.33	0.05	0.60	0.65	0.30	0.16	0.67	2.44
Mann Whitney U-test	Z=.000 p=1.000 (No significance)	Z=-2.230 p=.026 (In favour of EU)	Z=-2.893 p=.004 (In favour of EU)	Z=-2.066 p=.039 (In favour of SG)	Z=-.194 p=.84 (No significance)	Z=-1.331 p=.83 (No significance)	Z=-.608 p=.543 (No significance)	Z=-2.972 p=.003 (In favour of SG)	Z=2.762 p=.006 (In favour of SG)

CONCLUSIONS

- ➡ The results show university students' difficulty in arguing and making decisions about relevant issues in a society where science and technology play an important role.
- ➡ An important aspect to consider is using evidence on social awareness based on students' personal ideas, mostly focused on opinions. Indeed, statistically significant differences were found in this type of evidence in favour of science graduates. Therefore, this type of evidence should be avoided and replaced by other evidence of higher argumentative quality.
- ➡ These results highlight the need for further training of science and engineering undergraduates to argue in their profession and in their daily life in the best possible way.
- ➡ Finally, based on this preliminary study and with the idea of improving the quality of the scientific-technological argumentation of students, the design of mobile applications for learning scientific argumentation on climate, environmental and resource efficient actions is intended as a future line of work

REFERENCES

1. Bogar, Y. (2019). Synthesis study on argumentation in science education. *International Educ. Studies*, *12*(9), 1-14.
2. European Union, The European Parliament and the Council of the European Union (2019). Directive (EU) 2019/904 of the European Parliament and the Council, of 5 June 2019 on the reduction of the impact of certain plastic products on the environment. European Union.
3. Toulmin, S. E (1958). The uses of argument (2003, 3rd ed.). Cambridge University Press.
4. Jiménez-Aleixandre, M.P. (2010). *10 ideas clave. Competencias en argumentación y uso de pruebas* (Vol. 12). Graó.

ACKNOWLEDGEMENTS

This publication is part of the R&D project (21ProyExcel_00176), funded by the Andalusian Plan for Research, Development and Innovation (PAIDI 2020) of the Regional Government of Andalusia (Spain).