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Fostering Scientific Citizenship in an Uncertain World (Proceedings of ESERA 2021)

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The Proceedings of ESERA 2021 is an electronic publication for revised and extended papers presented at the ESERA 2021 conference organised by the University of Minho, Portugal, from 30 August to 3 September 2021. All papers in the e-Proceedings correspond to communications submitted and accepted for the ESERA 2021 conference. All proposals to the conference went through a double-blind review process by two or three reviewers before being accepted to the conference. A total of 739 proposals (out of which 33 were symposia) were presented at the conference, and 158 papers are included in the ESERA e-Proceedings, 5 of them from symposia.

The authors were asked to produce updated versions of their papers and consider the discussion that took place after the presentation and the suggestions received from other participants at the conference. The e-Proceedings presents a comprehensive overview of ongoing studies in Science Education Research in Europe and beyond. This book represents the current interests and areas of emphasis in the ESERA community at the end of 2021.

The e-Proceedings book contains seventeen Parts representing papers presented across 17 strands at the ESERA 2021 conference. The strand chairs for ESERA 2021 co-edited the corresponding Part for each strand 1 to 17. All formats of presentation (single oral, interactive poster, demonstration/workshop and symposium) used during the conference were eligible to be submitted to the e-Proceedings.

The co-editors reviewed the updated versions of the papers submitted after the conference at the end of 2021. ESERA, the editors and co-editors do not necessarily endorse or share the ideas and views presented in or implied by the papers included in this book.

The appropriate APA style for referencing this e-Proceedings book is as follows:

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WITHIN THE PROCEEDINGS:

Part 13 / Strand 13

Pre-service Science Teacher Education

Editors: *Maria Evagorou & María Ruth Jimenez Liso*

Part 13. Pre-service Science Teacher Education

Professional knowledge of teachers, pre-service teacher preparation, instructional methods in pre-service teacher education, programs and policy, field experience, relation of theory with practice, and issues related to pre-service teacher education reform.

PRIORITY MATTERS TO BE RESEARCHED ACCORDING TO TRAINEE PRIMARY EDUCATION TEACHERS

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It is important to train scientifically literate citizens. In this, formal education plays a relevant role. In the present work, a questionnaire was administered which was prepared ad hoc for a convenience sample comprised of 367 primary education teachers undergoing initial training, from 5 Spanish universities. The questionnaire sought to detect how teachers are able to identify science in society and what matters are considered most priority. The results of the analysis show that Health and the Environment, but not others, are the subjects consider most important by future primary teachers. The awareness of scientific issues forgotten needs to be included among the teacher education course activities. The analysis according to sex, age and academic year variables have shown statistically significant differences regarding the sex variable. Comparative analysis with the results of questionnaires addressed to the population at large, both European and Spanish, have found some differences in order of priority of scientific issues.

Keywords: Initial Teacher Training, Scientific Literacy, Socio scientific Issues

INTRODUCTION

The scientific literacy of all citizens is increasingly necessary in today's world (Aikenhead, 2006; Ezquerra and Magaña, 2017) in the face of the evident crisis of confidence in science as indicated rise of anti-vaccine movements, terraplanists, Climate Change deniers or advocates of homeopathy… (Achterberg et al., 2017; Saltelli and Funtowicz, 2017). The pursuit of scientific literacy for participatory democracy is a goal claimed within the movement socio-scientific issues (ISS) and advocated in science education reforms internationally, which is necessarily linked to the development of critical thinking or the ability to search for and evaluate information (Acar, Turkmen y Roychoudhury, 2010; Sadler, Romine and Topçu, 2016). That concern mobilises institutions in different countries who seek to know the situation of the population and its evolution (DeBoer, 2011; DeBoer, 2014; Roberts & Bybee, 2014; Cortassa, 2016) in order to improve the scientific training of their citizens. This diagnosis in Spain has been carried out through surveys by the Spanish Foundation for Science and Technology (FECYT according to the acronym in Spanish) every 2 years from 2002 and at European level through the Eurobarometer study on Public Perceptions of Science (Directorate-General for Communication, 2014).

Due to the important role formal education has in scientific training of citizens, different countries have enshrined in their legislation the intention to train their population scientifically. In the case of Spain, it is included in the current educational law (LOMCE, 2013): "Preparation for the exercise of citizenship and for active participation in economic, social and cultural life, with a critical and responsible attitude and with the ability to adapt to the changing situations of the knowledge society". However, legislating is not enough, more research efforts are needed

both to document the potentialities or constraints of scientific literacy and citizenship education through science curricula and to evaluate what training and viewpoint teachers have. Especially relevant is improving of teachers training of the first stages of education. More so since, research has showed the public domain of science of the trainee Primary Education teachers affects the kind of thinking they develop, and their teaching plans (Spiliotopoulou and Papantoniou, 2011). For this it would be necessary to consider factors and skills such as decision making, problem solving, identification of science in the environment, sustainable development, etc. (Hodson, 2003). Nevertheless, scare work has been carried out on this group to detect its capacity to identify science in society and its transfer to the classroom. Prior studies show that Primary Education teachers in initial training do not show differences compared with other citizens of the same age (Fuertes-Prieto et al., 2020). Moreover, they have difficulties in adequately including science in the learning process (Ezquerra, Rodríguez & Hamed, 2014; Rivero et al., 2017).

Due to all this, it is of interest to diagnose capacity to identify the presence of science in society among this group of teachers. Therefore, the aim of this work was to analyse what subjects are considered important to be researched by science in a sample of students of the Degree in Primary Education.

METHOD

Participants

A convenience sample was drawn, it was composed for 367 students of Primary Education Degree, belonging to five Spanish universities (Granada University, Valladolid University, Complutense University of Madrid, Castilla-La Mancha University and CEU Cardenal Spinola, Sevilla). Most of the participants of the group (72,75%) were women. This is a similar percentage to that of the Spanish active teaching staff. As expected, the majority were young people between 19 and 24 years old. None of the students were in their first year.

Coding of data procedure

The method used to carry out this work is described below. In order to achieve the objectives, the research has had three stages (Figure 1). The first was putting into circulation the next question: *"please tell us which topics you consider to be the most important for science to investigate. If you can, please tell us up to five topics"*. The question was on-line administered in the context of a science education course during the first semester of academic year 2019-2020.

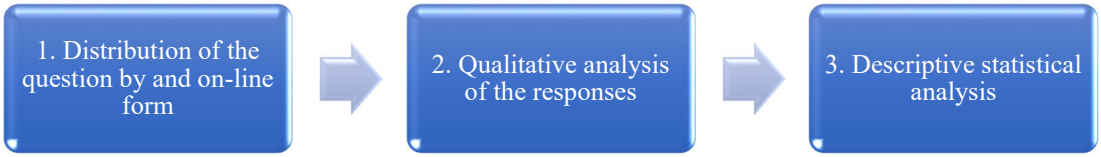

Figure 1. Stage of research.

Once the responses were received, next stage was to implement a qualitative analysis of the responses (content analysed by adopting an emergent coding approach) to detect the recurring

themes. Initially, three coders independently inspected the answers what were encoded and assigned to categories. Next, emergent categories identified by the independent coders were compared and differences were reconciled, resulting in a common list. In the different refining phases until to find the consensus, the research team grouped the categories to generate a system of macro-categories. These major categories are comparable to those already used in similar studies such as the FECYT surveys administered to citizens in Spain and Eurobarometer in Europe. Thus, expressions such as "Alzheimer" or "Rare diseases" were encoded in the emergent category "Diseases" that, along with other emergent categories such as "Treatments" or "Vaccines", configured the macro-category "Health". Subsequently, a descriptive statistical analysis was carried out of the citations to allow the relative frequency of each macro-category to be obtained in the set of responses.

RESULTS AND DISCUSSION

The overall results obtained are shown in Table 1. It gives a brief description of the macro categories detected in alphabetical order and their relative frequencies. According to our sample, the topics that Spanish trainee teachers consider a priority to be investigated by science could be grouped into seven macro categories.

Table 1. Short description of the macro- categories and their relative frequencies (RF).

MACRO-CATEGORIES	DESCRIPTION	RF
Basic and applied science	Groups the mention of basic scientific disciplines and their applications in society.	11.1%
Education	Compiles aspects related to scientific literacy and teaching.	5.9%
Environment	Records codes that refer to climate change, energy sources, pollution, conservation of the environment, etc.	21.1%
Food	Records content related to types of food, nutritional characteristics and properties, diets, etc.	3,2%
Health	Covers references to diseases, medical treatments, medicines, etc.	37.8%
Pseudo-science	Compiles mentions of non-scientific practices.	0.3%
Society	Covers items linked to wellbeing, consumption, culture, sports, the economy, politics, and population.	9%
Technology	Covers codes related to telecommunications, means of transport, robotics, and new materials.	11.4%

The data indicate that students show interest in two topics: Health (37.8%) and Environment (21.1%); while Technology (11.4%) and Basic and Applied Science (11.1%) occupy the third and fourth place, respectively. The themes Society (9%), Education (5.9%) and Food (3.2%) are presented as a lower priority. It is important to point out that responses were also gathered on practices that are not considered scientific, for example "Astrology". These affirmations are

grouped in an eighth category, Pseudoscience (0.3%). Although it could be considered as anecdotal for, they amount to a low percentage, in our opinion it is a type of declaration that should not arise among future teachers. Their presence among preservice teachers should be a source of reflection, since these may be part of the hidden curriculum that they will transmit to their students (Fuertes-Prieto et al., 2020).

In order to obtain greater detail of the distribution of priorities that future Primary Teachers have, the relation between the macro-categories established and three distinctive variables was studied: sex, age and academic year. We point out that there are no statistically significant differences for the age and academic year variables. Nevertheless, our data shows, with significant differences ($p<0.05$) that women are more likely than men to mention Health (39,66% vs. 33,09%), Environment (23,11% vs. 16,18%), Education (6,99% vs. 3,31%) and Food (3,28% vs. 2,94%). However, men prioritize topics related to Basic and Applied Sciences (16,54% vs. 8,99%), Technology (15,81% vs. 9,70%), Society (11,76% vs. 7,99%), and Pseudoscience (0,37% vs. 0,29%) (see Figure 2). These results differ from the findings of Revuelta and Corchero (2016) who identify women as one of the social groups that most believe in pseudoscience.

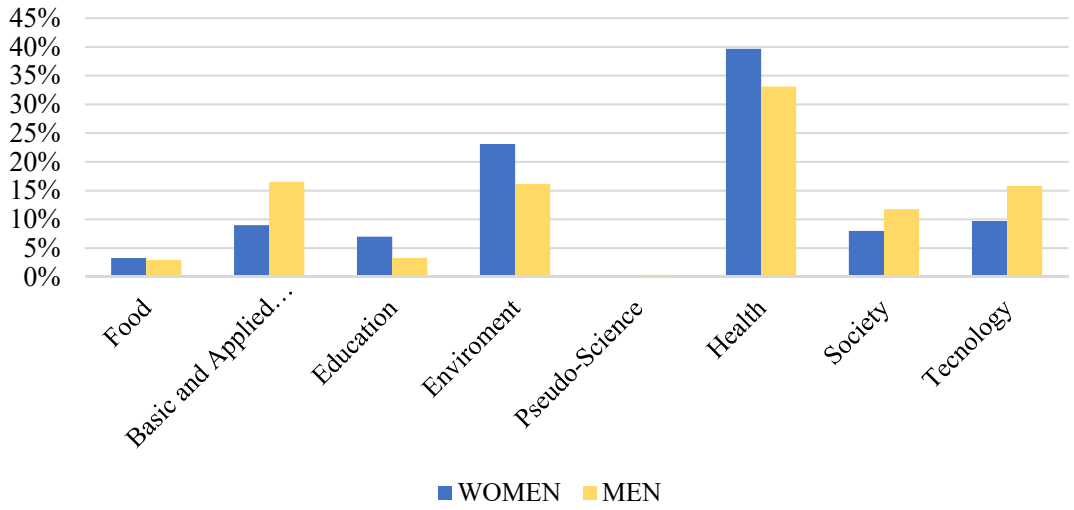

Figure 2. Comparative study between sex variables.

Comparative study between teacher-students and citizens

Although the question was not exactly the same, a comparative study has been carried out for the discussion in this study between our data and the results (1) of the Eurobarometer (2014) and (2) the Social Perception of Science Survey (FECYT, 2019) among Spanish citizens. The preliminary study carried out compares the position that each subject occupies according to the importance the different samples are assigned. Figure 3 shows the results obtained in this study, Figure 4 shows the results of the social perception of science in Spain and Figure 5 shows the results for European citizenship.

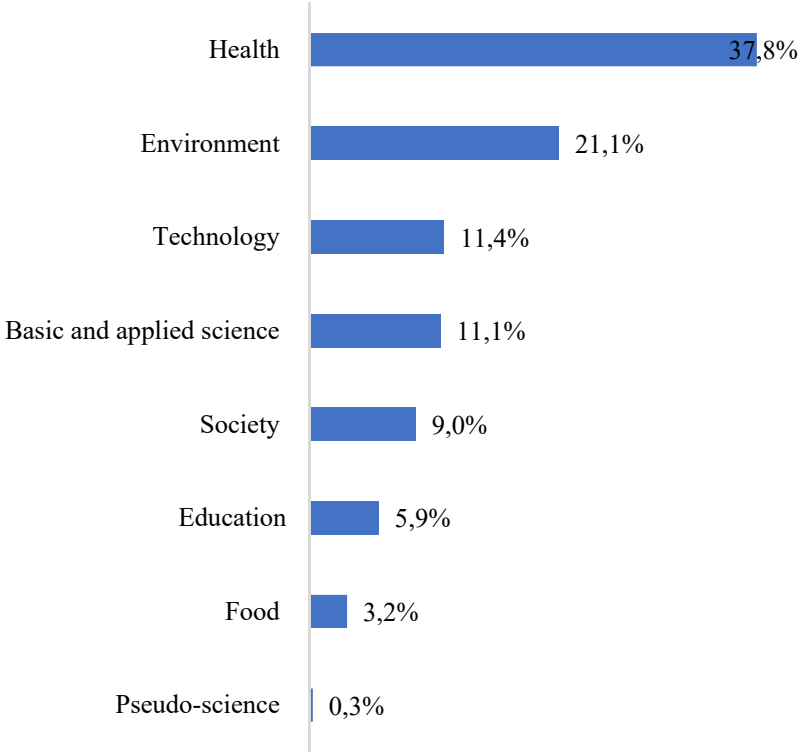

Figure 3. Results of teachers training obtained in this research.

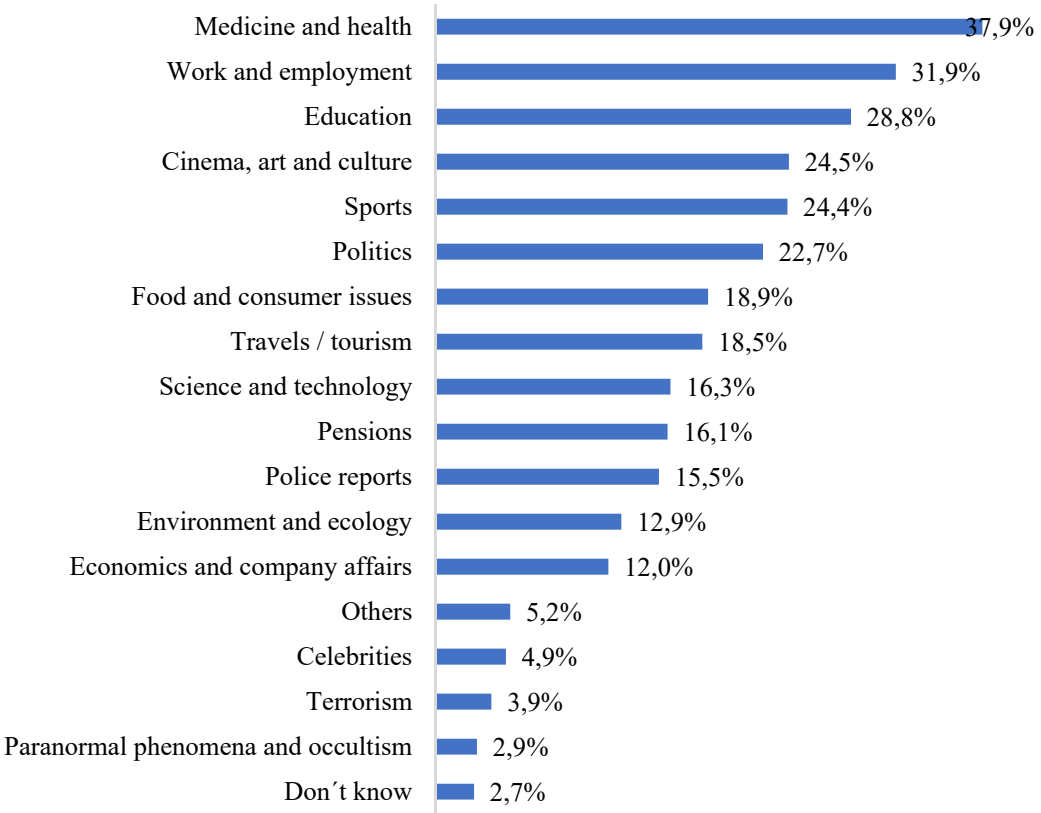

Figure 4. Results of Social perception of science and technology survey (Spanish Foundation for Science and Technology -FECYT-). Source: FECYT (2019). Percepción social de la ciencia y la tecnología 2018.

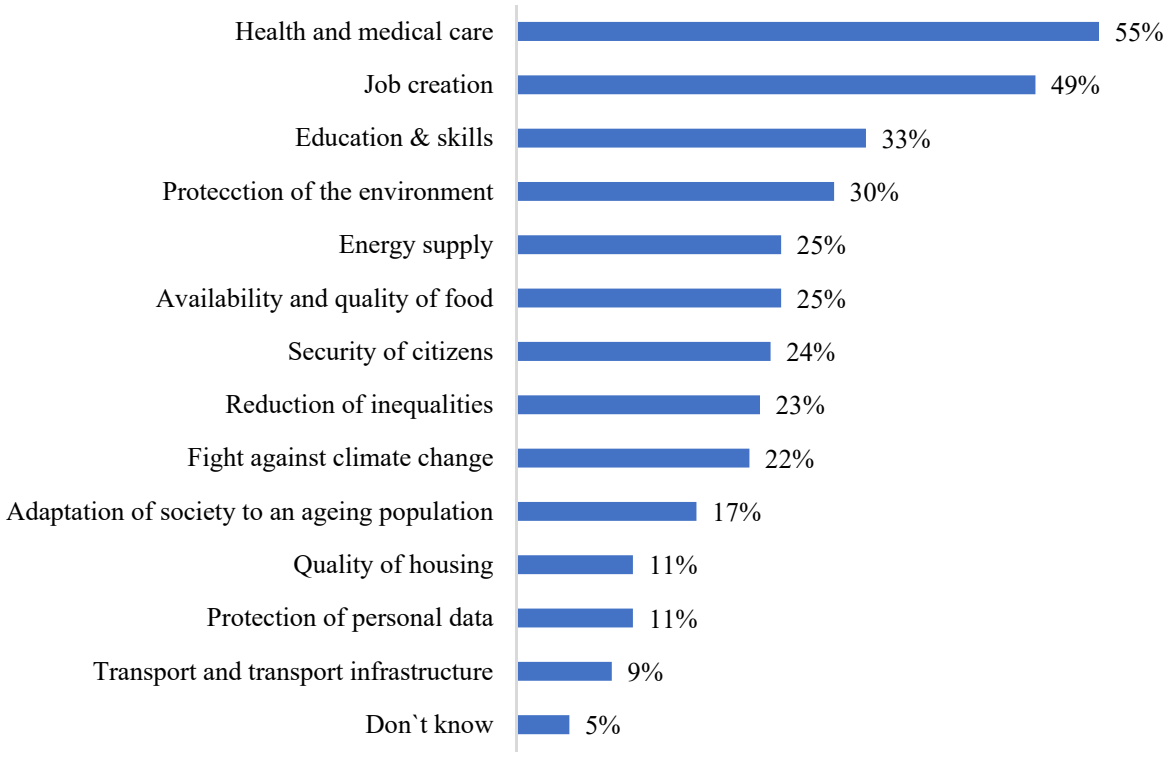

Figure 5. Result of Eurobarometer. Source: Directorate-General for Communication (Coord.) (2014). Special Eurobarometer 419.

Health is in a high position, regarding the European population (55%), the Spanish citizens (37,9 %), and the trainee Primary Education teachers (37,8 %). But if the Environment macro-category is considered to include protection of the environment, climate change and sources of energy as it is in the present research, the European population put this macro-category above Health (the sum of percentages is 77%). However, that is not the case for Spanish citizens. In regard of Environment, the Spanish general population consider in a lower position (12,9 %) than the university students of this research (21,1 %), and the European population.

About Education, Spaniards (28,8 %) match European citizens (33 %) when, in both cases, they grant greater importance to that matter than the sample in our study (5,9 %), which are preservice teachers. It is surprising that future teachers place Education in such a low position compared with other matters and that this order is less ambitious than that gathered from citizens at large, especially for the Spanish citizens.

We found concerning the emergence of pseudo-sciences (0,3%) among the answers to our study but the relative frequency in the sample is low than that from Spanish citizens (2,9%). The emergence of uncritical pseudo-scientific proposals in our society has been a matter of concern for years but has recently become more pronounced in Spain (Cano-Orón 2019; Cortiñas-Rovira et al. 2015; Fuertes-Prieto et al., 2020). These results confirm the need to improve the training of future teachers in this aspect, since it would affect in the citizens of the future.

CONCLUSIONS AND LIMITS OF THE STUDY

Findings showed that, according to our sample, Spanish student-teachers priority issues to be investigate by science could be group in seven macro-categories. Health and Environment were the main. Considering the responses provided in each of the identified macro categories, it can be seen how future teachers value the role of science in society through a utilitarian approach to science to achieve individual or collective good. Results showed no significant difference between students' age or academic year. Statistically significant differences were found in sex.

What the students mention as the more important matters to be researched differs from the Spanish and European population. Their awareness of scientific issues of daily life needs further development and evidence suggests that there is a need for more specific guidance to be included in the teacher education course activities. This study has allowed us to identify a wide range on which to work on Science in Society in the classroom. In this way, an education that responds to the needs of students would be achieved, improving their quality of life and promoting educational inclusion.

This preliminary study requires more deep analysis and that cannot be covered in the limited length of this text. Our research group infer the relationship between the priority issues than science must research for the trainee Primary Education teachers and the Nature of Science conception. This inference comes from the low position for social issues, especially Education, and is now in process of study.

Lastly, it is necessary to point out that the results shown here reflect a pre Covid-19 vision, that would foreseeably change if the data gathering had taken place late.

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