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Mathematics Teachers Facing the Challenges of Global Society: A Study in Primary and Secondary Education in Spain

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Abstract

The global society in which we are immersed is facing the challenges set out in 2030 Agenda: Sustainable Development Goals (SDGs). This study focuses on whether mathematics teachers teach SDGs alongside with their subject in schools located in rural areas of Castilla and León (Spain). Specifically, this research aims to find out how teachers of mathematics with generalist training who teach in Primary Education (6-12) and teachers with more specific training who teach in Secondary Education and Baccalaureate (12-18) work with these aspects. The methodology used was quantitative, as an online questionnaire was used to collect the 150 responses that make up the sample for this study. The results show that teachers of mathematics at both educational levels should pay greater attention to the content linked to the SDGs within their subject.

Keywords: global citizenship education, sustainable development goals, mathematics teachers, primary education, secondary education, rural schools

INTRODUCTION

There is no doubt that today's society faces multiple challenges, with Sustainable Development Goals (SDGs) proposed by the UN (2015) being among the most relevant when addressing issues that involve everyone at an international level. Thus, if we want to act in favor of achieving SDGs it is necessary to educate active citizens who will act in favor of their fulfilment and, therefore, we must not forget the important role played by the educational establishment (Bourn, 2015; Vladimirova & Le Blanc, 2016).

This study focuses on this area, as it aims to find out whether the teachers who teach mathematics in schools of Primary (6-12 years) and Secondary (12-18 years) Education, located in rural areas in Spain, work the SDGs. The reason why we have focused our study on the area of mathematics is because, in the opinion of authors such as Skovsmose and Valero (2012), Skovsmose, Yasukawa and Ravn (2015) or Valero, Andrade-Molina and Montecino (2015), this subject presents a socio-political component and therefore has ethical implications and should be committed to social justice (Sriraman, 2008).

We begin with a review of the literature dealing with the two key aspects of this study: education in the face of global challenges and the area of mathematics in the face of social justice.

LITERATURE REVIEW

Education in the Face of Global Challenges

The education of global citizens is the purpose of Global Citizenship Education (hereafter GCE), but what do we mean by GCE? Defining this concept is a complex question, as it takes on different interpretations depending on the author considered (Santamaría-Cárdaba, 2020). Considering this, we have taken as a reference the definitions proposed by Bourn (2015, 2016), Martínez-Scott, Monjas and Torrego (2019), Lourenço (2018) or Pashby, Costa, Stein and Andreotti (2020), coming to understand in this article GCE as an educational process that aims at developing autonomous citizens who think critically and act against inequalities by defending the fulfilment of Human Rights and Sustainable Development.

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Contribution to the literature

- This study focuses on whether mathematics teachers teach SDGs alongside with their subject in schools located in rural areas of Castilla and León (Spain).
- This research aims to find out how teachers of mathematics with generalist training who teach in Primary Education and teachers with more specific training who teach in Secondary Education and Baccalaureate work with SDGs.
- The results show that teachers of mathematics at both educational levels should pay greater attention to the content linked to the SDGs within their subject.

The GCE is called education for world citizenship by UNESCO. This international organization points out that this teaching to develop citizens with a global outlook can also be understood as "a way of understanding, acting and relating to others and to the environment in space and time, based on universal values, through respect for diversity and pluralism" (UNESCO, 2015, p. 15). Therefore, GCE is directly related to Sustainable Development and, by extension, to the fulfilment of the SDGs since it is directly related to "the evolution of development theories and practices" (Pérez-Pérez, 2018, p. 3).

SDGs are framed within the Sustainable Development 2030 Agenda, which was shaped with the support of UN member countries and committed to the former Millennium Development Goals. This Agenda 2030 is understood as a set of goals whose achievement is the responsibility of all people, organizations or entities, as the future of the planet depends on the actions of all actors at a local and global level (Vargas & Boni, 2017). Accordingly, training global citizens who understand global challenges is indispensable for the achievement of SDGs, so much so that the fourth SDG focuses on the educational field and aims to train students in theory and practice in order to "promote sustainable development, [...] human rights, gender equality, the promotion of a culture of peace and non-violence, global citizenship and the appreciation of cultural diversity" (UN, 2015, p. 20).

For all these reasons, the educational field in all its areas (formal, informal and non-formal) have an essential role in the training of global citizens who promote Sustainable Development and are active agents encouraging the promotion of measures and actions that favor the sustainability of the planet and the fulfilment of 2030 Agenda (Boni, Belda-Miquel, & Calabuig, 2020).

This study, as indicated in previous lines, focuses on the area of formal education, as this is an aspect that should be worked on from all areas of knowledge. Specifically, this article focuses on whether Spanish teachers in mathematics deal with issues linked to the SDGs stemming from this area of formal education and, therefore, promote GCE. This relationship between mathematics teachers and training in issues related to social change plays an important role, as will be discussed in detail in the next section.

Mathematical Education and Social Transformation

Authors such as Leirós, Ramírez and Ochoviet (2016) or Vanegas and Giménez (2010) in their research within the area of mathematics point out that there is a close relationship between this area and GCE because mathematics teachers promote

> ... citizen competence through mathematics insofar as we promote [...] a set of knowledge and reflective, committed, responsible and supportive mathematical practices [...], in order to learn to recognize the value of constructing mathematics to interpret facts and social changes, and to learn to participate democratically in community decision-making processes [...]. (Vanegas & Giménez, 2010, p. 5)

Mathematical education should, in the opinion of Skomovse and Valero (2012), encourage students to understand the relationship between mathematics and other issues such as social reality and cultural diversity; thus, the area of mathematics should aim at students assuming their responsibilities as citizens living together in a democratic society and supporting social justice (Gutsein, 2003; Xenofontos, Fraser, Priestley, & Priestley, 2020; Valero, 2018). In this sense, Callejo (2000) adds the importance of the education of citizens capable of solving problems or complex situations from mathematics. Hannaford (1998) even pointed out that if students received an ideal mathematical education, they would be taught "much of the freedom, skills and, of course, the disciplines of expression, dissent and tolerance that democracy needs in order to succeed" (p. 186).

Likewise, the area of mathematics should also include content that introduces sustainability and, by extension, SDGs as a thread for dealing with curricular content (Alsina & Calabuig, 2019; Serow, 2015), as has been promoted in learning projects such as *Maths of the Planet Earth* (MPE, 2013). Accordingly, it should be pointed out that educating global citizens who are committed to sustainability requires that teachers have adequate training (Bourn & Hunt, 2017); therefore, in this case, mathematics teachers must understand that "education for sustainability amplifies questions about the purpose of teachers in society. They do not only hold the key to promote sustainable development

understanding and competences, but also support social justice, equity, and environmental responsibility in our communities" (Alsina & Mulà, 2019, p. 2).

The publication *Global citizenship education: preparing learners for the challenges of the 21st century* (UNESCO, 2014) presents a "paradigmatic framework that synthesizes how education can develop the knowledge, skills, values, and attitudes that students need to ensure a more just, peaceful, tolerant, inclusive, safe, and sustainable world" (p. 9). Because understanding the relationships between mathematical ideas, both within specific topics in this area of knowledge and between mathematical ideas and other areas of learning, is an essential component of mathematics education, all students should be provided with the promotion of activities that highlight and explore these connections.

As Bourn (2020) affirms, GCE is more than an area of education, since "it is becoming a distinctive pedagogical approach that in many ways is counter-hegemonic and that challenges the dominant orthodoxies and ideologies that have historically influenced educational theory and practice" (Bourn, 2020, p. 20), mathematics, like any other area of knowledge, can and should take advantage of GCE approaches in the study of mathematical subjects and thus contribute to the formation of responsible citizens.

Therefore, the realization of statistical projects in the field of mathematics is an example of a significant task for the natural integration of the contents of the GCE. In this context, the organization and processing of data is an essential mathematical learning that will undoubtedly contribute to the formation of more active, critical and responsible citizens.

RESEARCH QUESTIONS

This study poses a general research question: do teachers who teach the subject of mathematics work with their students on content linked to SDGs? Several sub-questions emerge from this general question:

- Are there any differences between Primary and Secondary School teachers when dealing with their students about these contents?
- Are there differences between men and women in the teaching of these contents?
- Are there differences in terms of the teaching experience of the participating teachers about the teaching of subjects linked to SDGs?

After indicating the questions that have guided this study, the following section explains the research methodology used to answer these questions.

METHODS

The methodology used in this study is quantitative, as it uses the survey as an information collection strategy because it "ensures that the information provided by a sample can be analyzed using quantitative methods and the results can be extrapolated with certain errors and confidence to a population" (Grande & Abascal, 2005, p. 14). Specifically, the most widely used tool in this type of study and used in this research is the questionnaire, which has a series of equal questions for all participants (Cea, 2001).

In this study, the questionnaire used was already validated by OCUVa (2017) and was provided by email to schools located in rural areas of Castilla y León (Spain) so that principals could forward it to teachers who could complete it online. This questionnaire designed by OCUVa (2017) consists of seven closed questions (dichotomous and multiple choice) and three open questions. However, in this research we were only interested in data from teachers who indicated in the survey that they were generalists in Primary Education (6-12 years) and specialists in Mathematics in Secondary Education and Baccalaureate (12-18 years). The reason for the interest in these teachers is because generalist teachers acquire their mathematical training during the Primary Education Degree and in school they teach general subjects such as Mathematics or Social Sciences; whereas, the Secondary Education and Baccalaureate teachers who teach the subject of Mathematics have taken the Degree in Mathematics or on a related area and, subsequently, a Master's Degree in Teacher Training. Therefore, the training received in both cases gives rise to a differentiated training profile among the teachers of these educational levels and makes it particularly interesting to check whether or not there are differences when teaching this subject in matters linked to SDGs and, by extension, to the GCE.

The sample included was 150 participants, of which 120 were generalist teachers in Primary Education and 30 mathematics teachers in Secondary Education and Baccalaureate. In this case, participation in this study was higher among women (81,3%) than among men (18,7%). Also, as can be seen in Figure 1, most of the participating teachers had between 0 and 20 years of teaching experience.

We then go on to analyze the responses provided by the generalist teachers of Primary Education and the Mathematics teachers of Secondary Education and Baccalaureate according to their gender and their teaching experience.

RESULTS AND DISCUSSION

Descriptive Analysis

Firstly, we will describe, on the one hand, the frequencies compiled with Table 1 with which the generalist teachers who teach the subject of Mathematics in Primary Education and, on the other hand, those of

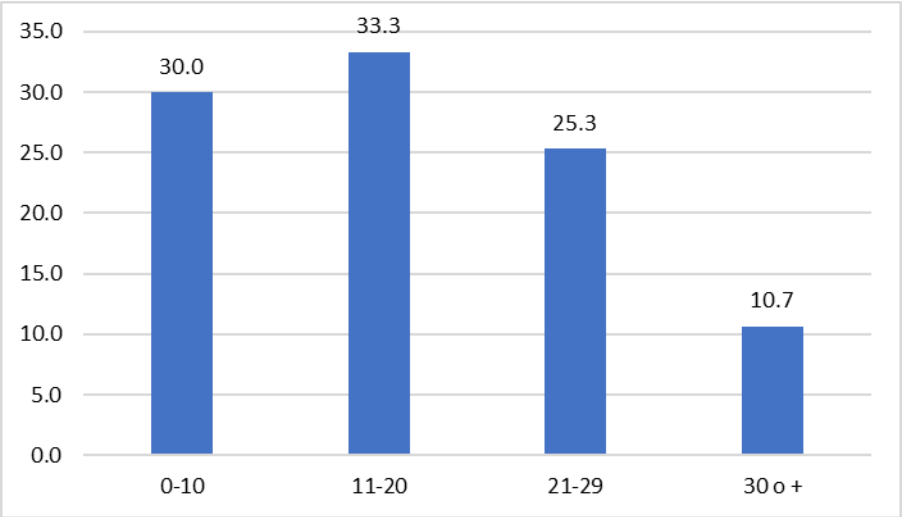

Figure 1. Relative frequencies of participation according to the teaching experience of the teaching staff
Own elaboration

Table 1. Frequency of treatment of content linked to teachers' SDGs

	Generalist teachers			Mathematics teachers		
	%			%		
CONTENTS	Nothing	A Little	Much	Nothing	A Little	Much
SDGs	11.7	43.3	45.0	23.3	40.0	36.7
Fair Trade	21.7	61.7	16.7	36.7	56.7	6.7
Humanitarian Aid	7.5	37.5	55.0	26.7	50.0	23.3
Responsible Consumption	2.5	18.3	79.2	10.0	46.7	43.3
Anti-globalisation Movements	47.5	44.2	8.3	63.3	23.3	13.3
Ethical purchasing	22.5	44.2	33.3	36.7	50.0	13.3
Cultural diversity	0.8	13.3	85.8	6.7	36.7	56.7
Sustainable human development	9.2	42.5	48.3	10.0	46.70	43.3
Forms of citizen participation	7.5	45.8	46.7	16.7	53.3	30.0
Economic inequality in the world	4.2	38.3	57.5	6.7	56.7	36.7
Poverty	4.2	35.8	60.0	20.0	46.7	33.3
Cooperation for Development	13.3	50.8	35.8	33.3	56.7	10.0
Social movements	21.7	53.3	25.0	30.0	60.0	10.0
Equality between men and women / Gender Equality	2.5	10.0	87.5	6.7	16.7	76.7
Globalisation	20.8	52.5	26.7	33.3	53.3	13.3
Solidarity	0.8	12.5	86.7	6.7	43.3	50.0
Intercultural Relations	2.5	26.7	70.8	20.0	46.7	33.3

Own elaboration

the teachers of Mathematics in Secondary Education and Baccalaureate.

On the one hand, no content is worked on by all the general teachers surveyed, as there is always a percentage of teachers who say they do not address any of the content. Above all, *Anti-globalization Movements* content stands out, which has almost 50% incidence (47.5%), being this time the least worked by teachers. The contents: *Fair Trade*, *Cooperation for Development*, *Social Movements* and *Globalization*, are those indicated as the least worked with the highest percentage, more than 50% of those surveyed indicate them as such. The most worked on, pointed out by more than 50% of the teachers, are: *Cultural diversity*, *Equality between women and men*, *Solidarity*, *Responsible consumption*, *Intercultural relations*, *Humanitarian aid* and *Economic inequality in the world*. It should be noted that the contents of *Cultural Diversity*, *Equality between women and men* and *Solidarity* show percentages above 80%.

On the other hand, as was the case with generalist teachers, no content is worked on by all the mathematics teachers surveyed (none of the content has a zero incidence in the column for the level nothing). The content of *Anti-globalization Movements* shows an incidence of more than 50% (63.3%) being, this time, what is indicated as the least worked by teachers of mathematics. The contents indicated with greater percentage as little worked are: *Fair Trade*, *Humanitarian Aid*, *Ethical purchasing*, *Forms of Citizen Participation*, *Economic Inequality in the World*, *Cooperation for Development*, *Social Movements* and *Globalization*, considering that equal or more than 50% of respondents classify them in this way, with a specific percentage between 50% and 60%. In this case, the most worked

contents, pointed out by more than 50% of the teachers, are: *Cultural Diversity*, *Equality between men and women*, with percentages of 56.7% and 76.7% respectively.

Therefore, comparing the contents worked by teachers according to the percentage of incidence in nothing or little, the content of the *Anti-Globalization Movement*s is common to both groups of teachers. Authors such as Dieste, Coma, and Blasco-Serrano (2019) found that in primary and secondary schools, located in rural areas of the province of Zaragoza (Spain), the content of the *Anti-Globalization Movements* is independent of the level of education, as in this case, the content they teach least. Along these lines, Quintano, Ortega, Tejedor, and Mardomingo (2019) verified that with a frequency of 72,7% the content of the *Anti-Globalization Movements* is not worked on in the educational context of the European countries that participated in their study.

Concerning the contents of *Fair Trade*, *Humanitarian Aid* and *Cooperation for Development*, they are among those that have been little worked on by both teachers. In relation to *Fair Trade*, studies such as that of Chen and Wu (2020), Hartman, Paris and Blache-Chogen (2014) or Pykett, Barnett, Clarke and Malpass (2010) point out the importance of dealing with this subject in order to train responsible people who are aware of the reality and are committed to consuming sustainable products that respect the producer and the environment, as the teaching of these subjects is necessary to develop global citizenship (Bourn, 2016). *Humanitarian Aid* should be a content that is given greater relevance in all subjects, but especially in Mathematics, since from this area strategies could be designed, and decisions taken on proposals for humanitarian aid (McKay & Perez, 2019). Likewise, the subject of *Cooperation for Development*¸ should, in the opinion of authors such as Bongiorno and Curbera (2018), Dreyfus, Artigue, Potari, Prediger, and Ruthven (2018) or Furinghetti (2014), be worked on in relation to mathematical education and therefore should be an issue that the participants in this study should teach to a greater extent in their classes.

The contents *Gender Equality* and *Cultural Diversity* are indicated by both groups of teachers as being much worked on (with an incidence of more than 50% in both cases). It should be noted that the *Gender Equality* content presents a percentage of more than 70% in both cases, the same not being true of the other content as they present quite different percentages (85.8% for generalists and 56.7% for mathematics teachers). This content appears in many studies which conclude that education for equality favors the prevention of male violence and gender equality (Moriana, 2017). Some of these publications focus on educational experiences, which deal with this issue with satisfactory results at all educational levels, for example: in Higher Education we highlight David (2015) or Mayorga (2018); in Secondary Education we highlight Brown and Alexandersen (2020) who deal with this issue from the area of Mathematics; and, in Primary Education we can see studies such as that of Bragg, Renold, Ringrose and Jackson (2018).

In addition, *Cultural Diversity* is also a topic covered in several publications on Higher Education (Figueredo & Ortiz, 2017; Rizvi, Naqvi, & Batool, 2016), Secondary Education (Pezetti, 2017; Sincer, Severiens, & Volman, 2019) and Primary Education (Grossen & Mirza, 2020); Rodríguez, Civeiro & Navarro, 2017), all of them reaching the conclusion that "to educate people we must know them, respect them, and welcome them in their diversity" (García-Medina, García-Fernández & Moreno-Herrero, 2012, p. 22).

Comparative Analysis as a Function of Sex

A comparison of the data based on sex and based on Pearson's coefficient shows that the contents of *Intercultural Relations*, *Cooperation for Development* and *Gender Equality* are particularly relevant. Specifically, the teachers who teach Mathematics in Secondary Education and Baccalaureate are those who present significant differences (sig. ,008) when working on *Intercultural Relations*; in this case, at the level 83.3% are women and in many cases they are exclusively women. The percentage of incidence is more balanced, relatively to the sex, being higher than 50% in men (57.1%). For their part, generalist teachers are those who present differences according to gender in the other two named contents: *Cooperation for Development* (sig. ,014) and *Globalization* (sig. ,019).

In the case of general teachers, the *Cooperation for Development* shows significant differences according to gender. At any one level the highest percentages (over 50%) are incident on women. In the case of "Nothing" 70%, in the case of "A Little" 64,7% and "Much" 100%. It should be noted that no man has indicated that he works a lot with this content and that the level of nothing is very expressive for women. On the other hand, the *Globalization* content presents significant differences according to the gender of the generalist teachers. In this case, no level presents a 0% percentage about gender. They highlight the levels of "Nothing" and "Much", with percentages of more than 70%, that occur in women. The percentage of incidence in "A Little" is also higher for women with a percentage of 62.5%.

Comparative Analysis as a Function of Teaching Experience

By also comparing the data according to the teaching experience and based on Pearson's coefficent significant differences have been found according to the teaching experience of the professors of mathematics in the content relating to *Forms of citizen participation* (sig. ,011) and of the generalist teachers in the content of *Ethical purchasing* (sig. ,047).

On the one hand, in the content *Ethical purchasing*, in the case of the professional experience of the generalist teachers, the percentage is divided by all the levels considered, none of the levels exceeding 50% (minimum 9,1% and maximum 36,4%, at levels 21-29 years and 11-20 years, respectively). "A Little" is the same, even if the levels with the highest percentages are 11-20 years and 30 or more, with equal percentages (33,3%). In the alternative "Much", the experience between 21-29 years stands out with 50% and the experience between 11-20 years with 0%.

On the other hand, in the content *Forms of citizen participation*, in the case of the professional experience of the mathematics teachers, the highest percentage is in the interval 21-29. It is worth mentioning that in the 9-10 range the percentage of 0% is highlighted, which means that all the teachers in this range work "A Little" or "Much" on this content. In "A Little" with less than 50% (43.8%) focuses on experience 11-20. In the "Much" range, the 0-10 years' experience stands out with 55.6% and 21- and 29-years' experience with 0%.

CONCLUSION

The results discussed in the previous lines show that the teachers who taught the subject of mathematics in Primary and Secondary Education did not present great differences between them since in both cases they tended to pay little attention to the contents linked to the SDGs. Specifically, the subjects that were least worked on by the participating teachers were the *Anti-Globalization Movement*, *Fair Trade*, *Cooperation for Development*, *Social Movements* and *Globalization*; while the issues that were taught most frequently were *Cultural Diversity*, *Gender Equality* and *Solidarity*.

In addition, the teachers surveyed did not present significant differences according to sex, neither regarding their teaching experience, except in the areas mentioned above. Therefore, in this case, in general, there are no significant differences according to either of these two comparative criteria.

In conclusion, teachers with generalist training who teach the subject of Mathematics in Primary Education and mathematics teachers who lecture this subject in Secondary Education and Baccalaureate do not pay special attention to the contents of SDGs from within their subject. This shows the need to promote these contents from the area of Mathematics because, if we want to form global citizens who think critically and act trying to transform the world into a more sustainable and fair place, it is necessary that GCE is promoted from within all subjects and that teachers are aware of the importance of teaching these contents.

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