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Knowledge of Trainee Teachers about the New Water Culture: A Comparative Study between Two Spanish Cities

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Abstract: Education is the main tool society has for transforming cultural habits and making them more sustainable. This work entails a comparative study in the sphere of initial teacher training regarding the knowledge of future educators on the New Water Culture (NWC). An ad-hoc questionnaire was administered to a sample of 1387 future primary and secondary school teachers studying in Granada (N = 942) and Melilla (N = 455), both Spanish cities with diverse education and water conditions. The results indicate that the trainee teachers in Granada display knowledge more in line with the NWC. However, there are contents where the results are inverted due to the media impact regarding water in Melilla. Furthermore, it is confirmed that both groups lack correct training that allows them to transfer appropriate knowledge effectively and thus create new behaviours in future generations in a visible and permanent way.

Keywords: new water culture; initial teacher training; sustainable development; water education; sustainability

Citation: Ramírez-Segado, A.; Rodríguez-Serrano, M.; Castro-Velásquez, F.E.; Benarroch, A.B. Knowledge of Trainee Teachers about the New Water Culture: A Comparative Study between Two Spanish Cities. *Sustainability* **2023**, *15*, 13672. https://doi.org/10.3390/su151813672

Academic Editor: Michail Kalogiannakis

Received: 17 July 2023
Revised: 10 September 2023
Accepted: 11 September 2023
Published: 13 September 2023

1. Introduction

The world is facing an unprecedented water crisis. Population growth, economic development, and climate change are all having an impact on the availability of freshwater. The first report on the state of global water resources issued by the World Meteorological Organization [1] evaluates these resources using two parameters: streamflow, which is the volume of water flowing through river channels, and terrestrial water storage, understood as the volume of water found on the land surface and sub-surface. In both parameters, the registers from the year 2021 show results lower than the average values from previous periods, which clearly indicates the problem of the depletion of freshwater resources on our planet. Other studies indicate depletion problems in subterranean water [2,3]. Aquifers provide 35% of freshwater consumed by human beings throughout the world. The study with the most media impact to demonstrate this was carried out by NASA and the German Aerospace Industry [3] between 2003 and 2013, in which the 37 largest aquifers in the world were studied from space using the GRACE satellite. The authors found that 13 of the 37 aquifers were subject to high water stress due to having been exploited beyond the extent to which nature had the capacity to replenish them.

In Spain, the weekly hydrological gazette provided by the Ministry for Ecological Transition and the Demographic Challenge enables the comparison between the total volume of collected water and the average value over the last 10 years. In the first week of April 2023, the water reserve stood at 51.74%, 13 points lower than the average level in the previous ten years (65.24%).

In the face of this critical situation, which predicts a 40% decrease in freshwater resources by 2030, together with the world population growth, it is not surprising that

the United Nations General Assembly has declared 2018–2028 as the decade of action for water, in order to promote the adoption of measures that help to transform the way we manage water. Neither is it encouraging that from 22 to 24 March 2023, the UN held, in its New York headquarters, the first world water conference in 50 years in order to review the progress of measures adopted in the Decade for Action on Water.

The water problem is presented as one of the most complex and important challenges of our time. When quantity and quality are inadequate, water can become a limiting factor in alleviating poverty and driving economic recovery, which has resulted in deteriorating health and low productivity, food insecurity, and restrictions on economic development. Moreover, its scarcity can even lead to armed conflict [4]. In fact, at the aforementioned UN water conference, Egypt expressed its unease with Ethiopia due to the recent construction of the Renaissance Dam, with which it shares the flow of the River Nile.

Within this framework, it is essential to design new policies, approaches, and collaborations that go beyond traditional economic thinking in order to radically change our manner of understanding, valuing, and managing water as a common asset. Amongst these, mention should be made of those relating to water education at all levels of the educational system. It does not just involve creating specialists in the subject; rather, above all, it means working on water problems in classrooms through socio-scientific conflicts, which must be confronted through argumentation and critical debate. From this perspective, teachers become the main agents for change and transition towards sustainability [5].

Working on water conflicts in classrooms demands teachers who are extremely prepared in these subjects. This article entails an inquiry into the knowledge of future Compulsory Education (Primary and Secondary) teachers from two Spanish cities (Melilla and Granada) with different water conditions. One of the first questions we must ask ourselves in a study on the knowledge of future teachers on water is undoubtedly what knowledge would it be desirable for them to have. In this regard, the authors of this work have found in the New Water Culture (NWC) a representative framework of such knowledge.

2. Theoretical Framework

2.1. New Water Culture

The NWC came about at the end of the 20th century as an alternative model to the traditional or Old Water Culture (OWC). Throughout the 20th century, water was considered a renewable resource, the consumption of which was limited by its availability and, under misunderstood slogans, such as water for all, or water is a public asset, we came to confuse consumption with waste and management policies were created based on increasing the amount of available water. In the face of this traditional culture, the NWC arises as a social movement that defends a change in water management policy in order to achieve more rational and sustainable actions [6–8]. It emerged as a result of the publication in 1993 of the draft National Water Plan bill for Spain, which gave rise to considerable public opposition towards large water infrastructures and channels envisaged therein [9]. The NWC has been a framework for many environmental education programs in European Education since the improvement of the Water Management Directive two decades ago [10].

According to Gómez [11], the main drivers and fundamental axes of NWC action are:

1. Developing new forms of governance as regards water management, placing it at the centre of a plural and participative debate.
2. Democratising water management.
3. Developing new policies in relation to water management, territorial planning, and conservation of ecosystems within a sustainable development framework.
4. Transitioning from the traditional supply management model, based on the promotion of large hydraulic works, towards demand management models that guarantee sustainable development.
5. Tackling problems of inequity and unsustainability present in water management models through legislative and institutional reforms.

For such a complex framework, it is important to differentiate between the NWC and the OWC. To this end, following an in-depth literary review, Benarroch et al. [12] established seven contexts that cover the main criteria characterised by the NWC and differentiate it from the traditional vision. From the NWC:

- It is considered that water is sufficient if we look after it and that occasional water scarcity is directly related to degradation, overexploitation of natural resources, and inadequate management thereof (Context 1. Water imbalance vs. natural balance).
- It is argued that water has a heritage value with different functions (economic, ecological-social, and environmental) (Context 2. Eco-social productive vs. active factor).
- There is an encouragement of governance that includes all sectors involved in water management, including citizens (Context 3. Water governability vs. water governance).
- There is an option towards governance of water resources focused on managing demand, in other words, improving efficiency and reducing consumption (Context 4. Supply management vs. demand management).
- Guaranteeing the comprehensive recovery of all costs when applying cost-effectiveness analysis (Context 5. Cost-benefit vs. cost-effectiveness) is fostered.
- It is considered that only vital water is a human right and, therefore, must be guaranteed to the extent that the remaining uses of water should be associated with a series of duties and obligations (Context 6. Water as a human right vs. human duty).
- Lastly, there is a defence of the need to become aware of the repercussions of our consumerist and eating habits on water resources, as well as promoting the saving thereof (Context 7. Consumerism vs. responsible consumer behaviour).

Based on the aforementioned seven contexts, Benarroch et al. [12] created the main criteria that enable differentiation between OWC and NWC, and that, from their perspective, are summarised in Table 1. Attention may be drawn to the fact that some of the formulations of these criteria have evolved slightly over time, in particular in relation to having used them to analyse the textbooks [13].

Table 1. Criteria of Old Water Culture vs. New Water Culture.

	Criteria	Old Water Culture	New Water Culture
Context 1	Water scarcity	Freshwater is scarce due to natural water imbalance.	Occasional water scarcity is due to anthropic reasons.
	Increasing availability	Reservoirs, desalination plants, dams... allow greater quantities of water to be obtained.	We must reduce consumption rather than attempt to obtain more water.
	Poorly distributed water	There are desertified zones that require transfers from zones more abundant in water.	Technologies and economic activities adapted to the water available should be implemented.
Context 2	Environmental damage of hydraulic works	Industrial facilities used for obtaining greater quantities of water do not damage the environment.	Industrial facilities used for obtaining greater quantities of water damage the environment.
	Reduction of availability due to climate change	Climate change does not affect water resources.	Climate change will make water resources increasingly scarce.
	Effect of water wastage on the environment	Water wastage does not affect the environment.	Water wastage affects the environment.
Context 3	Responsibility shared by all	Responsibility for water falls to the Government.	Responsibility for water should fall to all citizens and political leaders.
Context 4	Priority in management	Satisfy demand It is necessary to increase the amount of freshwater available via hydraulic infrastructures.	Control demand We must reduce consumption rather than attempt to obtain more water.

Table 1. *Cont.*

	Criteria	Old Water Culture	New Water Culture
Context 5	Polluters pay	There is no requirement for all productive activities to revert water to sources in the same way as they extracted it.	There is a requirement for all productive activities to return water to sources in the same way as they extracted it.
Context 6	Education of citizens	Education of citizens not promoted.	There is a need for solid education of citizens to enable them to participate in water management policies.
Context 7	Promotion of domestic and urban saving	Water saving is important but not a priority.	Water saving is a priority at all levels.
	Control of consumerism and eating habits	Consumerist and eating habits do not affect water availability.	Consumerist and eating habits imply an indirect consumption of water.

2.2. The New Water Culture in the Spanish Curriculum

Water is one of the topics with the most media impact in our society, both in itself and also due to being at the centre of the debate on sustainable development. Sustainable Development Goal (SDG) no. 6 does not just recognise the central nature of water and the importance of cleanliness and hygiene for personal stability and development; rather, it also declares that water is key to enabling the fulfilment of the other SDGs, as it has been confirmed that it forms a central or transverse part of their aims. Furthermore, the World Bank [14] also highlights the importance of water for achieving the SDGs, adding that there is a need for fundamental change in regard to how this vital resource is understood, valued, and managed.

The interest in good water usage cannot be absent from the education of our school students as responsible citizens. The topic of water offers abundant content that can be approached in the school sphere, either in a globalised context or from the complementary perspectives afforded by different curricular materials. Given that water is not a subject that is the responsibility of one single discipline but one that affects each and every aspect of society and the lives of people, a transverse approach would be ideal for dealing with it in a didactic manner, but this complicates its teaching in schools, which are usually structured according to ordered spaces and timetables. To this end, the teaching proposals and resources that have been designed for the classroom are normally versatile as regards their usage (for example, [15]; https://ecologistasmanchuela.org/ud (accessed on 24 May 2023); https://tiempodeactuar.es/blog/los-juegos-del-agua/ (accessed on 24 May 2023)).

Although concern regarding the topic of water is not new, and nor is the inclusion of this content in school curricula [16], there are new elements in its teaching, which is the result of water becoming increasingly important in the panorama of global sustainability.

Specifically, if a search is made to count the terms "water", "sustainable development", and "sustainability" in the Spanish compulsory education curriculum, in both current legislation associated with the Organic Law Amending the Organic Law of Education (LOMLOE) [17–19]; and with the recently repealed Organic Law for the Improvement of Educational Quality (LOMCE) [20,21], we obtain the results shown in Table 2. A brief reading thereof suggests that water loses importance in the most recent compared to the previous education legislation. In contrast, there is a spectacular increase in the terms "sustainable development" and "sustainability" in the current legislation.

The importance of sustainability in the LOMLOE is unarguable. Its preamble prioritises this concept and highlights that sustainable development is one of the key objectives of the law. Furthermore, included among its guiding principles is "education for ecological transition, with criteria of social justice as a contribution to environmental, social and economic sustainability" ([22] p. 45). Water is immersed in this global concept of sustainable

development, as sustainable development cannot be achieved without water security [23], which is the reason for the number of citations.

Table 2. Number of times the content "water", "sustainable development" and "sustainability" are cited in the Spanish compulsory education curriculum.

	LOMCE [Organic Law for the Improvement of Educational Quality]		**LOMLOE [Organic Law Amending the Organic Law of Education]**	
	Primary Education [20]	**Compulsory Secondary Education and Post-16 Secondary Education [21]**	**Primary Education [17]**	**Compulsory Secondary Education and Post-16 Secondary Education [18,19]**
Water	11	69	7	11
Sustainable development	4	17	16	100
Sustainability	0	5	12	179

We concur with the LOMLOE in that the education system cannot be removed from the challenges faced by the planet; schools must become places for encouraging solidarity and commitment towards sustainable development, and teachers must be the tools driving change towards sustainable education, integrating the NWC in the curriculum.

In a previous study, Benarroch et al. [24] analysed the knowledge of a sample of future teachers in Melilla on the NWC. Their results revealed the difficulties they had in their conceptions of water. Nevertheless, it could be supposed by critical voices that the results obtained are influenced by the context of Melilla and that these difficulties would be eliminated in other locations with a higher education level. To this end, the aim of this comparative study is to provide more general data regarding the training of future teachers about water.

3. Materials and Methods

3.1. Instrument

The NWC questionnaire created by Benarroch et al. [12] was used. In its design stage, it was subjected to a double validation process. Firstly, using a panel of experts, the content validity was carried out, and secondly, the questionnaire was put to a pilot test to study its reliability. Given that the selection of experts constitutes a principle element for establishing content validity [25], the participating judges were teachers from the field of Science Teaching with research experience as regards water uses and consumption, professionals in the scientific sphere related to water, specifically, and technical personnel related to water management, as well as members of the *Fundación Nueva Cultura del Agua* [New Water Culture Foundation]. In regards to the reliability study, it was calculated using Cronbach's alpha, which produced a coefficient of 0.913, representing an excellent degree of internal consistency [26], confirming the robustness and reliability of the instrument.

The final questionnaire comprised 27 questions, some with various sub-questions, which supposes a total of 71 items, with four options (from 1 to 4) expressing a degree of agreement with the statement (1: completely disagree; 2: disagree; 3: agree; 4: completely agree). It was decided to adopt an even number of possible categories to avoid neutral points of view from the respondents. The items were grouped into four content blocks: water as a resource, water dimensions, water management, and personal actions associated with water, which contemplate the contexts created around the NWC (Table 3).

Table 3. List of NWC contexts and the blocks and items from the inquiry questionnaire.

Contexts	Blocks	Questions
C1. Water imbalance and natural balance	B1. Water resource protection	1, 2, 3, 4, 5, 6, 7, 8, 9 (17 items)
C2. Eco-social productive vs. active factor C3. Water governability vs. water governance	B2. Water dimensions	10, 11, 12, 13, 14 (12 items)
C4. Supply management vs. demand management C5. Cost-benefit vs. cost-effectiveness	B3. Water management	15, 16, 17, 18, 19, 20, 21 (23 items)
C6. Water as a human right vs. human duty C7. Consumerism vs. responsible consumer behaviour	B4. Personal actions associated with water	22, 23, 24, 25, 26, 27 (19 items)
TOTAL	27 questions (71 items)	

3.2. Contexts and Participants

The study was carried out with future teachers studying in two Spanish cities, specifically in Melilla (located in the north of Africa) and Granada (located in the south of the Iberian Peninsula). Some relevant differences between the cities are:

- The Programme for International Student Assessment (PISA) report, which contributes towards the systematic evaluation of the skills acquired by students when they finish their compulsory secondary education, found that, along general lines, the results are poorer the further south the autonomous communities are in Spain [27]. In particular, the scores obtained in Granada (Andalusia) for science and maths skills (471 and 468 points, respectively) exceeded those obtained in Melilla (439 and 432) by over thirty points. According to the Ministry of Education, the keys to understanding the low results in Melilla are related to the lack of infrastructure, high ratios (among the highest in Spain), and the language gap that teachers must deal with in the case of immigrant students [28].
- Melilla, which covers a surface area of 12 km^2 and has a population of 85,170 inhabitants [29], essentially obtains its supply from desalinated water but also from underground catchments that exploit the city's aquifers. In contrast, Granada, with 12,531 km^2 and 921,987 inhabitants [30], is supplied from the hydraulic resources of the Sierra Nevada, the subterranean waters of the fertile lowlands of Granada and, furthermore, has an artificial reserve in the form of collected water and a network of supply wells. As regards water consumption, in the case of Melilla in 2021, the daily figure stood at 270 L per inhabitant [31], twice the 126 L per inhabitant of Granada, close to the national average (133 L per inhabitant per day) [32]. It is worth pointing out that water scarcity in the city is the reason behind continuous water cuts, to which the residents of Melilla frequently complain. The expansion of a fourth module in the desalination plant is the response on the part of the authorities to put an end to the limitations of water availability.

The population study comprised 1397 trainee teachers (Primary and Secondary Education), 942 from the Granada campus, and the remaining 455 from the Melilla campus, which also belongs to the University of Granada. As they belong to the same university, both samples of future teachers have the same degree study plans, none of which contain any compulsory subject related to sustainability or environmental education. The age range is wide, from 17 to 54 for the Granada sample and up to 55 for Melilla, with the most common ages being 18 (20.6%) and 21 (13.6%), respectively. The Granada sample was, on the whole, female (71.7% women), whereas Melilla was better distributed in terms of gender (49.2% women). For both campuses, the majority of the students came from a Humanities and Educational Sciences background and identified with European culture, although there was a not inconsiderable percentage of 21.1% originating from the Berber culture in the Melilla sample.

3.3. Procedure

The questionnaire was administered in both cities during the first semester of the 2020–2021 academic year and was conducted both in situ and online using the Google Forms tool.

A reliability analysis was carried out on the questionnaire for each of the samples using Cronbach's alpha, which produced a coefficient of 0.870 for the Melilla sample and 0.843 for the Granada sample, which represented an internal reliability that was quite good in both cases [26].

The analyses were carried out with the statistical analysis software program IBM SPSS version 28. The analysis process began with a recoding of the inverse items, which were identified with an "i" together with the item number, and were as follows: 1i, 2i, 6i, 8ai, 9ai (Block 1), 13i, 14ei (Block 2), 15ai, 15bi, 16ai, 16ci, 16di, 17ci, 18ai, 18bi, 18di (Block 3) and 22i, 26di (Block 4). Following this, four variables were created entitled "Block1", "Block2", "Block3", and "Block4", which summarised the results of the items in each block of the questionnaire, respectively, along with another variable entitled "Global", obtained via the arithmetic sum of all of the items in the questionnaire. This "Global" variable represents the overall results obtained in the questionnaire.

Once it was verified via the Kolmogorov–Smirnov test that the variables involved did not respond to a normal distribution, the Mann–Whitney U test was employed to study the possible significant differences between the responses provided by the Melilla and Granada students.

4. Results

Table 4 summarises the results for both the questionnaire and its four blocks and the sample combined and separated by cities. The final column shows the bilateral asymptotic significance of the Mann–Whitney U test upon verifying the Melilla and Granada results. This table shows that:

(a) The average value of the "Global" variable for the combined sample (2.9) and for Melilla (2.8) and Granada (2.9) indicates that the overall results obtained by the future teachers, although higher than the theoretical average (2.5), are far from those desired, which would complicate their ability to transmit appropriate knowledge effectively and thus be able to forge new behaviours in future generations in a visible and permanent manner.

(b) A comparison of the results between blocks reveals a general trend amongst the samples. In particular, both in the combined and the Melilla and Granada samples, Block 2 (Water dimensions) obtains the best results, followed by Block 4 (Personal actions associated with water). Nevertheless, Block 1 (Water resource protection) and Block 3 (Water management) alternate in the final positions to the extent that in the combined and Granada samples, Block 1 obtains the poorest results, whereas for the Melilla sample, this is the case for Block 3.

(c) Significant differences are produced ($p < 0.05$) between Melilla and Granada for the questionnaire overall ("Global" variable, $Z = -5.885$, $p = 0.000$) and in all blocks. On comparing the mean values obtained in the variables where significance occurs (final column of Table 4), it can be stated that the future teachers in Granada achieved better results than those of Melilla in Block 2: Water dimensions ($Z = -4.648$, $p = 0.000$), Block 3: Water management ($Z = -10.742$, $p = 0.000$) and Block 4: Personal actions associated with water ($Z = -6.696$, $p = 0.000$). In Block 1: Water resource protection ($Z = 10.422$, $p = 0.000$), this result is inverted.

The items where significant differences ($p < 0.05$) occur between both samples are shown below, grouped according to the content blocks.

Table 4. Descriptive statistics and comparative analysis of both samples for the Global variable and the four blocks.

	Combined Sample (N = 1397)	ML Students (N = 455)	GR Students (N = 942)	Comparative Analysis	
Variable	**Mean**	**Mean**	**Mean**	**U de Mann Whitney (Z)**	**Bilateral Sig. (*p*)**
Global	2.9	2.8	2.9	−5.885	0.000
Block 1	2.7	2.8	2.6	−10.422	0.000
Block 2	3.1	3.0	3.1	−4.648	0.000
Block 3	2.8	2.7	2.9	−10.742	0.000
Block 4	3.0	2.9	3.0	−6.696	0.000

4.1. Block 1: Water Resource Protection

The main aim of this block is to ascertain what perception the future teachers have regarding the existing water situation in Spain and in the city where they live.

Significant differences were obtained ($Z = -10.422$, $p = 0.000$) amongst the compared samples in eight items. The statement of these items is the following:

- The main problems affecting water in Spain are: Scarcity (item 8ai).
- The main problems affecting water in Spain are: Poor management of water supply (item 8b).
- The main problems affecting water in Spain are: Poor water quality (item 8d).
- The main problems affecting water in Melilla/Granada are: Scarcity (item 9ai).
- The main problems affecting water in Melilla/Granada are: Poor management of water supplied (item 9b).
- The main problems affecting water in Melilla/Granada are: Dumping of untreated waste water (item 9c).
- The main problems affecting water in Melilla/Granada are: Poor water quality (item 9d, item 9di).
- The main problems affecting water in Melilla/Granada are: Environmental degradation (item 9e).

In Figure 1, the correct response rate for the eight items where significant differences have been obtained for Block 1: Water resource protection is shown via a column chart.

It is evident that there are differences between the Melilla and Granada students regarding the perception of problems affecting water in Spain and their respective cities. Of the nine items to reveal significant differences, in the case of seven of them, the results for Melilla are better than Granada. Specifically, the students in Melilla are more aware of the fact that scarcity (item 8ai) is not the main problem affecting water in Spain; rather, it is the poor quality present in many regions (item 8d). Moreover, they are better informed about the water problems in their city related to management (item 9b), the dumping of untreated waste water (item 9c), water quality (item 9d), and environmental degradation (item 9e).

It is worth mentioning the considerable differences that occur in item 9ai in regard to the scarcity of water where they live. In other words, the students in Melilla consider that water is scarce in their city to a greater extent than those in Granada do as regards their city.

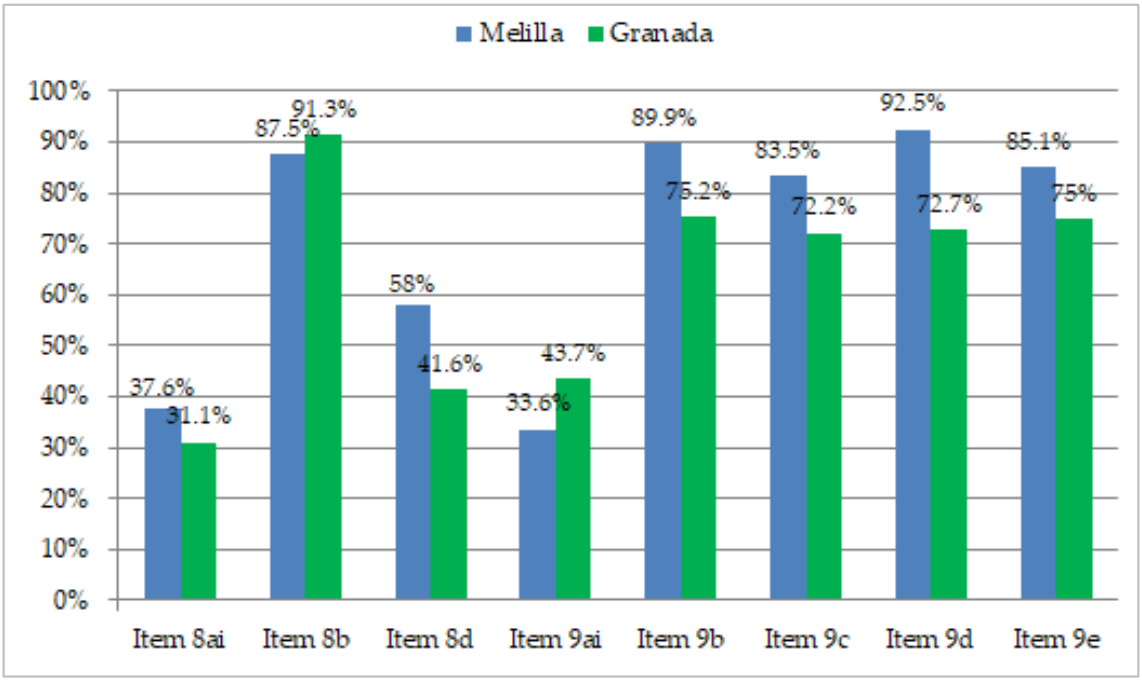

Figure 1. Response rate for the options most aligned with the NWC from Melilla and Granada students for Block 1: Water resource protection items with significant differences between both groups.

4.2. Block 2: Water Dimensions

In Block 2, there is an inquiry into the degree of responsibility given by the respondents to the parties involved in the management of water, as well as the impact hydraulic works normally used to satisfy water needs have on the environment.

In six of the 12 items that comprise this block, significant differences ($Z = -4.648$, $p = 0.000$) were produced between the compared populations ($p < 0.05$). The statement of these items is the following:

- The water problem should be solved by. . .: Central Government (item 10a).
- The water problem should be solved by. . .: Concessionaire companies (item 10c).
- The water problem should be solved by. . .: Citizens (item 10d).
- Industrial facilities used for obtaining greater quantities of water damage the environment (item 11).
- Water resources will be increasingly scarce with climate change (item 12).
- When I am in cities without water problems, I don't mind wasting water because it's not going to affect the environment (item 13i).

In Figure 2, the correct response rate for the six items where significant differences have been obtained for Block 2: Water dimensions is shown via a column chart.

In view of Figure 2, a clear discrepancy exists between the students from Melilla and those from Granada in regard to the role that the different agents involved in solving problems relating to water should play. Although both populations agree on Central Government (item 10a) being the main agent responsible for water management, the Granada students consider to a much larger degree than the Melilla students that there is a need for jointly responsible participation on the part of concessionaire companies (item 10c) and citizens (item 10d).

Furthermore, the Granada students are more aware that facilities such as dams, reservoirs, transfers, and desalination plants, destined to increase the supply of water, are detrimental to the environment (item 11), along with the effect of climate change on water (item 12), and the need to save water even in localities without problems of availability (item 13i).

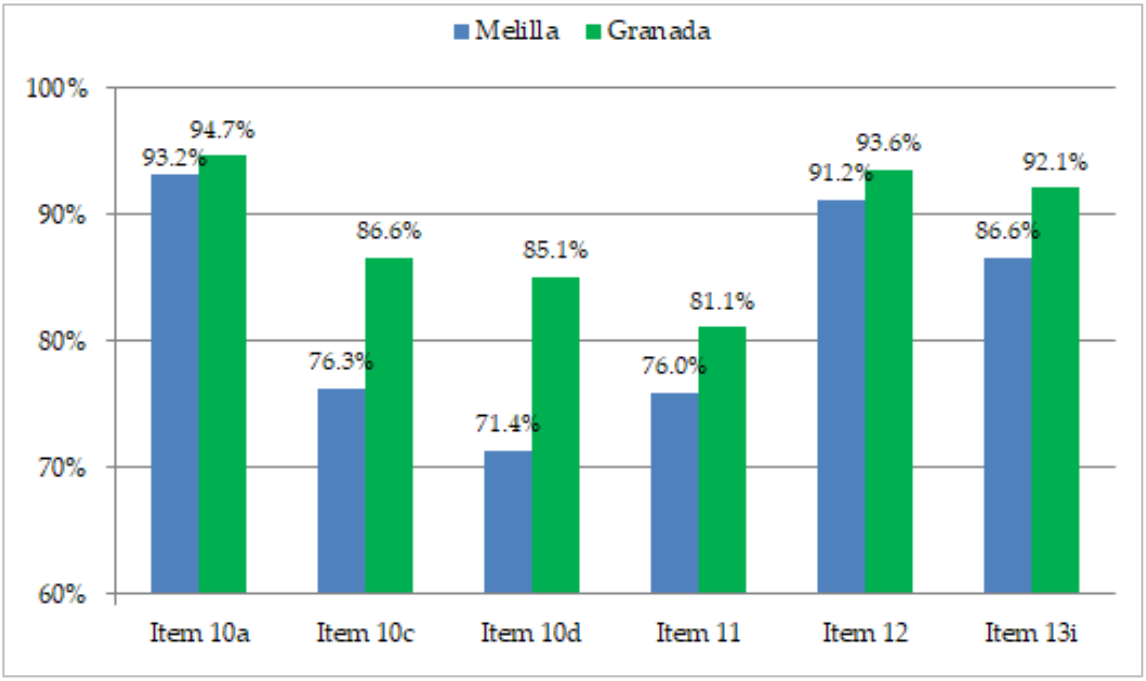

Figure 2. Response rate for the options most aligned with the NWC from Melilla and Granada students for Block 2: Water dimensions items with significant differences between both groups.

4.3. Block 3: Water Management

Block 3 is aimed at determining how the interviewees position themselves regarding water management, either in favour of increasing the water supply according to traditional management of water or, as supported by the NWC, in favour of controlling demand.

Significant differences ($Z = -10.742$, $p = 0.000$) were produced in this block between the samples compared in 14 of the 21 variables that comprise it. The statement of these items is the following:

- If you were responsible for water management in Spain, you would opt for: Controlling water demand and applying stringent costs to those that consume the most (item 15c).
- If you were responsible for water management in Spain, you would opt for: Reusing treated water (item 15f).
- If you were responsible for water management in Melilla/Granada, you would opt for: Building another desalination plant (Melilla)/Increasing the amount of water available (Granada) (item 16ai).
- If you were responsible for water management in Granada, you would opt for: Encouraging water saving (item 16b).
- If you were responsible for water management in Granada, you would opt for: Extracting more water from wells (item 16ci).
- If you were responsible for water management in Granada, you would opt for: Reusing treated water (item 16f).
- The water I use at home comes from. . .: The sea (Melilla)/Reservoirs (Granada) (item 17b).
- The water I use at home comes from. . .: Directly from rain (item 17ci).
- The water I use at home comes from. . .: Reservoirs (item 17d).
- The water we have used goes. . .: Directly to the sea (Melilla)/Directly to the reservoir (Granada) (item 18ai).
- The water we have used goes. . .: To irrigation after treatment (item 18c).
- The water we have used goes. . .: To drinking water, after treatment (item 18di).
- Water undergoes some kind of treatment before reaching my home (item 19).

- Water consumption in Melilla is far higher than the national average (Melilla)/Water consumption in Granada is similar to the national average (Granada) (item 21).

In Figure 3, the total response rate for the correct options for each of the items where significant differences have occurred for Block 3: Water management is shown via a column chart.

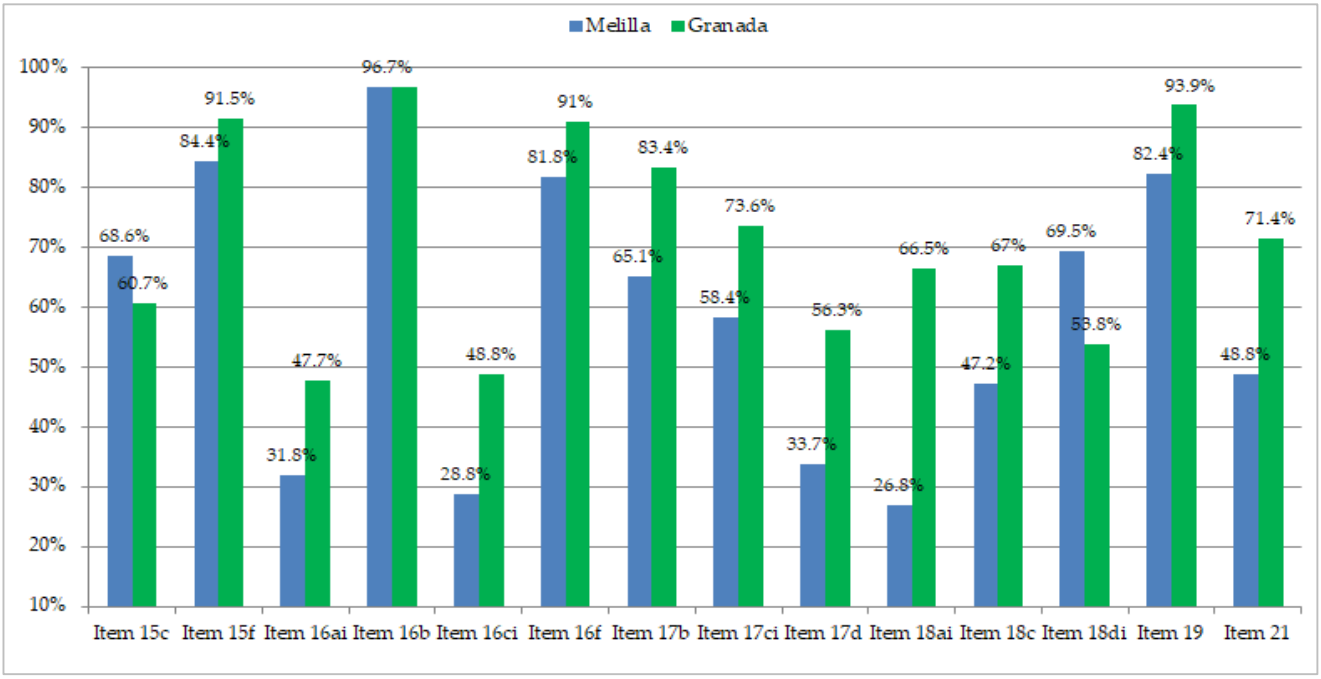

Figure 3. Response rate for the options most aligned with the NWC from Melilla and Granada students for Block 3: Water management items with significant differences between both groups.

In this block, the Granada students obtain results more aligned with the NWC than those from Melilla.

Effectively, with the exception of items 15c and 18di, where the Melilla students obtain more value-laden results, the rest of the items with significant differences show that those from Granada are more informed about water management.

In particular, they opt for reusing treated water at a national level (item 15f), not increasing the quantity of water available at the national level (item 16ai), encouraging water saving at local level (item 16b), not extracting more water from wells at local level (item 16ci) and reusing treated water at local level (item 16f). In addition, they are more aware of where water in their locality comes from (items 17b; 17ci; 17d), have better knowledge of the destination of waste water (items 18ai; 18c; 19), and also better know the quantity of water used in their city (item 21). If we look at the response rates for this last item in Figure 3, we see that only 48.8% of the Melilla students are aware of the high consumption of water that occurs in their city.

4.4. Block 4: Personal Actions Associated with Water

The aim of this block is to discover what degree of commitment the future teachers have in regard to water saving and if they are aware of how eating and consumer habits affect water consumption.

Fourteen items show significant differences ($Z = -6.696$, $p = 0.000$) between both groups. Their statements are:

- We could save water in homes by…: Turning off the tap when brushing teeth or soaping (item 25a).
- We could save water in homes by…: Using a dishwasher (item 25b).

- We could save water in homes by. . .: Consuming foods of mainly vegetable origin (item 25c).
- We could save water in homes by. . .: Reusing shower water for the toilet (item 25d).
- We could save water in homes by. . .: Buying fewer clothes (item 25e).
- We could save water in homes by. . .: Consuming less meat (item 25f).
- In our urban environment we could save water by. . .: Adapting crop types to water availability (item 26a).
- In our urban environment we could save water by. . .: Adapting ornamental plants to water availability (item 26b).
- In our urban environment we could save water by. . .: Building independent rainwater collection systems (item 26c).
- In our urban environment we could save water by. . .: Increasing the production of necessary products instead of importing them (item 26di).
- In our urban environment we could save water by. . .: Eliminating private swimming pools (item 26f).
- The following actions affect water availability: Buying lots of clothes (item 27a).
- The following actions affect water availability: Frequently changing mobile phone, tablet, computer. . . (item 27b).
- The following actions affect water availability: Using plastic bags (item 27c).

Figure 4 shows the correct response rate for each of the items where significant differences occur for Block 4: Personal actions associated with water. It highlights more decisively that the students in Granada think it is essential to save water, both at home (items 25a, 25b, 25c, 25d, 25e, 25f) and in their urban environment (items 26a, 26b, 26c, 26f). Furthermore, the future teachers in Granada appear to have a wider view of how consumption habits (items 27a, 27b, 27c) affect water availability. Specifically, some of the items that reveal the greatest differences between both groups are those that relate indirect water consumption with the consumption of goods (item 25e; 27a; 27b) and eating habits (item 25f).

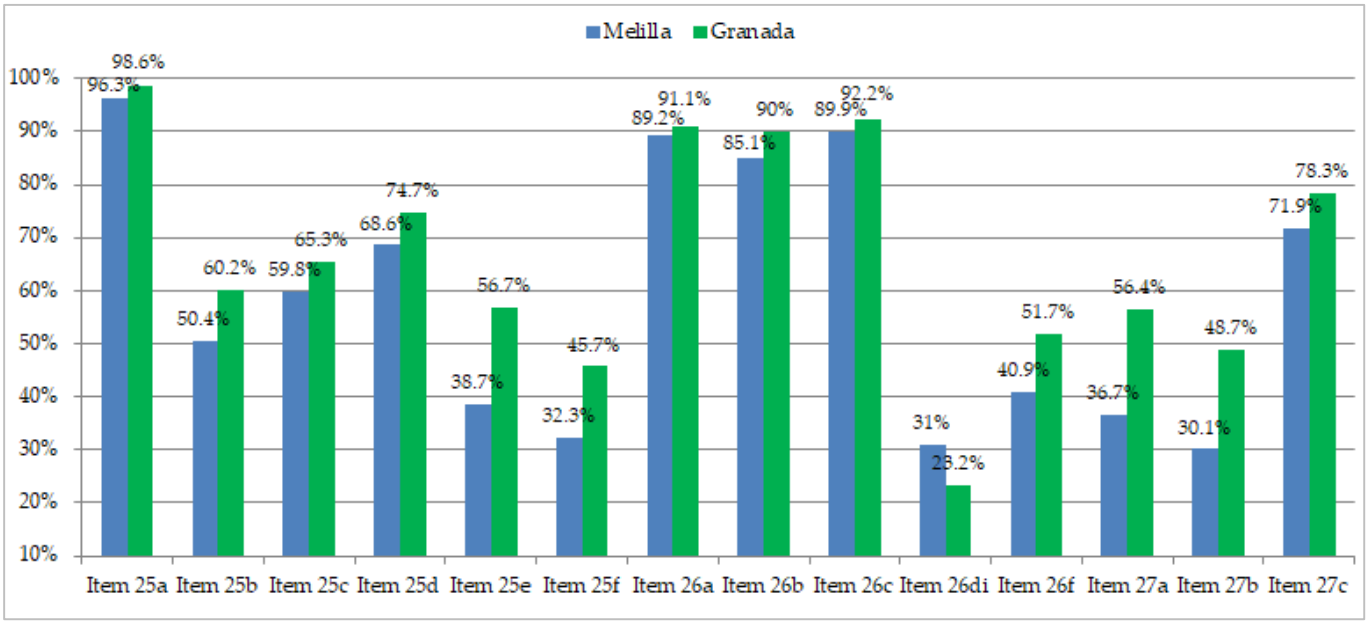

Figure 4. Response rate for the options most aligned with the NWC from Melilla and Granada students for Block 4: Personal actions associated with water items with significant differences between both groups.

5. Discussion of Results

This study has focused on the differences between the knowledge that two samples of future teachers from Melilla and Granada have on water. The two reference cities have different educational realities, as demonstrated by PISA test results. Moreover, attention may also be drawn to their differences in relation to water resources and the impact of these in the media.

The most noteworthy conclusion is that, overall, the future teachers in Granada had a more current and sustainable water culture than those in Melilla.

This general rule is truncated for Block 1 of the questionnaire, related to the protection of the water resource, in which the Melilla students demonstrate that they have a clearer idea of the consequences of anthropic activities as regards water scarcity. It is highly likely that his knowledge is a result of the enormous media impact water has in the Melilla context, particularly in the last year, due to the extension of the fourth module of the desalination plant [33]. Nevertheless, for the remaining blocks, the general trend set is maintained.

Thus, in the case of Block 2, which addresses water dimensions, the students in Granada show a greater awareness of the need for water governance, with the active participation of all agents involved. In addition, in contrast to the Melilla students, they recognise that responsibility in water-related decision-making does not fall solely to the public authorities but is collective and shared [34].

In Block 3, on water management, both groups of students defend water saving in the face of traditional methods aimed at increasing the supply of water. This defence is slightly more convincing in the Granada students. It is highly probable that the poor quality of water in Melilla is the reason for even justifying unacceptable arguments in relation to water management, such as traditional strategies based on increasing water availability at the hands of large hydraulic works.

Lastly, in regards to personal actions associated with water (Block 4), the future teachers in Granada show a slightly higher tendency than those in Melilla towards more sustainable consumption habits related to consumerism (impulsive buying of clothes, technology, plastic bags...) and eating habits. As a result, there is a lack of awareness, especially among the Melilla students, as regards indirect water consumption, which can account for up to 96% of the total water consumed by a single person. They are largely unaware of the impact that anthropic activities have both on water quality and the availability of this resource [35].

It is reasonable to conclude that, even where the results of the future teachers in Granada are very similar to those in Melilla, we find significant differences that move the former towards knowledge more in line with the NWC.

6. Conclusions

A previous study revealed the difficulties regarding knowledge of water culture presented by the Melilla students [24]. With this comparative study, we seek to provide more extensive and general data on the training of future teachers regarding the NWC, in which the findings contribute to the overall understanding of the training needs in relation to the water problem and transcend the particularities of a specific context.

With this study, we conclude that the sample of future teachers from Granada also has knowledge of water that is far from what is required for a good education for sustainable development.

The differences between both groups may be due to the obstacles faced by the education system in Melilla: disproportionate ratios, crumbling infrastructures, scarcity of economic resources, and a complex socio-economic panorama that includes the incorporation in classrooms of foreign students whose mother tongue is not Spanish [28]. These challenges, together with the need to rely on classroom translators for those students who do not speak the language, as well as pressing the linguistic brake pedal, make the task of teaching more difficult and slow down the learning rhythm. Moreover, the communications media in Melilla have afforded extended coverage and visibility to the water problem due

to its local relevance, along with the challenges the region faces in terms of supply and management of the water resource, factors we consider may have created greater interest and knowledge on the topic amongst the population of the city. Hence, the students in Melilla show better results than those in Granada in Block 1 (Water resource protection).

However, both groups are far from reaching optimum knowledge of the NWC. The main problems found are:

(a) The scarcity of water on Earth is conceived as an endemic problem rather than a consequence of anthropic activities that originated above all over the course of the previous century.
(b) Water continues to be seen as a material asset but not a heritage asset of the first order. In fact, the two items that obtained worse results in the questionnaire as a whole are those related to this concept, stating: "When I am in localities without water problems, I don't mind wasting water because it's not going to affect the environment" and "Given the quantity of water on Earth, I don't think water saving is important".
(c) Scarce knowledge of the urban water cycle. In particular, in the origin of drinking water and the destination of waste water.
(d) The relationships between our food and water needs. Specifically, they are unaware that to produce a kilo of meat, it is necessary to use 15,000 litres of water, whereas a kilo of wheat flour only requires 1800 litres. In fact, a vegetarian diet would reduce water use by 36% [36].
(e) The relationships between the consumption of technological objects (mobile phone, tablet, computer. . .) and water consumption. This leads us to infer that they fail to understand the relationships of the water-energy binomial.

These results are congruent with those obtained in the literature. For example, with the knowledge obtained for future Melilla teachers [24,37] and that transmitted by textbooks [13]. Likewise, the absence of connections between water consumption and material goods and food habits, in short, with our lifestyle, was identified with students aged 6–12 years [38], but it is surprising that this persists in future teachers.

A teacher with this knowledge is going to have serious problems encouraging their students to understand the relationships between our current way of life and water depletion, which could give rise to a continued increase in problems relating to water availability on our planet. It is necessary to correct this situation in order to advance in the transition to a new water culture and, in general, in the transition to sustainability. In this sense, the curricula for the training of future teachers should be reviewed, and collaboration with associations such as the FNWC [39] should be encouraged to improve water awareness among these students. In this situation, it is difficult to develop educational designs that help children deepen their understanding of sustainability issues and become empowered citizens who will work for a sustainable future [40].

An important question that is convenient to discuss, to finish with, is whether future teachers should possess knowledge about the NWC.

From our perspective and that of all of the international organisms [41], education plays an essential role in the sustainable development of our planet, and, to this end, the initial training of teachers in these topics is unquestionable. We even have a strong ethical commitment to society in the promotion of science-society relations [42]. The curricula of the study plans of the training qualifications for future teachers should prioritise these demands and make them the specific foundations for the training of teachers. These tendencies are included in the new law on the Spanish education system [22]. Notwithstanding, the trends in the reforms for the study plans in regard to teacher training being discussed in the Spanish sphere [43,44] are not in accordance with these priorities. It is fundamental that these proposals be rethought, and a strong and committed educational response be given to the urgent global needs of sustainable development, amongst which attention should be drawn to those associated with water.

Author Contributions: Conceptualization, A.R.-S. and A.B.B.; methodology, A.R.-S., M.R.-S., F.E.C.-V. and A.B.B.; formal analysis, A.R.-S., M.R.-S., F.E.C.-V. and A.B.B.; investigation, A.R.-S., M.R.-S., F.E.C.-V. and A.B.B.; data curation, A.R.-S., M.R.-S., F.E.C.-V. and A.B.B.; writing—original draft preparation, A.R.-S., M.R.-S., F.E.C.-V. and A.B.B.; writing—review and editing, A.R.-S., M.R.-S., F.E.C.-V. and A.B.B. All authors have read and agreed to the published version of the manuscript.

Funding: This work has been funded by Project TED2021-129474B-I00 funded by MCIN/AEI/10.13039/501100011033 and by the European Union NextGenerationEU/PRTR.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of Cooperation and Social Responsibility Department of the University of Granada (ML_09_09_21).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the first author.

Conflicts of Interest: The authors declare no conflict of interest.

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