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Teaching Digital Competence and Eco-Responsible Use of Technologies: Development and Validation of a Scale

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Received: 19 August 2020; Accepted: 17 September 2020; Published: 18 September 2020

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Abstract: The environmental impact produced by digital technologies is one of the fundamental contents to be developed by teachers of the 21st century. Different investigations raise the need to redesign education towards sustainable models and promote a critical look at digital technologies. The main objective of this manuscript is to design a valid, reliable and useful scale to measure self-perceived teacher digital competence regarding the eco-responsible use of technologies. The instrument has been designed based on a detailed analysis of the main frameworks for the development of digital competence in Europe: INTEF and DigCompEdu. A content validation process has been followed through the expert judgment method. Subsequently, its reliability and validity are estimated using structural equation modeling techniques. The results obtained guarantee the reliability and validity of the model. Therefore, the need to establish environmental teacher training plans and more awareness about the eco-responsible use of technologies is established.

Keywords: ICT; digital competence; sustainable education; Green TIC; digital security; teacher training; validation methods

1. Introduction

Teaching digital competence is defined as the set of knowledge, skills and attitudes that are necessary for a responsible use of Digital Technologies in the educational context [1]. Therefore, it implies that the teacher masters those didactic and pedagogical principles that allow them to integrate technologies in the learning process to ensure digital competence in students [2–5]. This is evidenced by the development of different frameworks for digital competence in Europe, such as DigCompEdu [6,7]. Through these frameworks, one begins to become aware of the need for teacher training to work on different aspects of security in the virtual space.

The safe use of digital technologies and environmental problems are issues that have acquired capital importance in our society. In the educational system, this need has been translated into curricular content that is taught in Early Childhood, Primary and Secondary Education; sometimes in a transversal way, other times in complementary activities and in the same way, included in subjects such as Education for Citizenship or Education in values. These arguments raise the need to redesign education and promote a critical and responsible view of digital technologies. Furthermore, although sustainable development is a concept that according to Gómez and Díaz [8], began to be defined at the end of the eighties of the 20th century, and in which it has been worked through different national and international organizations. In the 2030 Agenda for Sustainable Development, the Sustainable Development Goals (SDGs), approved by the United Nations General Assembly in 2015 [9,10], are maintained. All this indicates that it is necessary, now more than ever, to continue researching on how to put them into teaching practice [11].

Including SDGs in the curriculum entails establishing relationships between reality and the classroom, allowing it to be observed in a critical, global and transformative way [12–15]. Currently, multiple works are being developed related to sustainability in the virtual space in the educational field [16,17]. In them, the need to train at any educational level arises. Currently, children are consumers of technological resources from a very young age. Therefore, teachers need to be trained to prepare future generations to make an eco-responsible use of technologies that guarantees sustainable development and consequently, the optimal health of the planet. This implies moving towards what has been called sustainable education [18,19].

As can be seen, there are many challenges that teachers face. Few doubt the benefits that the use of ICTs can have in any field, but are teachers prepared to assume responsibility for teaching digital security? Do they understand the environmental impact of using the Internet? Do they understand the damage that technological waste causes on our planet? These are issues which must be addressed in the development of educational programs that help raise awareness of the importance of making responsible use of technologies.

The environmental impact produced by technologies depends on the population that uses ICTs, the use made of them and the type of technology that is possessed. The manufacture of technological devices requires the extraction of raw materials and their refinement, which causes an activity with a very large environmental and landscape impact, in addition to the use and abuse of children in the extraction of materials, such as coltan, in developing countries [20]. On the other hand, the increase in data traffic in the network causes an increase in data centers. To store them, these facilities need electricity to maintain the servers that preserve the data and also require powerful cooling systems, which increases electricity consumption significantly, and contributes to the emission of greenhouse gases [21]. It is also necessary to point out the importance of the obsolescence of technological means, since technological waste is a very important polluting element. In this sense, it is necessary to indicate that several factors influence the production of technological waste. On the one hand, the consumerist zeal that our society instigates by pushing consumerism when the useful life of technology can still be extended [22]. On the other hand, dishonest practices by the industry, which leads to planned obsolescence or in other words, to program the useful life of the technology to force users to consume the new ones. This leads to the conclusion that societies have confused the relationship they should have with nature. Leon considers that he has fallen into a materialistic and consumerist pattern, in which the human being seeks to possess more, not only to satisfy basic needs but also to please luxuries, through the use of the resources offered by the Earth [23]. For Ortega, 99% of the things that are bought are thrown away in 6 months; now, is consumed twice what was consumed in the 1950s [24]. A change in awareness and in the industrial model is necessary, although, as already indicated, the industry shows little or no concern for the environment. Likewise, it is necessary to point out that currently we are working on what is called Green ICT. This concept is based on the possibilities offered by ICTs to evolve towards more efficient products and services with lower energy consumption [25].

In recent years, multiple initiatives have emerged that are interested in the research and analysis of environmental effects and technological diffusion in today's societies [20,21,26,27]. Together, the exceptional situation that COVID-19 has caused has forced digital adaptation, intensifying the use of technologies as an alternative to face-to-face activity [28,29]. In this very specific and unusual context, the lack of training in digital security and the eco-responsible use of technologies is much more pronounced. This is why, during the suspension of the in-person activity, the activity in the virtual space has increased notably. This, together with the increase in sales of technological devices, computers, mobile devices and consoles, shows the need to train for the empowerment and awareness of the importance of making a responsible use of technologies.

Many studies have emphasized the measurement of teaching digital competence [6,19,30–32], but no instruments have been developed that measure such a specific dimension of it. The need to know the self-perceived level of competence that teachers have to educate in eco-responsible use has led to the development and design of a scale of measurement of this competence that serves as a basis for teachers' self-reflection. In addition, it allows assessing the strengths and weaknesses/needs in areas of digital competence and the environment. The measurement of this competence with a reliable and valid instrument also allows reflection on how to incorporate the ecological and technological dimension in the training of education professionals. Many authors defend the incorporation of environmental professional competence in the training of professionals as a need generated by the current technological and globalized society [33,34]. Therefore, it is necessary to know the previous knowledge available to the teaching staff to train them in this competence.

Based on these references, the interest of this work is linked to the design and study of the scale of measurement of the self-perceived teaching digital competence in the eco-responsible use of technology. Therefore, the main objective is to analyze the reliability and validity of the scale.

2. Materials and Methods

The general objective of the questionnaire is to allow a diagnosis of the "security in virtual space" competence. This encompasses environmental impact, cyberbullying, and digital addiction. Therefore, the complete instrument is made up of three scales. This article focuses on carrying out the validation of the first scale, which, as mentioned above, measures the eco-responsible use of technology.

2.1. Objectives

As previously indicated, the main purpose of this work was to design a valid, reliable and useful scale to measure self-perceived teacher digital competence regarding the eco-responsible use of technologies. To do this, the following specific objectives are proposed: (a) to guarantee that the information obtained through the analysis and the different interpretations assess the reality to be measured and (b) to analyze the reliability of the instrument. Together, we aim to (c) analyze the construct validity of the scale by analyzing the simple correlations with an exploratory factor analysis and (d) confirm the variables and the structure of the scale by showing the existing relationships between the different dimensions.

2.2. Instrument Development and Content Validation

The instrument has been designed based on a detailed analysis of the main frameworks for the development of digital competence in Europe: INTEF [7] and DigCompEdu [6]. From these frameworks, a first version of the instrument was made. The items measured the degree of agreement or disagreement with them on an 8-point Likert scale, where 1 means total disagreement and 8 means maximum agreement.

To ensure that the information obtained through the analysis and the different interpretations value the reality that is to be measured (Objective a), a first content validation is carried out through expert judgment. For this, there are five University Professors in the field of Educational Technology. They assessed the adequacy of the language, the clarity of the items and their adjustment to the proposed objectives on a scale of 1 to 8. In addition, proposals for improvement on each of them are qualitatively collected, if deemed appropriate.

Expert judgment showed that all the items used a language appropriate to their recipients, met the intended objectives and were valued with the highest score regarding their clarity—with the exception of the second, "I have heard about the environmental impact caused by the use of technologies, but could not define it clearly". It is proposed to modify the adversarial contradiction or to eliminate the second part of the sentence. On the other hand, items 3 "I have received training on the environmental impact caused by the use of technologies" and 4 "I have received information on the environmental impact caused by the use of technologies" are considered similar. Although one refers to receiving information and the other to receiving training, it was estimated, by the experts, that it is a very subtle difference to be part of two items. Regarding item 4, the proposal consists of specifying this training, for which reason the word training was changed to "courses", providing a more formal connotation to the item.

In the final instrument, item 2 was divided into two (the second part was included in an independent item (item 3), which was defined as follows, "It could clearly define what is the environmental impact caused by the use of technologies" and the original item 3 was eliminated. This covers the two proposals made without reducing the total number of questions. Then, the scale of the final questionnaire was attached together with the objectives that each item covers (Table 1).

Table 1. List of objectives and items of the definitive scale.

Objectives	Items
Identify the degree of knowledge of teachers about the environmental impact of the use of technologies, at a formal or informal level (items 1–5)	1. I am clear about the environmental impact caused by the use of technologies. 2. I have heard about the environmental impact caused by the use of technologies. 3. You could clearly define what is the environmental impact caused by the use of technologies. 4. I have received courses on the environmental impact caused by the use of technologies. 5. I would know how to perfectly define the technological uses that cause environmental impact.
Discover the real possibilities of applying this knowledge in a functional way in teaching work with students and families (items 6,7)	6. With the knowledge that I currently have, I can prepare a didactic guide for students to prevent the environmental impact caused by the use of technologies. 7. With the knowledge that I currently have, I can prepare a didactic guide for families, to prevent the environmental impact caused by the use of technologies
Know the teaching skills to identify the environmental impact of the use of technologies and reduce it (items 8, 9 and 14)	8. I consider myself capable of identifying the technological actions that cause the greatest environmental impact. 9. I am able to establish measures that reduce the environmental impact caused by the use of technologies. 14. As a teacher, I would be able to establish the procedure to follow based on the use of technologies to prevent environmental impact.
Recognize the teaching skills to train students and families in the prevention of this impact (items 10–13)	10. I am able to help another person to manage situations in which the use of technologies is creating a great environmental impact. 11. As a teacher, I am able to inform students about the risks caused by the use of technologies on the environmental impact. 12. As a teacher, I am able to inform families about the risks caused by the use of technologies on the environmental impact. 13. As a teacher, I am able to design actions to prevent the risks caused by the use of technologies on environmental impact aimed at students and families.

After validation, the final questionnaire is adapted for online application through the Google Forms application (Figure 1) and applied in different centers of Early Childhood, Primary and Secondary Education of the Autonomous Community of Andalusia (Spain). Previously, the management of these centers is contacted by sending them, together with the informed consent, the objectives and the link to the questionnaire for dissemination among the teaching staff during the first quarter of the current year.

Figure 1. Digitized Google Forms questionnaire fragment.

2.3. Research Subjects

The questionnaire was answered by a total of 778 Early Childhood Education (25.4%), Primary (41.7%) and Secondary (32.9) teachers from Spain, 530 women and 248 men with an average age of 37 years (Figure 2). For their selection, incidental or convenience criteria were chosen, depending on their availability to answer the questionnaire [35].

Regarding the technological profile, the vast majority claimed to have a personal computer (92.1%), a smart mobile phone (99.3%) and an internet connection (97.4%). Likewise, the most common place of internet connection is "anywhere, having mobile internet" (58.7%). At the same time, most of the participants report connecting to the Internet between 5 and 10 h (41.9%), more than 10 h a week (29.8%), between 1 and 5 h (24%) and 1 h or less (4.3%).

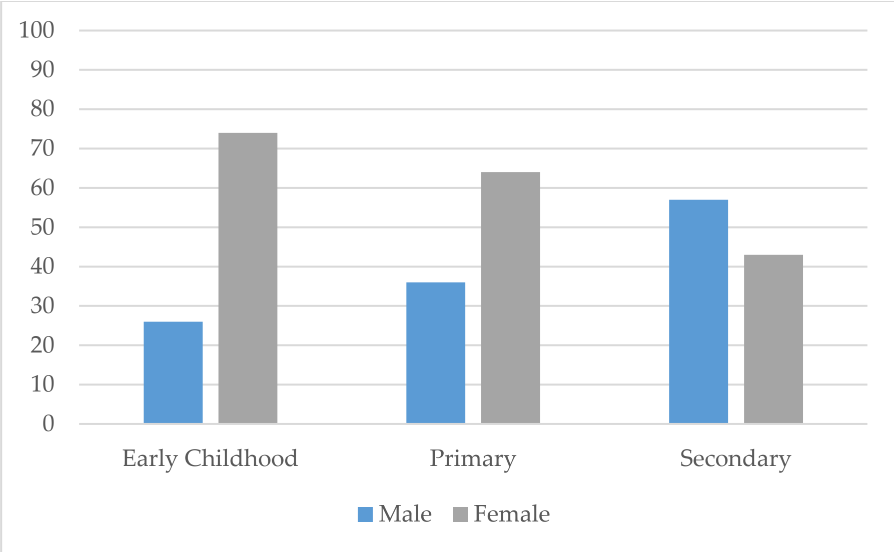

Figure 2. Percentage of participants by educational level and gender.

2.4. Procedure and Data Analysis

To achieve the proposed objectives (b, c and d), different statistical tests were carried out as suggested by related studies [30–32,35]. The reliability, discriminant validity and convergent validity of the questionnaire were calculated using the coefficients: Cronbach's Alpha, McDonald's Omega, composite reliability (CR) and average variance extracted (AVE). Additionally, and to compare these results, the inferential analysis method was used to compare these results. For this, the bivariate correlational analysis technique was used by means of the Spearman correlation coefficient ρ. For its part, the construct validity of the test has been obtained through an exploratory factor analysis (EFA). The method used for the selection of the factors is the principal components method. The factors obtained are rotated orthogonally using the Varimax method with Kaiser normalization. Once the number of factors has been determined, a confirmatory factor analysis (CFA) is performed. Confirmatory factor analysis is used to check whether the theoretical measures of the model are consistent through the modeling of diagrams and the use of structural equations [36]. In other words, it is checked whether the data conform to the hypothetical measurement model produced by the exploratory factor analysis. The method used to contrast the theoretical model has been the weighted least squares (WLS), which provides consistent estimates in samples that do not conform to normality criteria [36]. For this last procedure, AMOS software has been used, capable of revealing hypothetical complex relationships between variables, using structural equation modeling (SEM). At the same time, it has been verified that the data are not normally distributed through a descriptive study in which skewness and kurtosis have been taken into account. The Kolmogorov–Smirnov goodness-of-fit test confirmed this finding, with a significance (p-value) equal to 0.000 for all items (non-normal distribution).

3. Results

The reliability of the questionnaire (objective b) was calculated using Cronbach's Alpha and McDonald's Omega coefficients globally. The results show an Alpha index of 0.979 and an Omega index of 0.981. It was established that this index is very high (>0.9), indicating a high degree of the reliability of the questionnaire [37]. Together, the coefficients of composite reliability (CR) and average extracted variance (AVE) are calculated. Table 2 shows the results, as well as the reference values taken for the model fit [38].

Table 2. Values of the composite reliability (CR) and average extracted variance (AVE) with reference value.

CR	Model Fit	AVE	Model Fit
0.979	CR > 0.7	0.769	AVE > 0.5

All the figures obtained adjust with the reference values. Therefore, the reliability of the model (CR) as well as its average variance extracted (AVE) were demonstrated. Then, the simple correlations of each item with the theoretical or construct dimension were analyzed. The results are shown in Table 3.

All values greater than 0.707 were considered to accept an item as a member of the dimension [39]. Therefore, all the items were integrated within the proposed model.

The construct validity of the test (objective c) was obtained through an exploratory factor analysis (Table 4). Previously, the applicability of factor analysis was confirmed through the Kaiser-Meyer-Olkin (KMO)test, with a statistically significant coefficient of 0.950, and through Bartlett's test of sphericity, with significance (p-value) equal to 0.000 (factor analysis can be applied).

The results, which explain 78.85% of the variance, determine a single theoretical factor: eco-responsible use of technologies (EUIT).

The theoretical model proposed by the exploratory factor analysis (EFA) is contrasted through a confirmatory factor analysis (CFA, objective d). Figure 3 shows the structural diagram proposed with the item–dimension and dimension–dimension correlation indices.

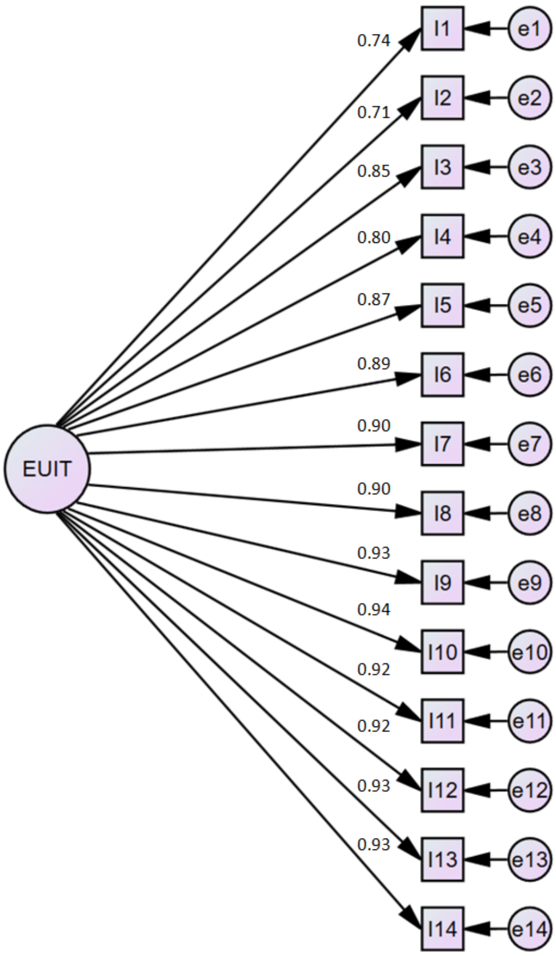

Figure 3. Structural diagram of the model.

Table 3. Correlations of the items with the dimension eco-responsible use of technologies (EUIT).

	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	I13	I14
EUIT	0.799	0.781	0.890	0.790	0.876	0.888	0.889	0.905	0.913	0.936	0.918	0.918	0.909	0.905
Significance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 4. Rotated component array.

	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	I13	I14
EUIT	0.786	0.762	0.887	0.831	0.903	0.913	0.913	0.913	0.924	0.936	0.911	0.909	0.910	0.912

The factorial loads of the dimensions are between 0.71 and 0.94. These values denote high levels of correlation. Therefore, the results confirm the proposed theoretical model. Table 5 shows the obtained and reference values for the fit of the model [40]: chi-squared (CMIN), goodness-of-fit index (GFI), parsimony goodness-of-fit index (PGFI), normalized fit index (NFI) and the normalized parsimony fit index (PNFI).

Table 5. Outcome indices of the model and reference values: chi-squared (CMIN), goodness-of-fit index (GFI), parsimony goodness-of-fit index (PGFI), normalized fit index (NFI) and normalized parsimony fit index (PNFI).

Index	Outcome	Model Fit
CMIN	477.81	CMIN < 500
GFI	0.875	GFI > 0.7
PGFI	0.948	PGFI > 0.7
NFI	0.753	NFI > 0.7
PNFI	0.937	PNFI > 0.7

4. Discussion

The main objective of this manuscript was to design a valid, reliable and useful scale to measure the self-perceived teaching digital competence regarding the eco-responsible use of technologies and it has been achieved. The results obtained after the different statistical tests described above ensure the achievement of the specific objectives proposed at the beginning of this manuscript:

(a) Guarantee that the information obtained through the analysis and the different interpretations value the reality that is being measured.
(b) Analyze the reliability of the instrument through Cronbach's Alpha and McDonald's Omega, together.
(c) Analyze the construct validity of the scale by analyzing the simple correlations with an exploratory factor analysis.
(d) Confirm the variables and the structure of the scale, showing the existing relationships between the different dimensions (confirmatory analysis).

The first of the objectives (a) was achieved following a standardized procedure for the construction of this type of scales [6,19,30–32,41–43]; which was included from developing preliminary versions (alpha versions), to obtaining a beta version that was subjected to a content analysis by a group of experts in educational technology. After applying the Likert-type scale of eight response options, the experts' report showed that almost all the items were written in a language appropriate to their recipients, that they met the objectives set out in their design and that they were assessed with the maximum score for its clarity of presentation.

Regarding the second of its objectives (b), the reliability of the information collection instrument, the Cronbach's Alpha coefficients (0.979) and its alternative, McDonald's Omega (0.981) show very high (high) rates [37], indicating a high degree of reliability of the questionnaire that we used in our study.

To achieve the third of the proposed objectives (c), the validity of the construct of the scale designed and applied in this study, an exploratory factor analysis was carried out, the results of which explain 78.85% of the variance, determine the factor proposed theory: the eco-responsible use of technologies among the interviewed subjects.

The theoretical model proposed by the previous exploratory factor analysis was contrasted through a confirmatory factor analysis, which corresponds to the fourth objective (d). The factorial loads of the dimensions of the questionnaire were between 0.71 and 0.94, values which imply high levels of correlation. The reference values obtained for the model fit according to Lévy Mangin et al. [40]: the chi-square (CMIN), goodness-of-fit index (GFI), parsimony goodness-of-fit index (PGFI), normalized fit index (NFI) and normalized parsimony fit index (PNFI) indicate that the results confirm the theoretical model that we proposed in our study.

For future research, it is intended to expand the sample size, representing the seventeen states (autonomous communities) that make up Spain. In this way, a profile is obtained that measures and compares the digital competence of teachers at the national level with respect to the eco-responsible use of technologies in Spain. Subsequently, it is proposed to replicate the study at the level of the European Union.

From the application of the scale and after analyzing the results, the training needs of the teaching staff can be detected and reports drawn up. These can be offered to the different administrations to develop training plans, such as the Teachers' Centers in Andalusia (TC). The TCs are the institutions that organize and manage teacher training. Collaboration agreements can even be signed between the University and these organizations to carry out specific training, as regulated by specific legislation [44]. Recently, the need for teacher training in digital competence has been insisted on through the Resolution of 2 July 2020 [45]. In it, the different Autonomous Communities are urged to promote the development of these competences.

The scale of this study contributes to the detection of these needs. Specifically, with regard to Competency 4.3 (Health protection: avoiding health risks related to the use of technology in terms of threats to physical integrity and psychological well-being) and Competency 4.4 (Protection of the environment: take into account the impact of technologies on the environment).

On the other hand, the application of this scale is also viable for teachers in initial training. It can be applied during the first years of the Degrees in Early Childhood and Primary Education. In addition, it can also be implemented as an initial evaluation in the University Master's Degree in Secondary Education Training. As it is done in digital format, it is easily applicable and evaluable, allowing the establishment of specific training actions in this area based on the results obtained.

Specific training can be articulated through innovation projects in the Degrees using a transversal method. This would allow a training complement for all students. It can also be articulated with the creation of free configuration activities. In this case, it would be aimed only at some students who voluntarily want to train in these subjects.

In the case of the master in Secondary Education, it would be necessary to establish coordination mechanisms among all the teachers involved in working on this issue in a transversal way, not only in specific modules of certain specialties.

5. Conclusions

With this paper, it was expected to awaken the sustainable awareness of readers, as well as that of the researchers and educators of different educational levels in everything related to the eco-responsible use of technologies. This is an important aspect because the concept of sustainable education in Spain is not yet sufficiently established in the school curriculum (it is only included in a superficial way) and it is a very necessary question [18,19]. Until now, this term was seen as associated exclusively with the natural and the most basic concept of ecology.

As some authors claim, there have been several efforts to incorporate sustainable development training into university curricula [46]. There has been greater insistence from the successive guidelines and recommendations of UNESCO to contribute to its development [47–49]. However, it is still a long way from achieving a reorientation of the curriculum as would be necessary for the training of future teachers who contribute to the transition to sustainable societies [46]. These proposals have led to sporadic actions in different areas of knowledge. These have mainly focused on Social and Experimental Sciences, both at the national [50–52] and international [53,54] level. However, this transformation did not occur in a generalized way, nor as part of the teachers' curriculum. Therefore, it is expected that teacher training in this sense is not as extensive or specific as today's society demands.

The study was carried out and the results obtained provide a reliable and valid instrument that allows generating useful and applied knowledge about the training and awareness that teachers have to advance towards an ecological education. In addition, it offers a solid base that allows us to guide the training plans of teachers on this subject. The self-perception of this competence (the eco-responsible use of technologies) allows reflection on how and in what way to incorporate the ecological and technological dimension in the educational system.

Although this topic has already been studied in previous research [16,17,41–43], these studies have not provided instruments to measure teaching competencies in this area. With this study, the aim was to provide a tool for the diagnosis of teachers where the competencies related to digital citizenship (at the level of responsible citizenship) and teaching competencies (ability to teach on the indicated topic) differ. This distinction is important because a first level of need could be linked to basic knowledge and skills, while for teaching it is necessary to handle more advanced skills that allow discovering the different possibilities of application in varied contexts.

The defense of the incorporation of professional environmental competence in the training of professionals is a need generated by the current technological and globalized society [33,34] and exacerbated by the recent situation that has caused COVID-19 [28,29]. Hence, this instrument represents an important advance to expand in other professional fields.

Author Contributions: R.B.-S. designed our research and structure of the paper. M.-C.C.-V., A.P.-R. and P.R.-G. validated this analysis and wrote the original draft and reviewed the draft and edited this article. A.P.-R. conducted data curation and visualization. Finally, all authors equally contributed to write and review this article. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Ministry of Science, Innovation and Universities of Spain, grant number RTI2018-097214-B-C31.

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

References

1. Tigelaar, D.E.; Dolmans, D.H.; Wolfhagen, I.H.; Van der Vleuten, C.P. The Development and Validation of a Framework for Teaching Competencies in Higher Education. *High. Educ.* **2004**, *48*, 253–268. [CrossRef]
2. Krumsvik, R. Situated learning in the network society and the digitised school. *Eur. J. Teach. Educ.* **2009**, *32*, 167–185. [CrossRef]
3. Pedro, K.M.; Chacon, M.C.M. Pesquisas na internet: Uma análise das competências digitais de estudantes precoces e/ou com comportamento dotado. *Educ. Rev.* **2017**, *33*, 227–240. [CrossRef]
4. Gallego-Arrufat, M.-J.; Torres-Hernández, N.; Pessoa, T. Competencia de futuros docentes en el área de seguridad digital. *Rev. Cient. Comun. Educ.* **2019**, *27*, 57–67. [CrossRef]
5. Mirete, A.B.; Maquilón, J.J.; Mirete, L.; Rodríguez, R.A. Digital Competence and University Teachers' Conceptions about Teaching. A Structural Causal Model. *Sustainability* **2020**, *12*, 4842. [CrossRef]
6. Redecker, C.; Punie, Y. *Digital Competence of Educators DigCompEdu*; Publications Office of the European Union: Luxembourg, 2017.
7. INTEF. *Marco Común de Competencia Digital Docente*; Instituto Nacional de Tecnologías Educativas y Formación del Profesorado: Madrid, Spain, 2017.
8. Gómez, C.; Díaz, J.A. Origen del concepto de desarrollo sostenible. In *Referencias Para un Análisis del Desarrollo Sostenible*; En Gómez, C., Díaz, J.A., Eds.; Universidad de Alcalá: Alcalá, Spain, 2013; pp. 7–16.
9. Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura (UNESCO). *Estrategia de Educación de la UNESCO 2014–2021*; UNESCO: París, France, 2015.

10. Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura (UNESCO). *Global Citizenship Education: Topics and Learning Objectives*; UNESCO: París, France, 2015.
11. Martínez Lirola, M. Hacia una educación inclusiva: Formación del profesorado de primaria enmarcada en los ODS que potencian la igualdad de género. *Rev. Iberoam. Educ.* **2020**, *8*, 27–45. [CrossRef]
12. Mesa, M. *El ODS 16 Sobre paz, Seguridad y Gobernanza: Desafíos Conceptuales, Seguimiento y Evaluación. En M. Mesa (Coord.). Derechos Humanos y Seguridad Internacional: Amenazas e Involución. Anuario de CEIPAZ 2017–2018*; CEIPAZ Fundación Cultura de Paz: Madrid, Spain, 2018; pp. 37–52.
13. Dieste, B.; Coma, T.; Blasco-Serrano, A.C. Inclusión de los Objetivos de Desarrollo Sostenible en el Currículum de Educación Primaria y Secundaria en Escuelas Rurales de Zaragoza. *Rev. Int. Educ. Justicia Soc.* **2019**, *8*, 97–115. [CrossRef]
14. Jiménez, M.D.; Felices de la Fuente, M.M. Cuestiones socialmente vivas en la formación inicial del profesorado: La infancia refugiada siria como problemática. *Rev. Investig. Didáct. Cienc. Soc. (REIDICS)* **2018**, *3*, 87–102. Available online: https://mascvuex.unex.es/revistas/index.php/reidics/article/view/2531-0968.03.87 (accessed on 15 June 2020).
15. Ortega Sánchez, D.; Pagés Blanch, J. Literacidad crítica, invisibilidad social y género en la formación del profesorado de Educación Primaria. *Rev. Investig. Didáct. Cienc. Soc. (REIDICS)* **2017**, *1*, 102–117. Available online: https://mascvuex.unex.es/revistas/index.php/reidics/article/view/2531-0968.01.118 (accessed on 15 June 2020).
16. Napal, M.; Mendióroz-Lacambra, A.M.; Peñalva, A. Sustainability Teaching Tools in the Digital Age. *Sustainability* **2020**, *12*, 3366. [CrossRef]
17. Carrión-Martínez, J.J.; Luque-de la Rosa, A.; Fernández-Cerero, J.; Montenegro-Rueda, M. Technologies (ICTs) in Education for Sustainable Development: A Bibliographic Review. *Sustainability* **2020**, *12*, 3288. [CrossRef]
18. Mian, S.H.; Salah, B.; Ameen, W.; Moiduddin, K.; Alkhalefah, H. Adapting Universities for Sustainability Education in Industry 4.0: Channel of Challenges and Opportunities. *Sustainability* **2020**, *12*, 6100. [CrossRef]
19. Mâță, L.; Clipa, O.; Tzafilkou, K. The Development and Validation of a Scale to Measure University Teachers' Attitude towards Ethical Use of Information Technology for a Sustainable Education. *Sustainability* **2020**, *12*, 6268. [CrossRef]
20. Becker, J. Ordenadores y ecología, una reflexión necesaria. *Telos* **2009**, *81*, 20–25. Available online: https://telos.fundaciontelefonica.com/archivo/numero081/una-reflexion-necesaria-ordenadores-y-ecologia/ (accessed on 15 June 2020).
21. Gabrys, J. Powering the Digital: From Energy Ecologies to Electronic Environmentalism. In *Media and the Ecological Crisis*; En, R., Maxwell, J.R., Lager Vestberg, N., Eds.; Routledge: London, UK, 2014; pp. 3–18.
22. Jardim, E. *From Smart to Senseless: The Global Impact of Ten Years of Smart-Phones*; Greenpeace: Washington, DC, USA, 2017. Available online: http://tinyurl.com/y9c6yrdr (accessed on 15 June 2020).
23. León Bolaños, N.V. *Propuesta de Instrumentos de Política Pública que Promuevan la Protección y Cuidado Ambiental en la Gestión Empresarial del Ecuador*; PUCE: Quito, Ecuador, 2015. Available online: http://repositorio.puce.edu.ec/handle/22000/10481 (accessed on 15 June 2020).
24. Ortega, S. *Problemas Ambientales Generales*; Brujas: Córdova, TN, USA, 2009.
25. Hankel, A.; Heimeriks, G.; Lago, P. Green ICT Adoption Using a Maturity Model. *Sustainability* **2019**, *11*, 7163. [CrossRef]
26. Anderson, A. Reflections on Environmental Communication and the Challenges of a New Research Agenda. *Environ. Commun.* **2015**, *9*, 379–383. [CrossRef]
27. Tucho Fernández, F.; Vicente Mariño, M.; García Madariaga Miranda, J.M. La cara oculta de la sociedad de la información: El impacto medioambiental de la producción, el consumo y los residuos tecnológicos. *Rev. Latinoam. Comun.* **2018**, *136*, 45–61. Available online: https://revistachasqui.org/index.php/chasqui/article/view/3321 (accessed on 15 June 2020). [CrossRef]
28. Moorhouse, B.L. Adaptations to a face-to-face initial teacher education course 'forced' online due to the COVID-19 pandemic. *J. Educ. Teach.* **2020**, 1–3. [CrossRef]
29. Ortiz, P.A. Teaching in the time of COVID-19. *Biochem. Mol. Biol. Educ.* **2020**, *48*, 201. [CrossRef]
30. Cabero-Almenara, J.; Palacios-Rodríguez, A. Marco europeo de competencia digital docente DigCompEdu y cuestionario DigCompEdu Check-In. *EDMETIC. Rev. Educ. Med. TIC* **2020**, *9*, 213–234. [CrossRef]
31. Romero, R.; Barragán, R.; Llorente, C.; Palacios, A. The Challenge of Initial Training for Early Childhood Teachers. A Cross Sectional Study of Their Digital Competences. *Sustainability* **2020**, *12*, 4782. [CrossRef]

32. Escudero, V.G.; Gutiérrez, R.C.; Somoza, J.A.G.C. Análisis de la autopercepción sobre el nivel de competencia digital docente en la formación inicial de maestros/as. *Rev. Electrón. Interuniv. Form. Profr.* **2019**, *22*, 193–218. Available online: https://revistas.um.es/reifop/article/view/373421 (accessed on 15 June 2020).
33. Valdés Rodríguez, M.C.; Martínez Rehpani, C.G.; Camachi Monar, M.A. La dimensión ambiental para el aula innovadora: Un contenido educativo digital por la no contaminación tecnológica. *Rev. Bol. Virtual Redipe* **2017**, *6*, 45–54. Available online: https://revista.redipe.org/index.php/1/article/view/195 (accessed on 15 June 2020).
34. Camacho Monar, M.A.; Valdés Rodríguez, M.C. La Dimensión Ambiental como fundamento para generar una asignatura básica en la Carrera de Ingeniería. *Rev. Conrado* **2019**, *15*, 83–90. Available online: http://conrado.ucf.edu.cu/index.php/conrado (accessed on 15 June 2020).
35. Hernández-Sampieri, R.; Fernández-Collado, C.; Baptista-Lucio, P. *Metodología de la Investigación*; McGraw-Hill Education: Madrid, Spain, 2014.
36. Ruiz, M.A.; Pardo, A.; San Martín, R. Modelos de Ecuaciones Estructurales. *Pap. Psicól.* **2010**, *31*, 34–45. Available online: http://www.papelesdelpsicologo.es/pdf/1794.pdf (accessed on 15 June 2020).
37. O'Dwyer, L.; Bernauer, J. *Quantitative Research for the Qualitative Researcher*; SAGE Publications, Inc.: Southend Oaks, CA, USA, 2014. [CrossRef]
38. Hair, J.; Black, W.; Babin, B.; Anderson, R. *Multivariate Data Analysis*; Prentice-Hall: Upper New Jersey River, NJ, USA, 2020.
39. Carmines, E.G.; Zeller, R.A. *Reliability and Validity Assessment*; SAGE Publications, Inc.: Southend Oaks, CA, USA, 1979. [CrossRef]
40. Lévy Mangin, J.P.; Varela Mallou, J.; Abad González, J. *Modelización con Estructuras de Covarianzas en Ciencias Sociales: Temas Esenciales, Avanzados y Aportaciones Especiales*; Netbiblo: A Coruña, Spain, 2006.
41. Reynol Díaz, S.E. *Desarrollo Sustentable, Oportunidad para la Vida*; Mc Graw Hill: Ciudad de México, México, 2009.
42. Román-Graván, P.; Hervás-Gómez, C.; Martín-Padilla, A.H.; Fernández-Márquez, E. Perceptions about the use of educational robotics in the initial training of future teachers: A study on steam sustainability among female teachers. *Sustainability* **2020**, *12*, 4154. [CrossRef]
43. Román-Graván, P.; Ballesteros-Regaña, C.; Díaz-Noguera, M.D. Academic whatsapp groups as alternative communication and motivation systems in higher education. *Espacios* **2018**, *39*, 29–39. Available online: https://www.revistaespacios.com/a18v39n10/18391029.html (accessed on 15 June 2020).
44. Ministerio de Educación y Formación Profesional. Resolución de 2 de julio de 2020, de la Dirección General de Evaluación y Cooperación Territorial, por la que se publica el Acuerdo de la Conferencia Sectorial de Educación sobre el marco de referencia de la competencia digital docente 2020. *Boletín Oficial del Estado de*. 13 de julio de 2020, 191, Sección III, 50638–50668. Available online: https://www.boe.es/boe/dias/2020/07/13/pdfs/BOE-A-2020-7775.pdf (accessed on 10 September 2020).
45. Consejería de Educación de la Junta de Andalucía. *Instrucciones de 14 de Febrero de 2017 de la Dirección General de Innovación, Para la Participación de los Centros Docentes Públicos no Universitarios en Intervenciones en el Ámbito de la Innovación y la Investigación Educativa Realizadas en Colaboración con las Universidades Andaluzas*; Consejería de Educación de la Junta de Andalucía: Andalucía, Spain, 2017. Available online: https://www.adideandalucia.es/normas/instruc/Instrucciones14febrero2017InnovacionEducativa.pdf (accessed on 10 September 2020).
46. Calero, M.; Mayoral, O.; Ull, M.A.; Vilches, A. La educación para la sostenibilidad en la formación del profesorado de ciencias experimentales en Secundaria. *Enseñ. Cienc.* **2019**, *37*, 157–175. [CrossRef]
47. UNESCO. *Implementation of the UNESCO Strategy for the Second Half of the United Nations Decade of Education for Sustainable Development (2005–2014)*; UNESCO: Paris, France, 2011. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000211040?posInSet=1&queryId=aa0cecdd-a985-4968-84b0-1a54eed50b94 (accessed on 10 September 2020).
48. UNESCO. *Shaping the Future We Want. UN Decade of Education for Sustainable Development (2005–2014), Final Report 2014a*; UNESCO: Paris, France, 2014. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000230171 (accessed on 10 September 2020).
49. UNESCO. *Roadmap for Implementing the Global Action Programme on Education for Sustainable Development*; UNESCO: Paris, France, 2014. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000230514 (accessed on 10 September 2020).
50. Cebrián, G.; Junyent, M. Competencias profesionales en Educación para la Sostenibilidad: Un estudio exploratorio de la visión de futuros maestros. *Enseñ. Cienc.* **2014**, *32*, 29–49. [CrossRef]

51. Ull Solís, M.A. Competencias para la sostenibilidad y competencias en educación para la sostenibilidad en la educación superior. *Uni-pluri/versidad* **2014**, *14*, 46–58. Available online: https://revistas.udea.edu.co/index.php/unip/article/view/21337 (accessed on 10 September 2020).
52. Murga-Menoyo, M.A. Competencias para el desarrollo sostenible: Las capacidades, actitu¬des y valores meta de la educación en el marco de la Agenda global post-2015. *Foro Educ.* **2015**, *13*, 55–83. [CrossRef]
53. Wiek, A.; Withycombe, L.; Redman, C.L. Key competencies in sustainability: A reference framework for academic program development. *Sustain. Sci.* **2011**, *6*, 203–218. [CrossRef]
54. Rieckmann, M. Future-oriented higher education: Which key competencies should be fostered through university teaching and learning? *Futures* **2012**, *44*, 127–135. [CrossRef]