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Gender and Digital Teaching Competence in Dual Vocational Education and Training

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Abstract: In recent decades, technological advances have been revolutionizing all areas of society, including the teaching resources and methodologies used in the world of education. Teachers are in the process of adapting to develop the digital skills they need for the use of Information and Communication Technologies (ICTs), a process that must be permanent and in which there are still knowledge gaps undermining its application. This study aims to determine whether this lack of digital skills is influenced by the gender of teachers, for example, whether there is a gender gap in ICT application in teaching, specifically Dual Vocational Education and Training, which is a teaching area that has been growing exponentially in recent years. A descriptive quantitative method has been used for this study with a sample of 1568 teachers of Dual Vocational Education and Training from the Autonomous Community of Andalusia, with data collected through a questionnaire. The results show that while the level of knowledge of ICT resources is medium among this group and is therefore improvable, there are no significant gender differences between teachers with respect to the application of e-skills by teaching professionals, despite the existence in other contexts of a large digital gender gap in new technology professionals.

Keywords: ICT skills; teacher training; e-learning; gender; dual vocational education and training

1. Introduction

Knowledge of Information and Communication Technologies (ICT) is increasingly essential in all facets of today's society, whether in the world of work or in everyday life. The development of ICTs, as in all facets of life, has also reached the field of education, contributing positive developments that significantly affect the processes of training and learning [1,2].

That is why European and national institutions have recently developed regulations to promote key skills in digital knowledge and their application to education. In December 2006, the 'European Parliament Recommendation on the Key Competences of Lifelong Learning' was published, one of which is digital competence, which was defined as "the creative, critical and secure use of information and communication (ICT) to achieve the objectives related to work, employability, learning, leisure, inclusion and social participation".

At the national level, Spanish legislation on education covers these areas in "Organic Law 8/2013, of December 9, for the improvement of educational quality". It states that ICTs should be used for pedagogical purposes in various areas of the curriculum, in order to promote the inclusion of digital resources and tools that stimulate activities among teachers and students.

Advances in technology in teaching improve meaningful learning [3], and lead to increased motivation for students [4,5].

As Sáez López [6] points out, the incorporation of ICTs into the learning process not only significantly improves practical knowledge of applications and programs, but also contributes to skills development and fosters active and self-employed students.

1.1. The Need for ICT Skills from Dual Vocational Education and Training Teachers

As the educational environment becomes the main place to develop digital skills, the figure of the teacher increasingly stands out as a fundamental actor in the process of learning such knowledge [6]. In addition, the digital competence of teachers, understood as all the skills and abilities teachers have to effectively achieve the management and deployment of technology in the educational field, is justified by the proliferation of resources, means and methodologies of new technologies in the classroom [7–9].

This means that a teacher needs to have good training in this area. In fact, many researchers izedhave discussed the need to include ICT knowledge in the competencies obtained by education professionals [10]. Training of digital teachers also requires 'permanent training' to improve technological skills and abilities, as ICT resources are constantly evolving [11].

In Spain, with the approval of the Organic Law for the Improvement of Educational Quality (LOMCE) the country's teacher training plans were reformulated, with the Europe 2020 Strategy emerging and positing the need for the acquisition of key skills to achieve quality teaching such as heterogeneity, languages, continuous training and of course ICT integration [8]. Thus, the National Institute of Educational Technologies and Teacher Training (INTEF) classified digital competence in five major areas, which are information and information literacy (A1), communication and collaboration (A2), creativity (A3), security (A4) and problem solving (A5) [12].

Recent research into digital competence and its integration into teaching learning processes has provided some notable insights:

- The integration of ICT into schools is often linked to technological infrastructure, its inclusion in curricular designs, availability of resources, teacher training and even the attitude of the teacher towards its use [13,14].
- Teachers do not have the optimal digital skills needed to teach ICT. Many authors such as Bates [15] point out that the main barrier to innovation in the use of technology is the fear of change; most teachers are not comfortable with technology and also feel that students as digital natives have more knowledge than them.
- However, at the university level, teachers are not reluctant to use ICT; on the contrary, they enthusiastically employ their pedagogical knowledge of ICT in the classroom [16,17].
- In general, teachers recognize that ICT mastery generates better results in their academic activities [18].
- Personal characteristics, such as gender and age, can influence how teachers adopt different types of teaching innovation [19,20].

Dual Vocational Education and Training is a new modality within vocational training. Dual Vocational Education and Training projects within an education system combine teaching and learning processes in a company and in a training center, and are characterized by the fact that they are carried out in a system of alternation between the education center and the company, with a number of hours or days of stay of variable duration between the work center and the education center. With this new innovative modality, companies can support new organizational models of Vocational Training that are directed towards the search for excellence in the company's relationship with Vocational Training Centers and promote their Corporate Social Responsibility [21].

This study aimed to determine the level of digital competence of Dual Vocational Training teachers (Dual VET) [22,23], as this is a key factor of analysis and study in direct relation to learning outcomes in students, as has already been studied in other branches of education such as universities [17].

As the number of students in Dual Vocational Education and Training have increased in recent years and therefore the increase in teachers in this modality of teaching, together with the scarcity of research related to the subject, it is envisaged that this research will help present and future teachers to better understand what are the elements of a methodology based on the use of information and communication technologies.

1.2. Gender Gap in ICT Knowledge and Skills

This article explores the influence of gender on teachers' digital knowledge. Based on research carried out in recent decades, technology has always been an area dominated essentially by men, with a major underrepresentation of the female gender. The data collected in different studies on the number of women engaged in the design and creation of software for technology companies found a very low level of women specialists [24].

It is clear that ICT-related university studies have low female participation. In addition, although in recent years the percentage of women enrolled in university degrees has been increasing, in they are still under-represented amongst engineering teachers [25,26].

New generations of women have been users since ICT's infancy, even in higher percentages than males, but they remain a minority of the people focused on the study, design and development of new technologies.

A study conducted by Garrido, Rubio and Valle [27] on the differences between men and women in ICT knowledge and management when they begin their university education indicates that "female students have less mastery than male students in regards to computer and Internet programming, database design, spreadsheets, use of collaborative working software and online help manuals, understanding hardware and software compatibility, and improving multimedia productions".

However, although other research shows how men often have a more optimistic vision and attitude than women regarding the use of ICT [28], the research of Garrido et al [27] points out that these gender distinctions in the "use" of ICTs disappear in the domain of "basic and moderate knowledge" of digital tools.

In this context, it can be said that women have equal digital knowledge to that of men at the "user level", but they represent a small minority in specialized studies and senior jobs in the area of Computer application development.

The "digital gender gap" is referred to as the distance between men and women in the use of new technologies. Barragán and Ruiz Pinto [29] point out that, in recent years, there have been many technological advances in society, leading to many new technological tools being incorporated into people's lives. Although these technological instruments offer many advantages, it is also true that they manifest new dangers, and even welcome and reproduce certain social threats. One of these threats is the transmission of gender inequality through ICT.

The difference in the use of technology between men and women is therefore a social problem that needs to be eradicated in all social spheres and, of course, also in school classrooms at all levels of education.

There are many works that point to the need for women to be incorporated into the use of ICTs as a form of the elimination of discrimination in IT. Hence, the importance of including gender equality in ICT management is seen as being high [30].

In theory, the possibilities for male and female access to ICT are gender-balanced [31], mainly due to equality legislation.

Organic Law 3/2007 states an intention to incorporate the principle of equal opportunities for men and women in the design and implementation of all public information society development programs, the intention to promote the full incorporation of women into the Information Society, the intention to promote content created by women in the field of the Information Society and finally, the intention to provide public funding for projects of the field of technology information and communication that include non-sexist language and content [32,33].

Despite this institutional commitment to equality, the differences between women and men in the technological field continue to persist. However, it must be stressed that these inequalities do not currently concern both the presence (access to ICTs) and the professionalization of women in this field.

In this context of promoting equality, this challenge highlights the importance of the role of teachers in providing educational interactions for their students. Therefore, this research aims to detect if there is a gender gap among Dual Vocational Education and Training teachers in Andalusia.

2. Materials and Methods

2.1. Objectives of the Study

This study is designed to find out the level of ICT skills possessed by Dual Vocational Education and Training teachers. In addition, the gender qualitative variable can be extrapolated to determine the differences in digital competencies between male and female teachers.

To this end, a study of two hypotheses was developed:

1. There are no significant differences between men and women in relation to the different variables in the study.
2. There are no significant differences between the subjects in relation to previous ICT training, the previous level of studies, the professional category, the professional family to which they belong and the population size where they teach.

We set out three specific objectives:

- To examine correlations between study-dependent variables and analyze how variables that are quantitative or qualitative contribute to the Degree of Information and Digital Literacy dimension (the degree of ICT knowledge held by teachers).
- Determine whether there are significant differences between participants based on previous ICT training, the previous level of studies, the professional category, the professional family to which they belong and the population size where they teach.
- Analyze the sample size needed to detect significant differences.

2.2. Method

This paper advocates the use of a methodological approach of a quantitative descriptive nature. The aim is to be able to describe through statistical tests the educational reality regarding the level of digital competence in the teaching staff of Dual Vocational Education and Training in Andalusia [34,35].

2.3. Instrument

Responses were collected through the development of an ad hoc questionnaire on the level of digital teacher competence. The initial data-frame included 68 columns and 1568 observations and participating subjects, which were Dual Vocational Education and Training teachers. The independent variables were then factored in:

- Gender (Man = 0; Woman = 1)
- Previous studies in ICT (TIC.F) (Yes = 1; No = 0)
- Previous study level (L. Stud) (Degree = 0; Degree, Master's = 1; Degree, Master's = 2; Doctorate = 3; Professional Formation = 4; Degree = 5; Degree, Professional Formation = 6; Degree, Master's = 7; Engineering = 8; Bachelor's Degree = 9; Bachelor's Degree, Master's = 10; Master's = 11)
- Professional Category (P. Categ) (Freelance = 0; Civil Servant = 1; Provisional employee = 2; Employee = 3)
- Professional family belonging (B. Know) (Others = 0; Administration and Management = 1; Commerce and Marketing = 2; Languages = 3)

- Number of inhabitants of the population where ICT is taught (Inhabitant) (Between 100,000 and 1,000,000 = 0; Between 25,000 and 100,000 = 1; More than 1,000,000 = 2; Between 1000 and 5000 = 3; Between 5000 and 25000 = 4; Less than 1000 = 5)

The dependent variables, which provide information about the different dimensions that make up digital teaching competence, were:

- IDL (Degree of Information and Digital Literacy)
- CCDR (Level of communication and collaboration of digital resources)
- CDC (Ability to create digital content)
- DC (Ability to create digital content)
- CS (Knowledge of computer security)
- PS (Problem-solving ability).

The questionnaire was subjected to a content validation process through expert judgement. This included professors from different Spanish universities (University of Seville, University of Malaga and University of Granada). The Kaiser-Meyer-Olkin measure for sampling adequacy (KMO = 0.841) and the Barlett sphericity test (χ^2 = 964.153; p-value = 0.000) were used.

Finally, regarding the internal consistency of the instrument, Cronbach's Alpha test was applied, which obtained a result of α = 0.875, an optimal value to guarantee the viability of the research.

2.4. Participants

A total of 1568 participants, dual-training teachers from the Autonomous Community of Andalusia, participated in the study, with the following characteristics:

- Minimum age (18)
- Average age (33)
- Maximum age (49)
- Men (823)
- Women (745).

2.5. Procedure

Initially, the outliers and lost values were analyzed, the latter being omitted from the data-frame. Two outliers were found, one for the variable age (55) and one for experience (25). In both cases, a manual function was defined with software R, stating that if the value of each of the variables was greater than the quantile or 95th percentile, it would be imputed by the median, while it was more robust than the mean.

The feature engineering was then carried out. The original dataset was divided into two large sets: training and testing using the initial-split function of R with a prop of 85%. This means that the training dataset kept 85% of the original data. This is because the training group was used to model the algorithm and the testing group to evaluate its performance.

The metric independent variables, age and experience, were applied to the transformation of Yeo-Johnson, which is an extension of Box-Cox's transformation. Categorical variables were then converted into indicator variables or dummies. Finally, the scores of the different study-dependent variables were added.

Before analyzing significant differences, an additional procedure was performed to implement a bin-based, funnel correlation based method:

- IDL (all scores equal to or above the average, which means 25.29 were replaced by 1, otherwise by 0)
- CCDR (all scores equal to or above the average, which means 25.23 were replaced by 1, otherwise by 0)

- CDC (all scores equal to or above the average, which means 25.31 were replaced by 1, otherwise by 0)
- DC (all scores equal to or above the average, which means 28.18 were replaced by 1, otherwise by 0)
- CS (all scores equal to or above the average, which means 25.31 were replaced by 1, otherwise by 0)
- PS (all scores equal to or above the average, which means 25.13 were replaced by 1, otherwise by 0)

A characteristic element of this analysis was that these bins cannot be factored if they were not converted into categorical variables.

3. Results

For illustrative purposes, before showing the results of the study object of this article (digital gap in teacher ICT), it is interesting to present the main results of the generic study on digital competences (Table 1):

Table 1. Descriptive statistics for the study.

Items	Mean	SD	Skew	Kurtosis
IDL.1	2.4925	1.1139	−0.01368	−1.35057
IDL.2	2.5169	1.1278	−0.03705	−1.38053
IDL.3	2.4753	1.1178	0.03666	−1.3579
IDL.4	2.4667	1.1302	0.04201	−1.38586
IDL.5	2.5271	1.1262	−0.01627	−1.37901
IDL.6	2.4957	1.0897	0.00923	−1.29275
IDL.7	2.5584	1.1285	−0.08645	−1.37635
IDL.8	2.5114	1.1068	−0.02008	−1.33307
IDL.9	2.5035	1.1209	−0.01051	−1.36615
IDL.10	2.44	1.1165	0.07457	−1.35162
CCDR.1	2.549	1.1086	−0.05296	−1.33611
CCDR.2	2.4463	1.1231	0.07108	−1.3669
CCDR.3	2.5467	1.1073	−0.04687	−1.33378
CCDR.4	2.4988	1.1075	0.00991	−1.33524
CCDR.5	2.4714	1.1255	0.01185	−1.37798
CCDR.6	2.4941	1.1369	0.00170	−1.4024
CCDR.7	2.4847	1.1166	0.03332	−1.35527
CCDR.8	2.4776	1.1002	0.02143	−1.31789
CCDR.9	2.462	1.1062	0.04230	−1.33095
CCDR.10	2.5035	1.0961	−0.01258	−1.30822
CDC.1	2.5176	1.1166	−0.04601	−1.35435
CDC.2	2.5075	1.1327	−0.02497	−1.39255
CDC.3	2.4957	1.1202	−0.00598	−1.36478
CDC.4	2.5027	1.1307	0.0307	−1.38872
CDC.5	2.531	1.1219	−0.00234	−1.37129
CDC.6	2.4776	1.1207	0.03082	−1.36488
CDC.7	2.5396	1.1348	−0.0368	−1.39755
CDC.8	2.4902	1.1265	0.02278	−1.3784
CDC.9	2.5365	1.1231	−0.04954	−1.36909
CDC.10	2.5051	1.0918	−0.0203	−1.29773
DC.1	2.5004	1.1209	−0.00601	−1.36625
DC.2	2.5122	1.1251	−0.0088	−1.37576
DC.3	2.5169	1.1046	−0.05674	−1.32577
DC.4	2.5435	1.1152	−0.03125	−1.35422
DC.5	2.4847	1.1117	0.01795	−1.3447
DC.6	2.4792	1.1228	0.02195	−1.37036
DC.7	2.5161	1.1409	−0.01423	−1.4113
DC.8	2.4988	1.1026	0.01530	−1.32353
DC.9	2.4643	1.1161	0.04726	−1.35331
DC.10	2.509	1.132	−0.0045	−1.39156

Table 1. *Cont.*

Items	Mean	SD	Skew	Kurtosis
CS.1	2.542	1.1257	−0.02037	−1.37978
CS.2	2.5027	1.1202	0.00319	−1.3647
CS.3	2.4949	1.1424	−0.00643	−1.41475
CS.4	2.5153	1.1278	−0.03643	−1.38066
CS.5	2.4651	1.1204	0.06896	−1.3603
CS.6	2.4957	1.1314	0.00419	−1.38995
CS.7	2.531	1.1135	−0.0182	−1.35015
CS.8	2.4816	1.1423	0.01057	−1.41463
CS.9	2.5161	1.1271	−0.0137	−1.38034
CS.10	2.4902	1.0954	0.02681	−1.30589
PS.1	2.5122	1.1244	−0.03035	−1.37324
PS.2	2.5106	1.1272	0.00985	−1.38118
PS.3	2.4549	1.1381	0.08426	−1.398
PS.4	2.5255	1.108	−0.02109	−1.33641
PS.5	2.4588	1.1533	0.04986	−1.43651
PS.6	2.4706	1.1205	0.01162	−1.36692
PS.7	2.4949	1.1209	−0.01571	−1.3666
PS.8	2.4933	1.1139	0.0253	−1.34957
PS.9	2.4878	1.1251	0.00548	−1.3759
PS.10	2.4549	1.1038	0.05129	−1.32466

Main statistical parameters for each item in the study.

The average age of the participants was 32.4 years and the amount of experience was 8.4 years. In general, the age of women was higher than men.

Hypothesis 1 (H1)**.** *There are no significant differences between men and women in relation to the different variables in the study.*

With respect to hypothesis 1, in relation to this gender study, the statistics show the following data (Figure 1):

- A weak correlation is observed between study-dependent variables. This suggests that there are no significant effects of interaction between the two.

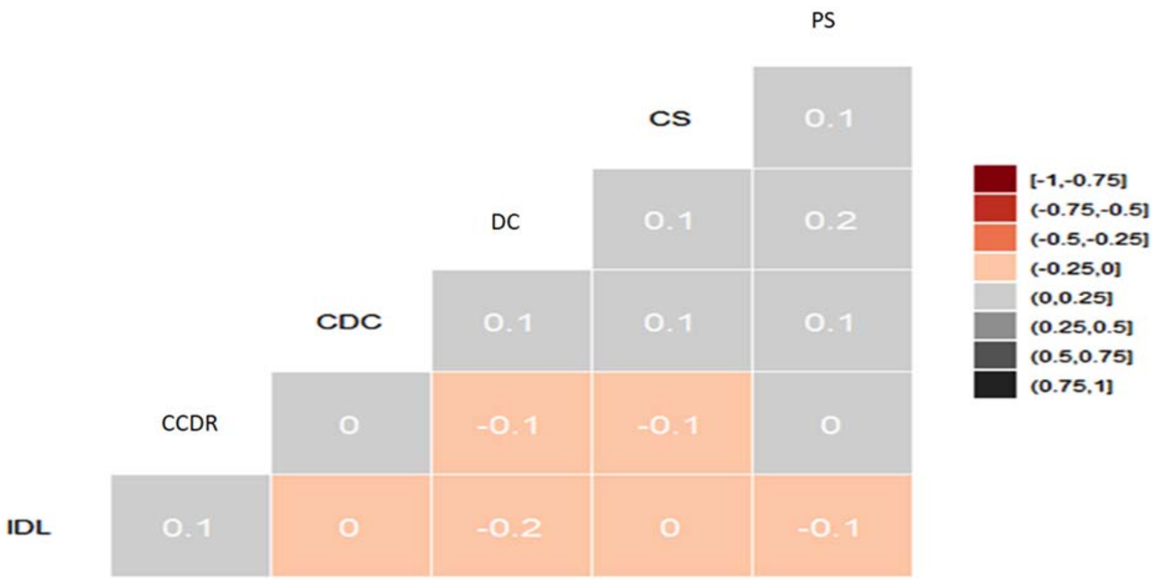

Figure 1. Correlations between the study-dependent variables.

Because the gender variable is nominal, the contingency coefficient and the V of Cramer were used. A weak relationship was observed (V.005). Fisher's paired comparisons indicated that there were no significant differences in relation to the different dependent variables (Figure 2):

- IDL:CCDR = 0.7452
- IDL:CDC = 0.6462
- IDL:DC = 0.7521
- IDL:CS = 0.9386
- CCDR:CDC = 0.7521
- CCDR:DC = 0.7521
- CCDR:CS = 0.7452
- CDC:DC = 0.7507
- CDC:CS = 0.6462
- DC:CS = 0.7521.

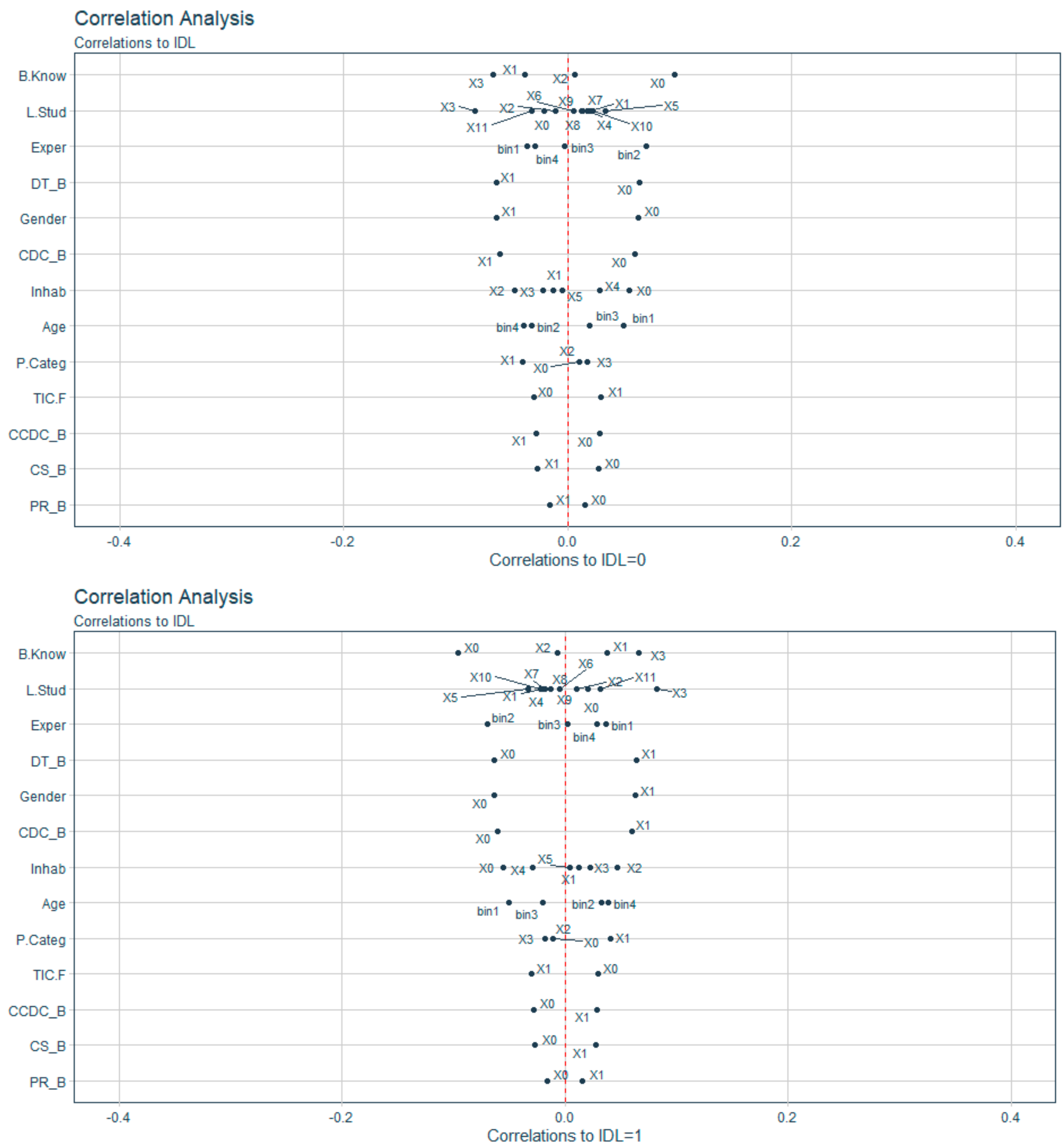

Figure 2. Variable correlation.

Based on these results, the hypothesis 1 is considered to be null.

Hypothesis 2 (H2)**.** *There are no significant differences between subjects in relation to previous ICT training, prior level of studies, the professional status, the professional family to which they belong and the population figure.*

To respond to hypothesis 2, the Mann-Whitney U-Test (for ICT) was used because it is a two-level ordinal. We also used the Pair wise post-hoc Test for Multiple Comparisons of Mean Rank Sums for non-replicated Blocked Data (Nemenyi-Test) and the Pair wise Test for Multiple Comparisons of Mean Rank Sums (Dunn's-Test) Comparisons of Rank Sums for non-replicated Blocked Data (Conover-Test).

The results were as follows:

- There were no significant differences in ICT in relation to each dependent variable, that is to say, previous ICT experience does not influence the ICT knowledge and skills identified in teachers.
- There were significant differences in L. Stud (factor 3 with respect to 4 and 5, and factor 4 relative to factor 8) in CCDCR; there were also significant different for factor 3 with respect to 4 and 5 in CDC. In other words, there are differences between the previous level of studies and the level of collaboration and communication, and also between both and the ability to create virtual content.
- There were significant differences in B. Know (factor 0 relative to factor 1) in IDL, meaning factor 2 relative to 3 in CDC. This means that the professional family which teachers belongs to influences their ability to create virtual content.
- There were significant differences in P. Categ between factor 0 and 1 for PS. Or put another way, the teacher's professional category influences their problem-solving ability.
- There were significant differences for inhabitants between factors 0 and 3 with respect to CCDR (the population number affects the level of communication).

Based on this data, although the differences are not very high, hypothesis 2 must be rejected, while admitting that there are factors that interact between the different variables.

Finally, the power of the statistical test was calculated, which was the probability of rejecting the null hypothesis. To this end, the following procedure was used:

A new dataset, x, was defined by selecting only the gender variable, DC, ICT. F (with level-0) and another analogous variable, and then selecting the same type of variables but using ICT.F level 1 instead. Cohen's d was then used for both datasets (d estimate 0.1). For the calculation of Power calculations for t-tests of means, the d value was replaced by the previous d estimate, and a power of 80% was defined. The results showed that 1052 subjects (n × 1052.024) were needed to detect significant differences in the study, a result that is otherwise within the sample limit.

4. Discussion and Conclusions

The main objective of this research work, as reflected, was to determine the existence of a gender gap in the ICT knowledge of Dual Vocational Education and Training teachers, that is to say that what was studied for hypothesis 1. In this context, it is necessary to clarify that, according to previous studies, as well as in the results obtained in this study, it is necessary to define what is meant by gender gap.

If by gender gap, we describe the distance that exists between qualified professionals in utilizing new information and communication technologies, it is clear that it still exists, as other previous studies indicate [20,28,30]. Society therefore has an obligation to alleviate it in order to encourage the inclusion of women in all areas.

However, in this study, the aim is to increase the ability of teachers to implement ICT in their teaching methodologies. This qualification does not require high-level knowledge, nor is it necessary to have high studies in computer technology, but instead an acceptable level of knowledge as a user of the relevant digital tools is needed.

If by gender gap, we mean the initial mastery of ICT tools or the degree of qualification at the user level achieved by teachers, then this study in its hypothesis 1 does not detect significant gender differences, which coincides with other studies such as those of Gil-Juárez, Vitores, Feliu and Vall-llovera [31], or those of Garrido et al. [27].

Teachers at all levels of education need ICT knowledge at the user level to implement digital tools in the classroom, and it seems that they are insufficiently trained in this context. However, there are no gender-significant differences other than in regards to the possession of high levels of professional knowledge.

In addition, the possibilities of access to ICT for men and women is gender balanced {28]. In short, it should be emphasized that, currently according to research in this area, these inequalities do not concern the presence (access to ICTs) or the professionalization of women in this field.

The main conclusions, therefore, are:

Firstly, and most importantly, as the main reason for this article, it can be concluded that there are no significant differences between the ICT knowledge applied in teaching by Dual Vocational Education and Training teachers compared to other teachers, as is apparent in the research conducted.

This lack of a digital gender gap refers exclusively to the basic knowledge needed to implement new technologies in a teaching didactic.

Secondly, this quantitative study supported the need for ICT skills used by teachers, as seen in the pre-existing literature in the introduction section.

This study corroborates this idea by taking into account that all the research about the level of ICT skills or knowledge that teachers, which have shown averages around 2.4 points out of four. Therefore, these skills should be improved through training programs in teacher studies and in the lifelong learning policies for teaching workers.

Finally, in relation to hypothesis 2, even if it is not the main objective of study in this article, it can be said that certain factors such as the level of previous study, the professional family to which the teacher belongs, their professional category and the population numbers where they work all influence the variables of collaboration and communication, the ability to create virtual content and the capacity to solve problems. These influences can be studied in other research work.

The main limitation of this study is that it is focused on a specific type of teachers, which are dual-training teachers. However, this was the purpose of this research, that is to say that to limit a teacher sector in one type of teaching, in order to support the general idea of a lack of significant differences in the implementation of ICT by all teachers, as there are other works that have investigated this aspect, but without differentiation between different educational stages.

As a future line of research, study could be limited at other specific educational stages such as early childhood education, university education, job training, etc.

In addition, the study could be extended to the other Autonomous Communities, as the present study only focuses on Andalusia.

Authors should discuss the results and how they can be interpreted in light of previous studies and of working hypotheses. The findings and their implications should be discussed in the broadest context possible. Future research directions may also be highlighted.

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