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Influence of ICTs on Math Teaching–Learning Processes and Their Connection to the Digital Gender Gap

Ascensión Palomares-Ruiz *, Antonio Cebrián, Emilio López-Parra and Eduardo García-Toledano

Department of Pedagogy, Universidad de Castilla-La Mancha, Plaza de la Universidad, 3, 02071 Albacete, Spain; Antonio.Cebrian@uclm.es (A.C.); Emilio.LopezParra@uclm.es (E.L.-P.); Toledanoeg@gmail.com (E.G.-T.)

* Correspondence: Ascension.Palomares@uclm.es; Tel.: +34-9675-992-00

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Abstract: This study presents research aimed at analyzing whether, in contrast with traditional methodologies, the usage of information and communication technologies (ICTs) in the process of learning mathematics affects gender distinctions by affecting the low rate of matriculation of women into technological studies. The research was carried out by utilizing a quasi-experimental pretest–posttest procedure using a non-equivalent control group with traditional teaching methodology (textbook and usual drawing tools), and an experimental group, in which a classroom wiki and its digital equivalents were used in the Cabri, Geogebra, and Descartes programs. A quantifiable comparison of the effects on teaching was performed by assessing the strengths and weaknesses of employing ICTs. The results show a higher motivation in the experimental group, evident in their learning and their better marks compared to those of the control group. In addition, in the pretest and posttest, women's marks were better than those of men. In conclusion, the transformation of the teaching–learning methodologies in mathematics is demanded with the use of programs such as Dynamic Geometry or Geogebra, which enable greater student involvement and more meaningful and relevant learning.

Keywords: digital gender gap; dynamic geometry; mathematics; inclusive education; sustainable citizenship

1. Introduction

In 2015, the United Nations General Assembly approved the 2030 Agenda for Sustainable Development, developing 17 Goals (SDGs), also known as the Global Goals, aiming to end poverty, protect the planet, and ensure that all people enjoy prosperity, universal peace, and access to justice. They also stress that the world's greatest challenge is poverty eradication, seeing it as a primary requirement for achieving sustainable development. Achieving these goals anywhere in the world requires creativity, knowledge, technology, and financial resources. In addition, it must be recognized that interventions in one area will affect the results of others and that development must balance environmental, economic, and social sustainability.

The importance and power of education are unquestionable, making it crucial for improving life and sustainable development [1]. It is unquestionable that quality, committed, and inclusive education is needed to form and promote a critical, conscious, and participatory educational movement that addresses the current unsustainable economic model and the serious environmental crisis from the perspective of personal responsibility and community co-responsibility [2].

Today, we are facing a global crisis caused by Covid-19, generating significant social, political, and economic changes. Unfortunately, the global health emergency has made the discrimination suffered by the most vulnerable groups visible. Therefore, more than ever, compliance with the SDGs is urgently needed, driving the commitment of the international community to building a better world. Among these goals, in this research, we focus in a coordinated and complementary way specifically on Objectives 4 and 5. Indeed, Objective 4—"ensuring inclusive and equitable quality education, and promoting lifelong learning opportunities for all"—shapes education as a key element in ensuring the future of humanity, as it is essential in promoting awareness of sustainability, critical participation, socio-environmental awareness, the transformation of the economy and society to achieve greater well-being of citizens, the sustainability of human activities, and the stability of the environment [3].

Objective 5—"achieving gender equality and empowering all women and girls"—compels us to work to eliminate inequalities between women and men, to make gender parity cross-cutting, and to make the empowerment of all girls and women an actuality [3]. Women's access to the scientific world and, in particular, that of mathematics has not been easy. As is known, the presence of women in professions linked to the areas of science, technology, engineering, and mathematics (STEM) continues to be significantly lower than that of men [4]. This gender gap begins to be generated in the early educational stages and is consolidated in the university stage, in view of the number of women who choose STEM careers [5], which is only 35% [6], producing the most pronounced decrease in mathematics with a drop of 12% in female students between the academic years of 2005–2006 and 2015–2016 [7]. This inequality in the proportion of women studying for STEM careers is determined by the confluence of various factors, such as the maternal wall, the glass ceiling, the action in the evaluation criteria, the lack of recognition and support, and a persistent gender bias with which society remains unconsciously infected [8].

This persists in spite of the implementation of policies, programs, and funding for the promotion of gender equality in research in recent decades, which has not prevented any barriers and gender gaps in the field of scientific research from continuing to exist [8].

Climate change, social conflict, and migration affect women even more. Rationally, it is imperative to guarantee women equal rights, fostering their entrepreneurship and leadership in order to make them leaders and achieve real gender equality. It must be acknowledged that, although the number of women in the labor market is rising, we are faced with many labor and social inequalities. In this sense, it can be pointed out that, in Spain, in the field of science and research, there are still obvious gender inequalities in research careers, in the governing bodies, and even in the calls for R&D&I grants, which is a situation for women far removed from that which is really desirable [9]. Violence and sexual exploitation, inequality at work, and discrimination in decision-making must also be overcome.

Consistently with the situation analyzed, investigating and making great women scientists and mathematicians would be not an easy task, since science and history have made their names and contributions invisible; this lack of recognition has generated the misconception that women cannot engage in science or, at best, as efficiently as men do [8]. The concealment of women scientists is permanent in our society and in text manuals, hiding many women who have contributed significant knowledge; they are relegated to being silenced and discriminated against. However, thanks to new research, such as that presented in this article, the need to eliminate sexist stereotypes and to work for equality as a basic objective is claimed, as demanded in SDG No. 5.

In the educational field, in the face of the challenging situation caused by the health alert, rapid and innovative responses have emerged, such as the program designed by the Chinese administration, "School's Out, But Class's On", carrying out a transformation of its educational model that has affected some 270 million non-university students [10]. Likewise, in all countries and at various educational levels, surprising innovation has been made in teaching–learning processes with the transformation of face-to-face education into connected education, promoting the individualization and personalization of teaching by adapting to and coordinating the particularities of digital tools with the actual conditions and requirements of the students.

In this socio-educational context, our work aims to improve the use of technology and, especially, information and communications technologies to promote the empowerment and leadership of women and girls [2]. In the like, there has also been much research that shows the causes of cultural differences between genders to lead to lower enrolment of women in technical careers [11,12] as well as the decline of their presence, in the last two decades [13–15].

Various research concludes that technology and computers have historically been considered to be pre-eminently male tools [16–20]. Likewise, in their leisure, women and girls use video games less, despite their influence on the use of technology [17,21–26]. It is reasonably appreciated that the digital gender gap can be connected to the meager matriculation of women in technological studies. If we focus on Spain and the allotment of undergraduates in tertiary education by area of study and gender, it can be perceived that women choose mostly careers related to education, health, and the services sector. However, men are guided by technical, engineering, and computer careers where women barely reach 10% (Table 1 and Figure 1) [27].

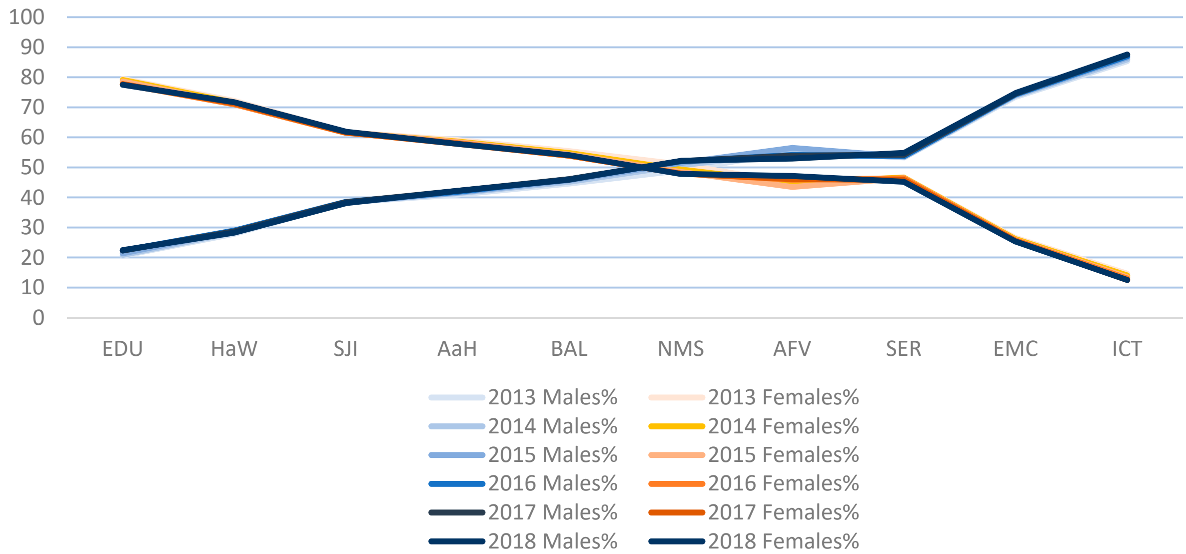


Figure 1. Students matriculated in Spain in tertiary education. Source: own elaboration adjusted from Eurostat [27].

As noted, this research was conducted with the aim of improving the use of technology and, in particular, information and communications technologies to promote the empowerment and leadership of women and girls, focusing on the teaching–learning processes of Mathematics, versus more traditional methods. So as to confirm, using inferential statistical exploration, the aim of the investigation, a Didactic Unit (UD) of the Geometry block *(Triangles)* was created for the students of First Compulsory Secondary Education (ESO) of an high school (IES) of Albacete capital in the autonomous community of Castilla-La Mancha in Spain. In the control group, the UD was worked with the textbook and the usual drawing instruments such as a ruler, square, chart, and compass; while, in the experimental group, a classroom wiki with its digital equivalents was used in the *Cabri*, *Geogebra*, and *Descartes* programs.

Table 1. Students matriculated in Spain in tertiary education.

Acronym		2013	2013	2014	2014	2015	2015	2016	2016	2017	2017	2018	2018
	Spain	**Male %**	**Female %**	**Male %**	**Female %**	**Male %**	**Female %**	**Male %**	**Female %**	**Male %**	**Female %**	**Males %**	**Females %**
EDU	Education	20.61	79.41	20.93	79.11	21.40	78.63	22.32	77.72	22.30	77.73	22.5	77.5
HaW	Health and Welfare	27.94	72.13	28.41	71.64	28.94	71.11	29.04	71.02	28.73	71.30	28.3	71.7
SJI	Social Sciences, Journalism and Information	38.32	61.72	38.44	61.62	38.34	61.70	38.52	61.52	38.40	61.64	38.1	61.9
AaH	Arts and Humanities	40.90	59.11	41.42	58.64	41.63	58.41	41.90	58.12	42.21	57.80	42.2	57.8
BAL	Business, Administration and Law	44.64	55.42	45.24	54.84	45.70	54.32	46.10	53.92	46.11	53.94	45.9	54.1
NMS	Natural Sciences, Mathematics and Statistics	49.01	51.02	50.73	49.32	51.51	48.50	52.01	48.04	52.12	47.91	52.2	47.8
AFV	Agriculture, Forestry, Fisheries and Veterinary	55.34	44.73	55.11	44.94	56.54	43.51	54.10	45.92	53.94	46.11	52.9	47.1
SER	Services	53.30	46.70	53.43	46.62	53.62	46.41	53.71	46.33	54.24	45.82	54.8	45.2
EMC	Engineering, Manufacturing and Construction	73.54	26.50	73.94	26.14	74.23	25.84	74.31	25.70	74.52	25.51	74.7	25.3
ICT	Information and Communication Technologies	85.43	14.61	86.04	14.00	86.61	13.42	87.04	13.03	87.50	12.52	87.5	12.5

Source: own elaboration adjusted from Eurostat [27].

2. Materials and Methods

Efforts were made to establish causative liaisons among the variables concerned in the research, so a quantitative approach with a quasi-experimental strategy was utilized, seeking to understand the magnitude to which the alterations logged in dependent variables were the result of handling on the independent variable, applying inferential statistical procedures. In addition, it was intended that the conditions in which the study was developed were similar to those noted in the usual leaning of the Mathematics course in First ESO of the Institute, in which the research was carried out. Similarly, considering that the decision could reduce the external validity of the research, participants were not assigned randomly, but two groups of students already constituted were selected. In addition, in order to guarantee the internal validity of the research and to ensure that there were no starting differences between the experimental group and control group that might alter the outcomes, a pretest was built to confirm that the averages between both groups were comparable. Another feature that was required to be controlled was the effect of teacher instruction involvement in the two groups, so it was decided that they would have the same teacher, in order to be able to diminish it.

The research was implemented applying a pretest–posttest quasi-experimental approach using a non-equivalent control group. Furthermore, since the interval of time between the termination of the posttest and pretest was 6 weeks, it was thought that the "learning effect" was not significant.

2.1. Variables Involved In the Study

The dichotomous qualitative independent variable was:

- The working method, which took two values: S (UD-TIC) and N (traditional UD).

The other independent dichotomous variable that was incorporated in the study was:

- Gender (GEN), which took two values: male (H) and female (M).

The continuous quantitative dependent variable was:

- The academic achievement of students in the posttest (POS) and the pretest (PRE). A new variable named amelioration (MEJ) was defined to estimate each participant's progress between the mark achieved in the posttest and the mark reached in the pretest.

Likewise, other potential external variables were considered that might disturb the investigation's results and were minimized by the chosen strategy. Therefore, it was considered that the teacher of the experimental and control groups was identical and so the unique difference in the teaching between the groups was the usage of an ICT method in the Didactic Unit explained in the experimental group, whereas in the control group, a traditional methodology focused on the textbook and the usual drawing instruments such as a ruler, square, chart, and compass was used in the UD.

2.2. Population and Sample

The population of the investigation was composed of the students of first course of Compulsory Secondary Education (ESO) of an institute in the city of Albacete in the autonomous community of Castilla-La Mancha in Spain, which had a size of 148 participants. Of the 6 existing groups, in 5 of them (A, B, C, E, and F), the subject of Mathematics was taught by the same teacher and participated in the research, whereas in one of the groups (D), the subject was taught by another teacher and did not participate in the research. Two groups were selected randomly for the control group (B, C, and E), and the other A groups (A and F) were assigned to the experimental group.

As can be seen in Table 2, the sample contained 123 students, 52 in the experimental group and 71 in the control group. The students were already assigned in groups before the investigation, so they were not randomized, and consequently, the groups were not equivalent. However, these conditions were not significant since the main aim of the investigation was not to generalize the conclusions but to analyze and comprehend the possible relation between the study variables.

Table 2. Population and sample

Group	Course	Population	Sample
Experimental	1A	24	52
	1F	28	
Control	1B	24	71
	1C	24	
	1E	23	
Does not participate	1D	25	
TOTAL		148	123

2.3. Measurement of Dependent Variables. Instruments Collected Data

This research developed its own instrument to measure the geometric competence of the students that constituted the sample. The test used as a pretest and posttest to measure dependent variables consisted of 25 items, 4 of them taken from the items from the international study TEDS-M (*Teacher Education Study in Mathematics*) On the other hand, the 8 items relating to Geometry were obtained from a study designed to measure mathematical competence and that is considered by the educational community as valid and reliable [28]. To systematize the results with the usual weights in the ESO from 0 to 10 points, it was determined that each of the 25 items in the test would be valued at 0.4 points. Link to the evaluation tool at Google Docs [29].

2.4. Test Reliability Analysis

The reliability of the items obtained from the TEDS-M study is already proven [30]. However, it is necessary to analyze the internal consistency of the test to which 21 own-made items have been added.

To analyze reliability in terms of the accuracy and stability of the data, it was decided to use the Cronbach's Alpha method, estimated through the data obtained when the survey was carried out in the sample investigated. In Table 3 can be seen the results; in the pretest PRE (.77), they are very close to 0.80, and in the posttest POS (0.87), they are greater than 0.80, implying very high reliability; subsequently, the test can be assumed to be internally consistent. In addition, the homogeneity of the survey was examined by testing the item-total correlation, and it was found that the erasure of any of the items significantly increased the Cronbach's Alpha.

Table 3. Cronbach's Alpha in pretest PRE and posttest POS.

		Cronbach's Alpha in Pretest PRE		Cronbach's Alpha at Posttest POS	
Case processing summary	Cases	N	%	N	%
	Valid	123	100	123	100
	Excluded	0	0	0	0
	Total	123	100	123	100
Reliability statistics	Cronbach Alpha	0.77		0.87	
	Number of items	25		25	

2.5. Educational Intervention

The research intended that the educational intervention in the experimental group was analogous to that in the control group. As previously commented, it was contemplated that the teacher should be the identical in all the groups that participated in the investigation, with the intention that the teaching, in all groups, was as equivalent as achievable. It was managed that the only modification was the usage of an ICT method in the experimental group and a more traditional method centered basically on the textbook and the usual drawing instruments such as a ruler, square, chart, and compass, in the control group. The rest of the teaching methods were analogous in all groups: running comparable content, implementing equal teaching activities, and developing analogous assessment tests. An active strategy was utilized while sustaining the pedagogical principles of collaborative, cooperative, and self-directed work, increasing critical thinking through conversations and discussions that stimulated active involvement. The problem-solving method was also used by encouraging students to seek to resolve them and explain to their peers the resolution processes used, using appropriate and participatory language in the discussion of possible resolution procedures. The teacher, at all times, sought to guide, encourage, and motivate students, using various material and virtual resources, adequately considering attention to diversity with reinforcement and expansion activities.

It should be noted that, for the correct learning of Geometry, students must experience the properties and relationships of geometric objects regardless of the position they occupy in space or the plane. The static teaching of Geometry has, for many years, been the most applied traditional method with the use of the chalk or pencil and paper as unique teaching resources, reinforcing false beliefs of the students about the shapes of the figures linked to the position they occupy in space or the plane [31]. All this justifies, as have been chosen for the UD-ICT, materials that are digitally manageable, allowing the displacement of the figures, which allows students to check the properties that remain unchanged despite virtual translations and movement, avoiding the association between solids or flat figures and their positions in space or planes.

2.6. Description of the UD-TIC (Triangles)

It was decided to exploit the many possibilities offered by the Internet and ICT through the development of a wiki for the creation of a Didactic Unit (UD) based on the use of ICT (UD-TIC) of the Geometry block (Triangles) of First Secondary Education, in which the problems that the students had to work autonomously, both in class under the control of the teacher and at home for the activities of extension and reinforcement, were able to be completed with an exchange information between the students and the teacher through the internal mail of the wiki, for which most students opted, with the discussion forum being less used.

Importantly, the use of new technologies does not imply the abandonment of traditional paper drawing instruments that students should also have used in a complementary way and handed over to their teacher (digitally or by hand) as part of the process of the continuous evaluation of the unit. For some parts of the unit, it was necessary for the students to handle with ease the usual drawing instruments: a ruler, square, letter, and compass and their digital equivalents in the Cabri, Geogebra, and Descartes programs—computer applications with tools to perform geometric constructions and that allow the visualization of all the elements of the flat geometry, allowing the student to better strengthen the concepts learned in the UD-ICT.

As the UD-TIC was raised through a wiki on which students had to work and solve the proposed activities, the use of the Internet and some digital tools such as browsers and, in particular, minimal training in the use of applications designed with Geogebra became indispensable. In the UD-TIC, rectangle triangles had to be drawn, so it was necessary for the participants to be able to draw perpendicular lines and draw triangles knowing some data, with traditional drawing instruments and Geogebra tools, which required a previous first-session instruction process in the experimental group.

The UD-TIC was divided into 10 sessions, the first 7 sessions being dedicated to the students working on and discovering the properties of the triangles, through the proposal of a series of activities with computer applications taken from the repositories of the Institute of Educational Technology (ITE) through the Gauss, Descartes, and Geogebra projects. Session 8 was dedicated entirely to summarizing and synthesizing all the concepts learned. In Session 9, the evaluation of the unit was carried out; the first self-assessment activities were introduced and completed with a questionnaire that students had to complete and forward to the teacher. Session 10 was dedicated to the introduction of the integrated activity that was also being worked on in the other subjects involved. All sessions started with a motivating activity that was a 2 or 3-min video, getting the participants started with the activities they were going to engage in. For all the videos, the students had to summarize them and submit their summaries through GDocs/Moodle. All the activities raised in the wiki followed the model of the 5 learning phases of Van Hiele: information, targeted guidance, explicitation, free guidance, and integration [32].

For the evaluation of the Didactic Unit (UD), numerous self-assessment activities were included, throughout the first 7 sessions and especially in Review Session 8 and Evaluation 9. In addition, 4 forms were designed in Gdocs/Moodle—a generic one where students could summarize the main ideas of each of the videos with which each of the first 8 sessions began, another generic one where they could answer the questions that appeared in the activities posed by the Gauss Project, and two other evaluation activities included at the end of the UD by relating each question to the evaluation criteria. All forms had to be sent by the students to the teacher, who received them in the form of a table with the name of each student, the date of completion, and the answers to each question. Link to UD-TIC (Triangles): [33].

3. Results

Performing a descriptive analysis of the data provided by the test to measure geometric competences and an inferential analysis will allow us to be able to answer the question that had been established as the main hypothesis of the research.

3.1. Descriptive Analysis

Tables 4 and 5, as well as Figures 2–4, provide a descriptive analysis of the qualifications obtained by students in the geometric knowledge test with respect to the gender variable (GEN). This test was carried out both pretest and posttest, thus providing two measurements from each student: one in the month of March, when the educational intervention had not yet been developed, and the other corresponding to the month of May after the educational intervention. An amelioration variable (MEJ) was defined that measured the advances in each student's mark in the geometric knowledge test, corresponding to the difference between the mark obtained in the posttest and the mark obtained in the pretest. The variable (MEJ) could take values between −10 and 10, since 10 was the maximum mark for that test. In the research, in fact, values between 0 and 5 were taken.

No data were lost from the initial sample of students who made up the control group and the experimental group because, in case of absence in any of the sessions where the tests were performed (pretest or posttest) in the reference group, a participant was tested another day in another group.

From the analysis of the data obtained, it can be observed that:

(a) Women, in the pretest, obtain an average of 0.754 points more than men, with a greater dispersion and a median of 1 point more than men.
(b) In posttest, women have an average of 0.878 points more than men, with a higher dispersion and a median of 1.45 points more than men.
(c) Women, in the variable amelioration, achieve an average of 0.124 points more than men, with a similar dispersion and a median of 0.1 points more than men.
(d) The two genders improve after the application of the UD; however, the average improvement for women is higher by 0.124 points than that for men with a similar dispersion.

Table 4. Descriptive statistics of the amelioration variable MEJ over the gender variable GEN

GEN_F				**Statistic**	**Standard Error**
MEJ_D	Man	Mean		1.584	0.0988
		95% confidence interval for the mean	Lower limit	1.387	
			Upper limit	1.781	
		Mean trimmed to 5%		1.553	
		Median		1.500	
		Variance		0.713	
		Standard deviation		0.8441	
		Minimum		0.0	
		Maximum		4.1	
		Range		4.1	
		Interquartile range		1.1	
		Asymmetry		0.531	0.281
		Kurtosis		0.914	0.555
	Woman	Mean		1.708	0.1414
		95% confidence interval for the mean	Lower limit	1.424	
			Upper limit	1.992	
		Mean trimmed to 5%		1.673	
		Median		1.600	
		Variance		1.000	
		Standard deviation		1.0002	
		Minimum		0.0	
		Maximum		4.2	
		Range		4.2	
		Interquartile range		1.0	
		Asymmetry		0.456	0.337
		Kurtosis		0.297	0.662

Table 5. Two-dimensional variable frequency table amelioration variable MEJ over the gender variable GEN.

	MEJ_D = [−5,−4)	**MEJ_D = [−4,−3)**	**MEJ_D = [−3,−2)**	**MEJ_D = [−2,−1)**	**MEJ_D = [−1,0)**	**MEJ_D = [0,1)**	**MEJ_D = [1,2)**	**MEJ_D = [2,3)**	**MEJ_D = [3,4)**	**MEJ_D = [4,5)**	**TOTAL**
GEN_F = Man	0	0	0	0	0	15	38	15	4	1	73
GEN_F = Woman	0	0	0	0	0	11	20	13	4	2	50
TOTAL	0	0	0	0	0	26	58	28	8	3	123

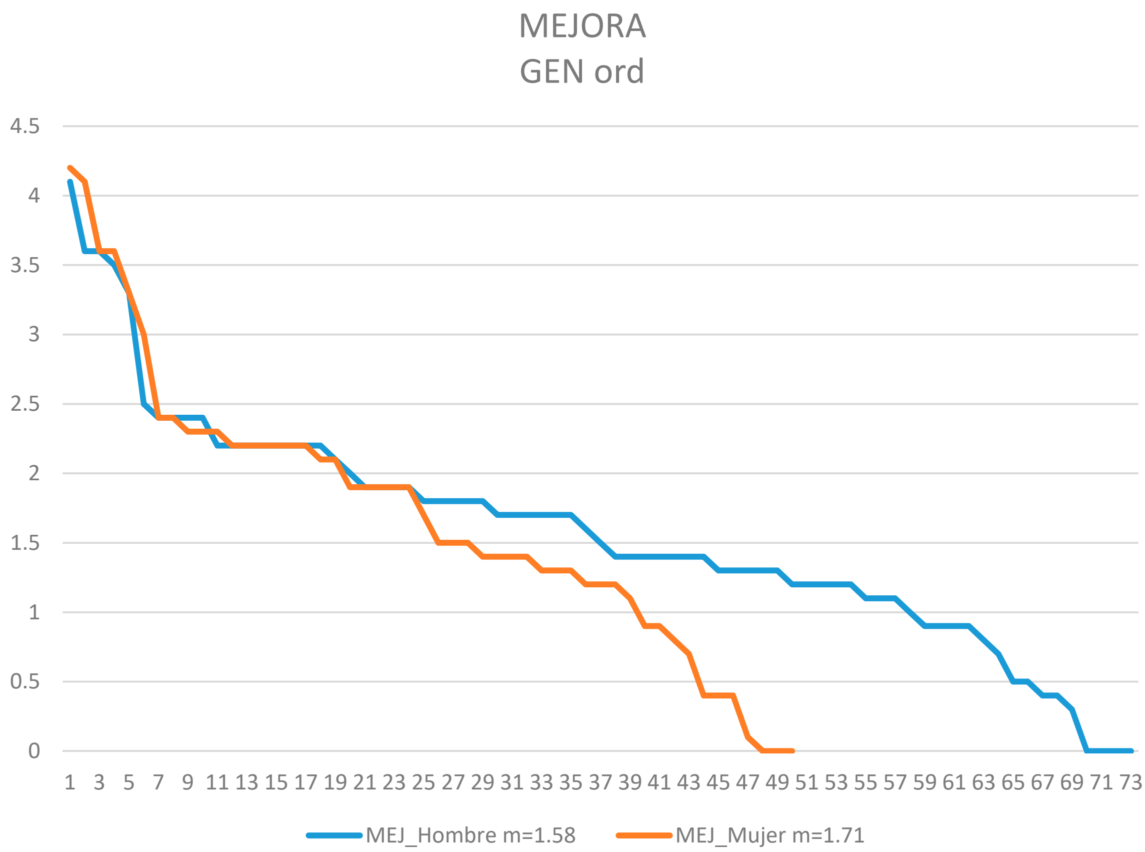
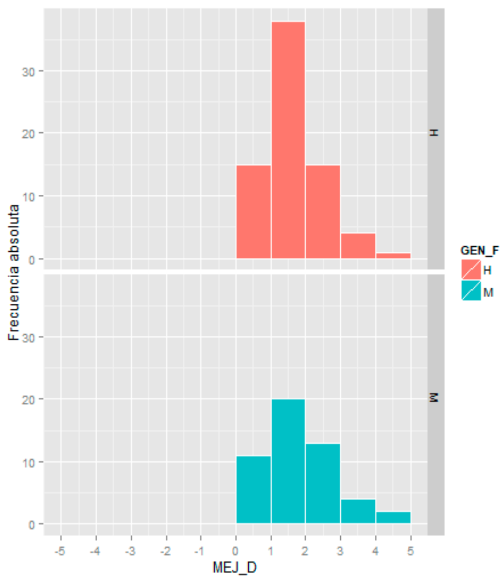
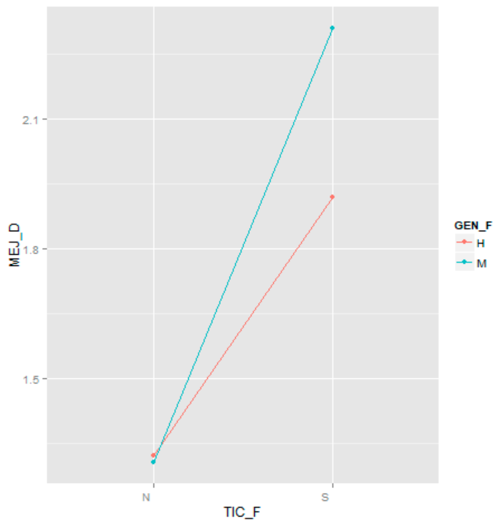


Figure 2. Trend chart of the amelioration variable MEJ over the gender variable GEN (results ordered from highest to lowest).



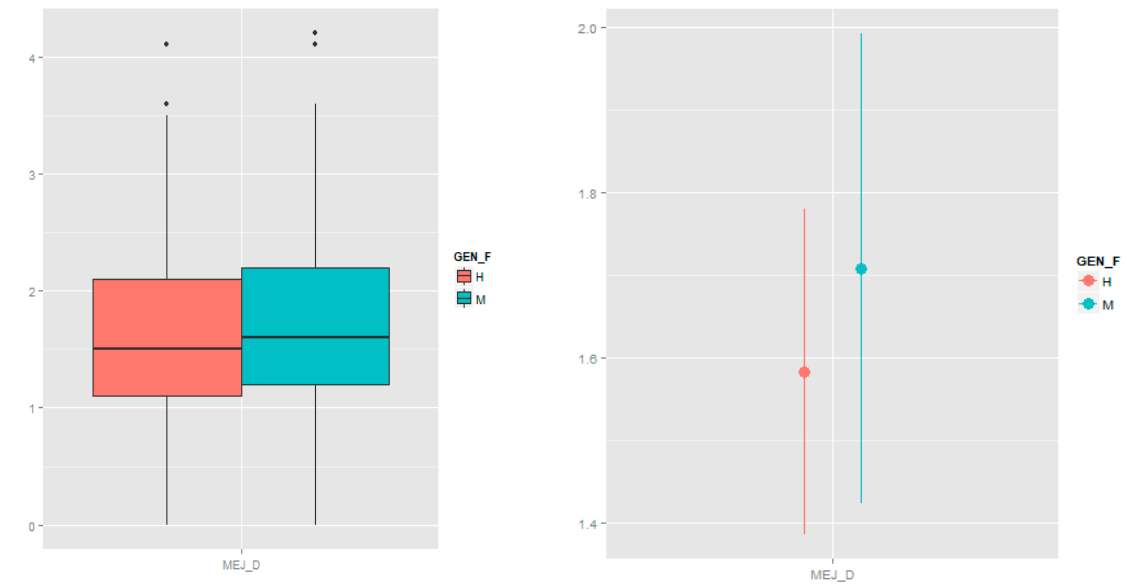
(**a**) Gender variable GEN (H—female; M—male)



Main independent ICT variable greater than interaction and independent variable conditioning GEN less than interaction

(**b**) Main variable interaction diagram for ICT and conditioned gender GEN with respect to amelioration variable MEJ

Figure 3. Histograms and interaction diagram of the amelioration variable MEJ over the gender variable GEN.



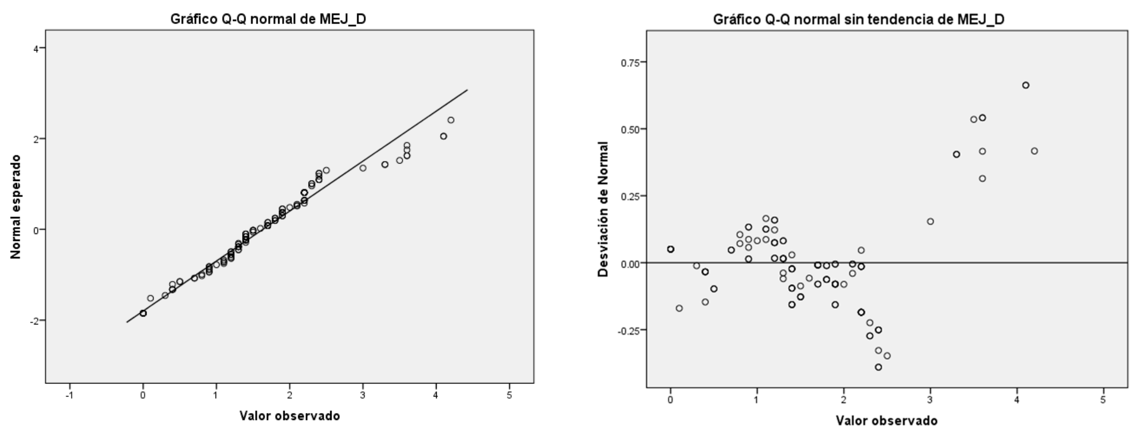
(**a**) **Box diagram**

(**b**) **Means diagram**
(Confidence interval: 0.95)

Figure 4. Diagrams of the variable amelioration MEJ over the gender variable GEN.

3.2. Inferential Analysis

The inferential statistical techniques used included the Kolmogorov–Smirnov normality proof, with the Lilliefors correction, to guarantee the normality prerequisite in the application of parametric techniques. The Levene proof was additionally employed to confirm the homoscedasticity in the contrast of the variances. The normalization can be seen in the Q-Q charts in Figure 5, as the points in the normal Q-Q diagram conform to the diagonal and the points of the normal Q-Q diagram without trend are randomly distributed without showing a clear pattern.



(**a**) Normal Q-Q quantile chart

(**b**) Normal Q-Q quantile chart without trend

Figure 5. Q-Q quantile charts of amelioration variable MEJ.

To answer to the investigation inquiry, it was tested if the null hypothesis might be excluded. H0: Mc-Me = 0, where Me and Mc, were the corresponding sample averages of the marks achieved by the students in control and experimental groups. We verified by means of statistical proof that the null hypothesis could be excluded, showing that were verified significant dissimilarities between the groups compared [34]. Moreover, the grade of significance was established, which denotes the probability of error that would be expected in refuting the null hypothesis. As is common in educational investigation, a p-significance value of 0.05 was accepted. The ANOVA proof multivariate general linear model with the SPSS 24 statistical package was utilized for the comparison of averages between independent samples.

In the ANOVA proof for one independent sample factor with regard to the ICT-independent variable, such as can be appreciated in Table 6, the significance value in the pretest (0.152) is greater than 0.05, so those averages can be considered similar for the selected confidence tier of 95%, so the null hypothesis of the likeness of averages H0: Mc-Me = 0 is accepted and the H1 alternative hypothesis of dissimilarity of the averages between the experimental group and control group is rejected. However, both in the posttest (0.005) and with respect to the amelioration variable (0.000), at the significance level of less than 0.05, the null hypothesis of the likeness of the averages H0: Mc = Me must be rejected, and the alternative hypothesis H1 of a difference of the averages between the experimental group and control group is accepted. With regard to the variable gender (GEN) the significance values in both the pretest (0.012) and posttest (0.025) are less than 0.05; the marks of women are higher than men's, both in pretest and posttest, and there are statistically significant gender differences. The same is not true of the amelioration variable (MEJ), which, with its significance value (0.226) being greater than 0.05, cannot be assumed to be statistically different.

Table 6. ANOVA gen-tic test multivariate general linear model.

Origin,	Dependent Variable	Type III Sum of Squares	gl	Quadratic Average	F	Sig,	Partial Eta Squared
Corrected Model	PRE_D	22.570 [a]	3	7.523	2.741	0.046	0.065
	POS_D	67.605 [b]	3	22.535	4.23	0.007	0.096
	MEJ_D	18.941 [c]	3	6.314	9.181	0	0.188
Intersection	PRE_D	881.444	1	881.444	321.115	0	0.730
	POS_D	2312.048	1	2312.048	434.021	0	0.785
	MEJ_D	338.363	1	338.363	492.025	0	0.805
GEN_F	PRE_D	17.86	1	17.86	6.507	0.012	0.017
	POS_D	27.402	1	27.402	5.144	0.025	0.066
	MEJ_D	1.017	1	1.017	1.479	0.226	0.184
TIC_F	PRE_D	5.695	1	5.695	2.075	0.152	0.052
	POS_D	44.606	1	44.606	8.373	0.005	0.041
	MEJ_D	18.424	1	18.424	26.791	0	0.012
GEN_F * TIC_F	PRE_D	0.308	1	0.308	0.112	0.738	0.001
	POS_D	2.709	1	2.709	0.508	0.477	0.004
	MEJ_D	1.189	1	1.189	1.729	0.191	0.014
Error	PRE_D	326.649	119	2.745			
	POS_D	633.919	119	5.327			
	MEJ_D	81.836	119	0.688			
Total	PRE_D	1218.56	123				
	POS_D	2968.06	123				
	MEJ_D	429.24	123				
Corrected Total	PRE_D	349.219	122				
	POS_D	701.523	122				
	MEJ_D	100.777	122				

* means interaction between the two variables; [a] R squared= 0.065 (R squared adjusted= 0.041); [b]. R squared= 0.096 (R squared adjusted= 0.074); [c]. R squared= 0.188 (R squared adjusted= 0.167).

4. Discussion

Similar averages were obtained, not factoring in this statistically significant dissimilarity, as was foreseeable, in the pretest in the experimental group (2.492) and the control group (2.887). In the posttest, the experimental group, consisting of class groups 1A and 1F, achieved an average of 4.956, better than that of the control group 3.807, comprising class groups 1B, 1C, and 1E; this dissimilarity is statistically significant, which makes it possible to positively answer the investigation question.

It is important to stress that women obtained, in the pretest, an average score of 3.106, higher than that of men at 2.352, and, in the posttest, an average score of 4.814, higher than that of men at 3.936—this being a statistically significant difference in academic performance; nevertheless, the improvement for women (1.708) was slightly higher than that of men (1.584), this difference not being statistically significant, which permits us to guess an incipient digital gender gap that is supported by Eurostat data [27] showing that girls have more difficulties than boys in expertly handling ICT, which is likely to be one of the reasons that will lead them to decline in the future for studies linked to health, education, and services.

Scenarios such as the global health emergency, COVID-19, have highlighted the need for a transformation from face-to-face education to connected education, highlighting the necessity for a transformation in the educational paradigm in which women overcome obstacles in the expert handling of ICT. Thus, it is essential and urgent, in line with the SDGs, that public administrations, with the implementation of the appropriate equity strategies, guarantee that any change in alarm situations does not involve a new handicap for students and women with difficulties in internet access.

5. Conclusions

Recent investigations show that the first digital gender gap is beginning to vanish, with a trend to equalization of the number of ICT handlers of the two genders [35,36]; nevertheless, in today's society, the second digital gender gap [16,37,38] continues to be present, caused by gender differences in skills that facilitate the expert use of ICT, demonstrating some influence in that there are only 17% women enrolled in Computer Engineering in Europe [39,40].

The problem is esteemed to be the consequence of some social praxis that promotes a scarce inclination of females for technology, as well as male supremacy in the fields of work where innovative technologies are acquired [35–37].

The findings of the study suggest that it would be beneficial to design further encouraging backgrounds for girls and females by spreading feminine examples in the area of technology, in order to stimulate, among the teachers of the initial levels of education, the achievement of training activities designed at enhance the teaching–learning processes reinforced by new technologies [41–45].

In this regard, it should also be highlighted that, even though the management of devices as a communication tool and relation is actually adequate among girls and boys, according to the outcomes found in other research [46–50], it is not evolving similarly to the usage of technological leisureliness, as in the field of electronic games. It is therefore necessary to consider that abundant research connects the digital gender gap to girls' unlikely usage of electronic games, leading to a reduction in females' educational and professional chances [21,49,51].

It should be highlighted, given the misperception in this regard, that in order for an educational paradigm modification [52], the phase of the "incorporation" of emergent technologies with conventional schooling organizations must be carefully considered, as should innovative pedagogies supported by theories such as constructivism, cognitivism, meaningful learning, etc., as well as other newly developed ideas resulting from the arrival of the Internet and the web—such as rhizomatic learning, self-regulated learning, peer learning, connectivism, LaaN theory, etc.—that, on many occasions, have not finished transforming traditional educational practices and that, in the present condition, can expedite the renovation of the pattern of education in the schoolroom, focusing on learning instead of teaching and on the student as an alive subject of their learning [10,53,54].

The spread of girls and women in the use of new technologies and technological studies has been studied to ease the eradication of discrimination they have endured throughout history and satisfy the universalization of human rights and the aims of education for sustainability. Certainly, girls and women will have superior representation and participation in all political and social areas, with more comprehensive preparation, without gender inequity. Arguably, education for sustainable citizenship requires that gender inequalities are eradicated from all spheres of society, an essential prerequisite for progressing science, education, and political and social organizations. Consequently, we face a challenge to achieve sustainable citizenship, promoting the use of information and communications technologies, advancing the elimination of discriminations between males and females, and realizing gender-equal opportunity and the encouragement of all girls and women everywhere in the world.

More than one and a half million schoolchildren of all ages have suffered the devastating effects of the COVID-19 pandemic; the lack of planning in all countries will bring consequences of very difficult recovery in various areas such as education, nutrition, gender equality, etc. That is why we are facing a crucial moment at the global level, when no more time can be wasted on useless disquisitions and action must be taken immediately if decades of progress are not to be reversed.

As indicated by the health emergency, large inequalities in education and gender equality have been highlighted, aggravating the prolonged closure of nurseries and schools at all levels of education, including universities.

There is no doubt that we are faced with a worldwide problem so far imaginable, where respect and compliance with human rights, imagination, and creativity are not only needed but also necessitate a clear commitment by all administrations to education by substantially increasing budgetary allocations. Indeed, education must be the center and a basic pillar of solidarity and investment for development and continue on the right path to advance the SDGs. This requires the adoption of literacy and digital infrastructure, eliminating the digital gender gap and inequalities in access to inclusive, resilient, and quality education, without discrimination [55].

We agree with the research carried out on the need for an inclusive and ecological education that instills knowledge, attitudes, and competences based on the critical spirit, responsibility, and commitment to the construction of a better world, accepting the challenge of moving towards a culture from co-responsibility for sustainable development [2].

In this sense, we have focused on Article 4 and Article 5 of the Sustainable Development Goals (SDGs), proving that empowering women has a multiplier effect that promotes economic growth and development globally. It is therefore essential to undermine any form of discrimination against women and girls if the Sustainable Development Goals (SDGs) are really to become a fact around the world.

As a final conclusion, our concern must be highlighted in the face of the world's involution in the implementation of the SDGs. Indeed, in 2020, there has been stagnation and a decline in some areas due to the COVID-19 pandemic, threatening many of the achievements and even decades of progress. With regard to SDG number 4, on which we have reflected in this work, it is highlighted that the pandemic has caused great damage—leading to the closure of many schools, leaving some 1500 million students (90%) out of school [56]—and evidenced a large digital gap between students from the most vulnerable and disadvantaged groups and societies. Logically, the digital gap has widened the differences in equality in education. However, focusing on objective number 5, there are significant improvements, especially in the world of work, with an increased representation of women in parliaments and a progressive increase in their presence in managerial positions. Similarly, despite being still about 7 points lower than that for men [56], women's empowerment through mobile telephony has been shown to accelerate social and economic development, reinforcing our approach to the need to improve women's training in the domain of information and communication technologies, reducing the digital gender gap.

6. Limitations and Future Lines of Research

As the most significant limitation of the investigation implemented, it is worth highlighting the small sample size. Aware of this and assessing the importance of the subject studied, new work has been initiated and the sample has been expanded with other groups and different contexts. Researchers who have participated in this study have adequately assessed the effects on gender equality of new changes in methodologies being introduced in face-to-face education, including online preparation courses, and the proliferation of uses and technological instruments.

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