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Digital Competences Relationship between Gender and Generation of University Professors

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***Abstract*— Digital competences can be defined as the set of techno-pedagogical and communicational skills that allow teachers to function effectively within the educational contexts that new technologies generate. This research work was aimed to establish the relationship between the level of university professors' digital competences concerning their gender and generation. The study was based on a sample of 613 professionals with an undergraduate degree, who came from different areas of Ecuador; they were the attendees to the "Training Program for Leveling Tutors using Virtual Modality" at Técnica del Norte University (Ibarra -Ecuador). This research applied a quantitative and explanatory approach where the non-parametric statistical test of Chi-square was used to corroborate the validity of the data; it was obtained from a survey applied to the participants in this training course. The results show that the level of digital competences is gender independent but generation dependent. Generation Z is the one with the best digital capabilities, with an average of 61.14%. Regarding the gender, a dependence is observed only with two out of five groups of competencies analyzed in this study; the cloud storage and the interaction of social network. The research line of digital competences is extensive, the results should not be generalized or extrapolated without considering the characteristics of the educators and the context, it is suggested to assess the teaching staff digital competencies, considering other types of demographic variables, so that higher education institutions can carry out a comprehensive training planning in digital skills.**

***Keywords*— ICT; digital competence; gender; generation; virtual learning.**

I. INTRODUCTION

The Internet has caused a media convergence, increasing use of new technologies, and social changes where the need for a digital competence is prevailing to become systematic participants in the knowledge society of the 21st century [1]. Digital competences can be defined as the set of techno-pedagogical and communicational skills that allow teachers to function effectively within the educational contexts that new technologies generate.

This reality is not exempt from the educational field because the digital age evidences a new definition of teacher's and student's roles. It implies rethinking the teaching-learning process according to the way new generations learn and access to knowledge [2] concerning International and Communication Technologies (ICT) tools or resources, as well as didactics and pedagogy. The students who belong to the current education system are different from the ones of previous generations.

The digital competence has marked a relevant research line in the technological education field at different levels and contexts [3]–[7], keeping in mind that the digital competence is a set of techno-pedagogical and communicative skills to function effectively in the new educational contexts generated by technology. The development of teachers' digital competence arises employing educational praxis in response to society and the demands of the digital age [8].

Different investigations have focused their interest on determining the relationship of digital competence among the variables gender, age, or generation [9]–[14] and others; in recent years, the rapid dissemination of digital technology has caused students to generate new skills and competences for their academic, social and cultural development. The digital divide between teachers and students is undoubtedly not only because of the characteristics of each generation, but also due to the use, management, and technology access [15].

Teacher training is essential in digital competence in order to enrich their professional growth, their knowledge basis, abilities, and skills, teaching methods, digital tools, aimed to understand and improve the training a new generation of students, who are digital natives [16]–[18]. In this sense [19], establish three digital generations: the current generation called the Generation Z (GZ) or better known as the Net Generation or digital natives, including people born between 1995 and 2012, they are conceived as experts in the ICT domain, their learning is autonomous and self-taught; the second Generation Y (GY), also called Baby Boomers or Millennials born between the years of 1977 to 1994 characterized as multitasking by performing several digital activities at once; finally Generation X (GX) born between 1966 until 1976, considered as digital immigrants.

Higher education institutions in Ecuador, aware of this reality, have made significant investments in technical, technological equipment and connectivity in recent years; however, in the substantive teaching function, there is still no significant change in the use of this technology in the classroom. Some studies focus on issues related to digital competences, where they reveal that, in Ecuador, teachers' digital skills are weak [19]–[22]; the incorporation of technological tools to enhance the teaching-learning process is limited while students use of these tools is accelerated.

In this context, the strengthening of digital competences in teachers is the most essential element to vitalize the use of ICT in education [23]; therefore, the importance of this research lies in establishing whether the digital competencies in university professors who participated in the "Training Program for Leveling Tutors Using Virtual Modality" at Técnica del Norte University (Ibarra-Ecuador) are related to the gender and generation they belong to, so that higher education institutions can carry out a comprehensive training planning in digital skills based on the results of this objective; professors to receive a differentiated training, considering their gender and generation.

II. Materials and Method

This research is quantitative with an interpretive approach to establish the dependence of the digital competence level between generation and gender. For this purpose, two hypotheses are defined for each one of the digital teaching competencies, the research hypothesis (H_1) and the null hypothesis (H_0). See Table I. The non-parametric statistical test of Chi-square was used, with a significance level (SL) of 5% (0.05). For the calculation of the assumed value of independence, the four levels of the domain were taken into account; therefore, each domain corresponds to 25% (0.25) as a probability of occurrence. It was necessary to calculate a correlation coefficient (Cc) in the tests resulting significant, allowing to identify in what percentage the different domain levels exceed or decrease in comparison to the assumed value of independence (0.25).

The population or universe was made up by 613 professionals, with an undergraduate degree as a minimum requirement, who applied for the "Training Program for Leveling Tutors using Virtual Modality" at Técnica del Norte University; 48.12% belong to the female gender, 51.71% belong to the male gender and 0.17% belong to the LGBTI gender. Table II shows the gender and generation of university professors according to the description of [19]. 13.05% belongs to Generation X, 32.46% to Generation Y, and 54.49% to Generation Z.

TABLE I
Hypothesis

Digital Competence	H_0	H_1
Office 365 domain	The Office 365 domain does not depend on the generation.	In the Office 365 domain at least, one depends on the generation.
	The Office 365 domain does not depend on gender.	In the Office 365 domain at least, one depends on gender.
Cloud storage	The cloud storage domain does not depend on generation.	In the cloud storage domain at least, one depends on the generation.
	The cloud storage domain does not depend on gender.	In the cloud storage domain at least, one depends on gender.
Creating online presentations	The creating online presentations domain does not depend on generation.	In the creating online presentations domain at least one depends on the generation.
	The creating online presentations domain does not depend on gender	In the creating online presentations domain at least one depends on gender.
Social networks interaction	The social network's interaction domain does not depend on generation.	In the social network's interaction domain at least, one depends on the generation.
	The social network's interaction domain does not depend on gender.	In the social network's interaction domain at least, one depends on gender
Troubleshooting technical issues	The troubleshooting technical issues domain does not depend on generation.	In the troubleshooting technical issues domain at least, one depends on the generation.
	The troubleshooting technical issues domain does not depend on gender	In the troubleshooting technical issues domain at least, one depends on gender.

TABLE III
Target Population, Gender, and Generation

Gender	Generation	f	%	f	%
Female				295	48.12%
	GZ	173	58.64%		
	GY	84	28.48%		
	GX	38	12.88%		
Male				317	51.71%
	GZ	160	50.47%		
	GY	115	36.28%		
	GX	42	13.25%		
LBGTI				1	0.17%
	GZ				
	GY	1	100%		
	GX				
Total				613	100%

The research instrument (questionnaire) was validated by three experts from Técnica del Norte University in the technological education area, where the corresponding corrections were made. After this, the survey was structured with 11 questions of demographic information, age, gender, availability, and knowledge of ICT (office automation, cloud storage, social networks, among others). Subsequently, this questionnaire was validated with a pilot test, distributed online for 24 hours, so that those professionals interested in participating as virtual education teachers could answer. In that period of time, 45 people responded, the technique of split halves was used; that is, half of the individuals for X and the other half for Y, to this effect a survey was deleted. The selection of the halves was entirely random to guarantee the measurement of reliability. Finally, to check its internal consistency, the Cronbach's α index was used, obtaining a value of 0.89; therefore, the reliability of the instrument is good according to the scale of [24], and the questionnaire could be applied online to the target population of this study, see Table III.

TABLE IIII
GEORGE AND MALLERY CRITERIA

Criteria	Valuation
Alpha Coefficient >0.9	Excellent
Alpha Coefficient >0.8	Good
Alpha Coefficient >0.7	Acceptable
Alpha Coefficient >0.6	Questionable
Alpha Coefficient >0.5	Unacceptable

The data ordering and inferential analysis were performed with the social research statistical package (SPSS) version 22.0

III. RESULTS AND DISCUSSION

The results assessed about the digital competence in relation to gender and generation were: 1) Office 365 domain; 2) cloud storage; 3) creating presentations online; 4) social networks interaction and 5) troubleshooting technical issues.

A. Digital Competence: Office 365 Domain

Table IV shows that the Office 365 domain is independent of gender because the value is >0.05; therefore, the null hypothesis is accepted.

TABLE IV
GENDER VS. OFFICE 365 DOMAIN

Gender		Advanced	Basic	Intermediate	None	Total
Female	FO	141	27	122	5	295
	FE	150.1	21.2	120.3	3.4	295
LGBTI	FO	1	0	0	0	1
	FE	.5	.1	.4	.0	1
Male	FO	170	17	128	2	317
	FE	161.3	22.8	129.3	3.6	317.0
Total	FO	312	44	250	7	613
	FE	312.0	44.0	250.0	7.0	613.0
Chi-square Test						6.595[a]
Asymptotic Significance (P-Value)						0.360

As the test was significant, it was necessary to calculate the correlational coefficient (Cc) which allowed us to see the percentage values obtained in each of the domains; the advanced domain exceeds with 103.59% compared to the assumed value of independence, the intermediate domain is greater with 63.13%, the underlying domain is lower with 71.29%, and finally, the none domain is lower with 95.43%. See Table V.

TABLE V
CORRELATION COEFFICIENT OFFICE 365

Generation	Advanced	Intermediate	Basic	None	Total
GX	34	32	12	2	80
GY	93	87	16	3	199
GZ	185	131	16	2	334
Total	312	250	44	7	613
%	50.90	40.78	7.18	1.14	
Cc	1.0359	0.6313	-0.7129	-0.9543	

When analyzing the advanced domain, Table VI shows that 59.29% belongs to the generation z (GZ) where 29.48% are women and 29.81% are men; similarly, the intermediate domain belongs to Generation Z with 52.40% of this stratum, 25.60% are men and 26.80% are women.

TABLE VI
ANALYSIS OF OFFICE 365 DOMAIN PER GENERATION

Generation	Advanced Domain		Intermediate Domain	
	F	Fr	F	Fr
GX	34	0.1090	32	0.1280
GY	93	0.2981	87	0.3480
GZ	185	0.5929	131	0.5240
Total	312	1.00	250	1.00

The alternative hypothesis is accepted in the results of the generation variable, which states that in the Office 365 domain, at least one depends on the generation (See Table VII).

TABLE VII
GENERATION VS. OFFICE 365

Generation		Advanced	Basic	Intermediate	None	Total
GX	FO	34	12	32	2	80
	FE	40.7	5.7	32.6	.9	80.0
GY	FO	93	16	87	3	199
	FE	101.3	14.3	81.2	2.3	199.0
GZ	FO	185	16	131	2	334
	FE	170.0	24.0	136.2	3.8	334.0
Total	FO	312	44	250	7	613
	FE	312.0	44.0	250.0	7.0	613.0
Chi-square Test						15.808a
Asymptotic Significance (P-Value)						0.015

B. Digital Competence: Cloud Storage

The digital competence of the cloud storage domain was assessed in h_0: The cloud storage domain does not depend on generation and as h_1: in the cloud storage domain, at least one depends on the generation. It was obtained that the p-value is <0.05; so that the null hypothesis is rejected and for the moment the alternate hypothesis is accepted, in the cloud storage domain, at least one depends on the generation. See Table VIII.

TABLE VIII
GENERATION VS. CLOUD STORAGE

Generation		Advanced	Basic	Intermediate	None	Total
GX	FO	26	20	31	3	80
	FE	40.8	8.4	29.9	.9	80
GY	FO	94	24	79	2	199
	FE	101.6	20.8	74.3	2.3	199
GZ	FO	193	20	119	2	334
	FE	170.5	34.9	124.8	3.8	334
Total	FO	313	64	229	7	613
	FE	313.0	64.0	229.0	7.0	613.0
Chi-square Test				38.271a		
Asymptotic Significance (P-Value)				.000		

Similar to the Office 365 assessment, it was necessary to calculate the correlation coefficient (Cc) in the tests that were significant; the percentage values obtained in each of the domains reflect that the advanced domain exceeds with 104.24% compared to the assumed value of independence, the intermediate domain is greater with 49.43%, the basic domain is lower with 58.24%, and the none domain is lower with 95.43%.

Table IX shows that both the advanced domain (61.66%) and the intermediate domain (51.97%) belong to generation Z. From the advanced domain, 28.43% are female and 33.23% are male.

TABLE IX
ANALYSIS OF DOMAINS PER GENERATION

Generation	Advanced Domain		Intermediate Domain	
	F	Fr	F	Fr
GX	26	0.0831	31	0.1354
GY	94	0.3003	79	0.3450
GZ	193	0.6166	119	0.5197
Total	313	1.00	229	1.00

To assess gender in relation to the cloud storage domain, it was established as h0: the cloud storage domain does not depend on gender and h1: in the cloud storage domain, at least one depends on gender. As the p-value is <0.05, the null hypothesis is rejected and the alternative hypothesis is accepted; therefore, in the cloud storage domain, at least one depends on the gender, see Table X.

TABLE X
ANALYSIS OF DOMAINS PER GENERATION

Gender		Advanced	Basic	Intermediate	None	Total
Female	FO	132	40	120	3	295
	FE	150.6	30.8	110.2	3.4	295.0
LGBTI	FO	0	0	1	0	1
	FE	.5	.1	.4	.0	1.0
Male	FO	181	24	108	4	317
	FE	161.9	33.1	118.4	3.6	317.0
Total	FO	313	64	229	7	613
	FE	313.0	64.0	229.0	7.0	613.0
Chi-square Test						13.36a
Asymptotic Significance (P-Value)						0.038

In regard to the analysis of the cloud storage domain per gender, it was evidenced that in the advanced domain the majority belongs to the male gender (57.83%), while in the intermediate domain 52.40% belongs to the female gender.

C. Digital Competence: Creating Presentations Online

The Chi-square analysis of this competence evidenced that the p-value is <0.05, the null hypothesis is rejected, and it is established that in the creating presentations online domain, at least one depends on the generation, see Table XI.

TABLE XI
GENERATION VS. ONLINE PRESENTATIONS

Generation		Advanced	Basic	Intermediate	None	Total
GX	FO	13	22	30	15	80
	FE	23.9	18.0	32.9	5.2	80.0
GY	FO	58	51	74	16	199
	FE	59.4	44.8	81.8	13.0	199.0
GZ	FO	112	65	148	9	334
	FE	99.7	75.2	137.3	21.8	334.0
Total	FO	183	138	252	40	613
	FE	183.0	138.0	252.0	40.0	613.0
Chi-square Test						37.995[a]
Asymptotic Significance (P-Value)						0.000

In the analysis of the correlational coefficient, the percentage values obtained in each of the domains reflect that the advanced domain exceeds 19.41% compared to the assumed value of independence, the intermediate domain is greater with 64.44%, the primary domain is lower with 9.95%, and finally, the none domain is lower with 73.90%. Regarding the advanced domain of university professors, 61.20% belong to generation Z (GZ) being 32.78% women and 28.42% men.

The gender relationship of the creating presentations online domain reveals that the p-value is> 0.05; therefore, the null hypothesis is rejected, and consequently, it can be determined that the presentation's online domain is gender independent, see Table XII.

TABLE XII
GENDER VS. CREATING PRESENTATIONS ONLINE

Gender		Advanced	Basic	Intermediate	None	Total
Female	FO	83	76	117	19	295
	FE	88.1	66.4	121.3	19.2	295.0
LGBTI	FO	0	0	1	0	1
	FE	.3	.2	.4	.1	1.0
Male	FO	100	62	134	21	317
	FE	94.6	71.4	130.3	20.7	317.0
Total	FO	183	138	252	40	613
	FE	183.0	138.0	252.0	40.0	613.0
Chi-square Test						4.904a
Asymptotic Significance (P-Value)						0.556

D. Digital Competence: Social Networks Interaction

Due to the fact, p-value in Table XIII was <0.05, the null hypothesis is rejected and the alternative hypothesis is accepted; in the social networks interaction domain, at least one depends on the generation.

TABLE XIII
GENERATION VS. SOCIAL NETWORKS INTERACTION

Generation		Advanced	Basic	Intermediate	None	Total
GX	FO	15	32	25	8	80
	FE	26.9	14.5	33.8	4.8	80.0
GY	FO	58	39	83	19	199
	FE	66.9	36.0	84.1	12.0	199.0
GZ	FO	133	40	151	10	334
	FE	112.2	60.5	141.1	20.2	334.0
Total	FO	206	111	259	37	613
	FE	206.0	111.0	259.0	37.0	613.0
Chi-square Test						52.890a
Asymptotic Significance (P-Value)						0.000

The percentage values obtained in the correlation coefficient of each domain reflect that the advanced domain exceeds 34.42% compared to the assumed value of independence, the intermediate domain is higher with 69%; the basic domain is lower with 27.57%, and the none domain is lower with 75.86%. As far as the advanced domain, 64.56% belong to Generation Z (GZ) from which 37.38% are male while 27.18% are female; regarding the intermediate domain, 58.30% belong to generation Z (GZ).

On the other hand, the relationship of gender with the social networks interaction domain was obtained as p-value <0.05, the null hypothesis is rejected, then the research hypothesis is accepted, which argues that in the social networks interaction domain, at least one depends on gender. (See Table XIV).

TABLE XIV
GENDER VS. SOCIAL NETWORKS INTERACTION

Gender		Advanced	Basic	Intermediate	None	Total
Female	FO	83	76	117	19	295
	FE	88.1	66.4	121.3	19.2	295.0
LGBTI	FO	0	0	1	0	1
	FE	0.3	0.2	0.4	0.1	1.0
Male	FO	100	62	134	21	317
	FE	94.6	71.4	130.3	20.7	317.0
Total	FO	183	138	252	40	613
	FE	183.0	138.0	252.0	40.0	613.0
Chi-square Test						24.033a
Asymptotic Significance (P-Value)						0.001

Regarding the advanced domain, it can be observed that 54.64% belong to the male gender, and in relation to the intermediate domain, 53.17% also belong to the male gender, see Table XV.

TABLE XV
ANALYSIS OF SOCIAL NETWORKS DOMAIN

Gender	Advanced Domain		Intermediate Domain	
	F	Fr	F	Fr
Female	83	0.4536	117	0.4643
LGBTI	0	0.0000	1	0.0040
Male	100	0.5464	134	0.5317
Total	183	1.00	252	1.00

E. Digital Competence: Troubleshooting Technical Issues

Due to the fact, the p-value is <0.05, the null hypothesis is rejected and the alternative hypothesis is accepted; therefore, it is established that in the domain of troubleshooting technical issues, at least one depends on the generation, see Table XVI.

TABLE XVI
GENERATION VS. TROUBLESHOOTING TECHNICAL ISSUES

Generation		Advanced	Basic	Intermediate	None	Total
GX	FO	34	12	32	2	80
	FE	40.7	5.7	32.6	.9	80.0
GY	FO	93	16	87	3	199
	FE	101.3	14.3	81.2	2.3	199.0
GZ	FO	185	16	131	2	334
	FE	170.0	24.0	136.2	3.8	334.0
Total	FO	312	44	250	7	613
	FE	312.0	44.0	250.0	7.0	613.0
Chi-square Test						46.207a
Asymptotic Significance (P-Value)						0.000

The results obtained from the correlational coefficient in each of the domains reflect that the advanced domain exceeds 103.59% compared to the assumed value of independence, the intermediate domain is greater with 63.13%, the basic domain is lower with 71.29%, and finally, the none domain is lower with 95.43%.

There are 62.99% of university professors belong to the generation at the advanced domain level, about the intermediate domain 55.13% belongs to generation Z. Concerning the gender relations and the troubleshooting technical issues domain, it was evidenced that it is gender independent because the p-value is> 0.05; therefore, the null hypothesis is not rejected. In regard to the advanced domain, 30.65% are female and 32.34% are male, see Table XVII.

TABLE XVII
GENDER VS. TROUBLESHOOTING TECHNICAL ISSUES

Gender		Advanced	Basic	Intermediate	None	Total
Female	FO	99	60	118	18	295
	FE	113.1	54.4	112.6	14.9	295.0
LGBTI	FO	1	0	0	0	1
	FE	.4	.2	.4	.1	1.0
Male	FO	135	53	116	13	317
	FE	121.5	58.4	121.0	16.0	317.0
Total	FO	235	113	234	31	613
	FE	235.0	113.0	234.0	31.0	613.0
Chi-square Test				7.620a		
Asymptotic Significance (P-Value)				0.267		

Table XVIII summarizes the relationship between the digital competence of university professors that make up the generation Z and gender.

TABLE XVIII
RELATION: DIGITAL COMPETENCE OF GENERATION Z AND GENDER

Digital Competence	Generation Z	
	Female Gender	Male Gender
Office 365	29.48%	29.81%
Cloud storage	28.43%	33.23%
Creating presentations online	32.78%	28.42%
Social networks interaction	27.18%	37.38%
Troubleshooting technical issues	30.65%	32.34%

The results show that the level of digital competences depends on the generation, having the generation Z the best digital capabilities, with an average of 61.94%. Concerning gender, the dependence is observed only with two out of five groups of competencies analyzed in this study: cloud storage and social networks interaction. These results partially agree with previous studies by [13] and [25] where they indicate that age and gender have an absolute incidence on the development of the teaching faculty digital competences.

In this study, gender at a statistical level is not as significant in the advanced domain, since the average digital competence in the male gender is 32.24% and 29.70% for the female gender; that is to say a difference of 2.54% in favor of men, an evidence related to the research findings done by [26]. Unlike other studies [27] and [28] which evidence a clear separation between men and women in all age groups, the level of men competence is indeed superior to women; similarly, other researchers present a different conclusion, the statistical difference in the relationship between gender and digital competence is greater in women [11], [29] and [30].

By specifying the domain in each of the digital competencies exposed in this work, it can be said that both men and women have the same level of competence in the Office 365 domain; regarding the domain of cloud storage, social networks interaction, and troubleshooting technical issues, men self-assess superiorly to women, which does not happen in the domain of creating presentations online, where the female gender is over-assessed in relation to men. It should be noted that the digital competence perception in gender is not very significant.

Likewise, the results obtained in this study corroborate the findings encountered in other works [31] and [32] where, age (generation) is a factor to be considered to establish differentiated training actions for educators; university professors with more than 53 years require a formal training process, carried out in the direct context of the teaching praxis for the development of techno-pedagogical knowledge in the effective use of ICT [33]. The more formal training teachers receive, the greater digital competence they will develop.

The university faculty that is the target population of this study, and at the same time makes up the generation Z generation, has better digital capabilities, with an average of 61.94%. In line with the results of [34] and [27], as the age of educators increases their level of digital competence decreases; hence, the young professors have a greater level of technological knowledge.

IV. CONCLUSIONS

As aforementioned, the results of this study do not reflect with certainty the relevance of generation for the development of digital competence. However, higher education institutions must take up the challenge of training and updating knowledge for educators, so that they develop digital competence in their students through a comprehensive training that allows them to function in the academic and professional field.

Finally, the research line of digital competences is very wide, the results should not be generalized or extrapolated without considering the characteristics of the educators and the context. The results of this research suggest the need to assess the teaching staff digital competencies, considering other types of demographic variables such as the level of training, the type of university, years and level of experience, discipline (area of knowledge), cultural context among others, in order to predict the nature of the use of digital technology in the teaching-learning process and plans a formal training adjusted to the requirements and needs of the university teacher.

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