Analysis of University Professors' Digital Teaching Competence

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Abstract:

Digital competence for teaching is the set of values, abilities, skills, and attitudes that allow the proper implementation of the teaching-learning process during online education. This study analyzed digital teaching competence in professors from two different university contexts concerning sociodemographic and academic variables in June 2021. This research had a quantitative approach, classified as non-experimental, analytical, and cross-sectional. The population comprised 79 professors from the Faculty of Health Sciences, National University of Chimborazo, Ecuador, as well as 35 from the Faculty of Educational Sciences, University of Granada, Spain. The data were collected using the Online Tutor Functions and Competencies Scale. There were statistically significant differences in the specific competence related to socialization activities regarding the university where the participants were teaching (p = 0.018) and experience as a professor (p = 0.028). Results of the global competence indicated significant differences according to the time of experience in teaching and preferred teaching modality. A significant association was established between the variables related to academic components and the global competence for digital teaching. The R^2 values indicated a low level of goodness of fit, with a higher percentage favoring the forecast level. The preferred teaching modality had a significant predictability value, but its odds ratio showed that it did not condition the state of global competence for digital teaching. The study innovated using binary logistic regression to analyze the predictive capacity of specific dimensions regarding digital competence in higher education settings.

Keywords: digital competence, higher education, digital teaching.

高校教授数字化教学能力分析

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摘要：

数字教学能力是一套价值观、能力、技能和态度，可以在在线教育中正确实施教学过程。本研究分析了 2021 年 6 月来自两所不同大学背景的教授在社会人口学和学术变量方面的数字教学能力。本研究采用定量方法，分为非实验性、分析性和横断面研究。人口包括来自厄瓜多尔钦博拉索国立大学健康科学学院的 79 名教授，以及来自西班牙格拉纳达大学教育科学学院的 35 名教授。数据是使用在线教师功能和能力量表收集的。与参与者教学的大学（p = 0.018）和作为教授的经验（p = 0.028）有关的社会化活动相关的特定能力存在统计学上的显着差异。全球能力的结果表明，根据教学经验的时间和首选的教学方式，存在显着差异。在与学术组成部分相关的变量与数字教学的全球能力之间建立了显着的关联。R2 值表明拟合优度较低，较高的百分比有利于预测水平。首选的教学模式具有显着的可预测性价值，但其比值比表明它并未影响数字教学的全球能力状况。该研究创新地使用二元逻辑回归来分析高等教育环境中有关数字能力的特定维度的预测能力。

关键词： 数字能力，高等教育，数字教学。

1. Introduction

Information and communication technologies (ICTs) have become valuable pedagogical resources. These generate innovative educational scenarios increasingly accessible to the entire population, challenging socioeconomic barriers by making knowledge available to everyone with technology and internet connection (Al-Shaher, 2019). Indeed, new didactic challenges arise in professor-student interaction, which requires the preparation of actors and environments of the teaching-learning process to achieve efficiency (Roque-Herrera et al., 2022; Levano et al., 2019).

The use of ICTs in academic environments had a gradual and natural evolution to the extent that society incorporated and massified these resources. The pandemic produced by Covid-19 was a catalyst for this phenomenon since its use was required to maintain the school activity at all levels without violating social isolation measures (Mukh & Tarteer, 2021). Thus, professors and students were forced to accelerate the formation of digital skills to develop the teaching-learning process (Rodríguez-Martínez, 2021; Díaz & Loyola, 2021).

Cateriano-Chávez et al. (2021) synthesize the concept of digital competence for teaching as the set of values, abilities, skills, and attitudes that allow the proper use of ICTs during the creation of teaching-learning scenarios, methodological resources, and didactic means to build general, cultural, technical, and professional knowledge to solve problems through research and innovation.

Rodríguez-Martínez (2021) mentions that the digital gaps that impose the differences in the technological development of countries and regions affect the massive implementation of online education.

Perdomo et al. (2020) highlight the importance of training university professors to form skills and abilities for digital teaching. In this regard, Rambay-Tobar and De La Cruz-Lozado (2021) established seven digital teaching competencies:

• Planning and designing learning activities in these academic environments;

• Developing and conducting collaborative learning activities;

• Orienting, guiding, and evaluating the processes of construction and restructuring of knowledge;

• Managing knowledge, promoting professional development and student autonomy;

• Generating research and pedagogical innovation for teaching efficiency in online environments;

• Using ICTs technically and ethically during professional teaching performance;

• Adapting online teaching environments to protect health, guaranteeing job security.

Jenaro-Río et al. (2013) explained that digital teaching is appropriate for using various teaching methodologies. Every pedagogical model that an educational institution assumes must include the alternative or unique use of this modality and the use of its potential, requiring the training of professors for efficient implementation. The digital tutor accompanies, guides, evaluates, and supports students, who become protagonists of their learning from principles of autonomy and independence.

During the Covid-19 pandemic, in the contexts investigated, the distance training model was assumed to require specific skills in teachers for managing ICTs for training purposes. The researchers analyzed the dimensions inherent to digital teaching competence, as well as the predictive capacity of these in this regard, which would offer a deep diagnosis for the taking of effective measures by the academic authorities for improving the teaching-learning process.

Thus, this study was conducted to analyze professors' digital teaching competence in two different university contexts concerning sociodemographic and academic variables.

2. Materials and Methods

The research was conducted with a quantitative approach, classified as non-experimental, analytical, and cross-sectional. Seventy-nine professors from the Faculty of Health Sciences, National University of Chimborazo (UNACH), Ecuador, and thirty-five from the Faculty of Educational Sciences, University of Granada (UGR), Spain, constituted the population of the study. The research was developed by applying instruments online through the Google Forms program

in June 2021.

The investigation was carried out in the following stages:

1. The establishment of collaboration agreements between research groups from the UGR and UNACH, regarding a common problem;

2. Planning of the research process and approval of the corresponding project;

3. The selection of participants;

4. Application of the data collection instrument;

5. The creation of a database, using the SPSS Software (Version 23);

6. Data processing using descriptive and inferential statistics;

7. Analysis of the results and generation of the final report.

The data collection was performed through the Scale of Functions and Competencies of the Online Tutor by Aznar-Díaz et al. (2019), who validated it using the expert criteria technique, as well as they obtained an acceptable internal consistency (α = 0.719). This instrument measures the state of the four dimensions that comprise it through 20 items, using the following Likert scale: always (4), frequently (3), sometimes (2), and never (1). The instrument was complemented with a general information section that enabled it to characterize the population better and conduct the corresponding analysis regarding general and specific competencies.

The possible score ranges between the values of 20 and 80. Those individuals with a global score greater than 59 points are classified as competent for developing teaching in the digital modality. The evaluation of the specific competencies was carried out as follows:

• Presentation and start of the course (Items 1-3), how the professor fulfills the tasks and activities that should be done at the beginning of the academic period (requires a minimum of 9 points to be considered achieved).

• Contents and support materials (Items 4-9), level of updating and mastery of the knowledge systems to be imparted, and the preparation of the appropriate didactic materials (it should reach at least 18 points to be considered acquired).

• Socialization activities (Items 10-13), teaching effectiveness in communication, and managing group academic work (requires a score greater than 11 to be considered present).

• Attention to students (Items 14-20), the attitude of the professor towards the individual and collective needs of the students (a minimum of 21 points to have it).

The data were organized and processed using the IBM SPSS Statistic Software Version 26. The study's object was characterized through frequency analysis tests (relative and absolute) and other central tendency tests.

The explanatory analysis of binary regression to establish the factors that affect competence in online teaching required the use of inferential tests: chi-square (to establish the association between the variables), Cox and Snell's R^2 and Nagelkerke's R^2 (as indicators of goodness of fit), and odds ratio (to determine the measure of the probability in which a factor could modify a variable).

Global and specific competencies were compared using non-parametric tests for unrelated samples: the Mann–Whitney U and the Kruskal-Wallis H, considering variables related to training and teaching experience of interest for the study.

Logistic regression analysis consists of obtaining a linear function of the independent variables that allows individuals to be classified into one of the two levels or groups established by the two values of the dependent variable (Sagaró Del Campo & Zamora Matamoros, 2019).

The participating professors were communicated about the elements related to the research process during the signing procedure of the informed consent, ensuring that none of them qualified as a vulnerable population: disabled, minors, or pregnant women, among others. The results were used exclusively for research and academic purposes and respecting the confidentiality clause.

The study was endorsed by the Research Directorate of the National University of Chimborazo through Resolution 138-CIV-7-7-2021, which approved the execution and financing of the institutional research project.

3. Findings

The data on the age ranges of the participants showed that 43% were between 25 and 39 years of age, 50.9% were between 40 and 59, and those older than 59 were 6.1%. Those who declared full-time dedication to teaching (66.7%) predominated in the study.

Table 1. Comparison between the categories of competencies according to variables of interest due to their relationship with teaching (Developed by the authors)

Grouping Variable	Statistical	Competencies				
		Global	Presentation and start	Content and materials	Socializing activities	Attention to students
University where they teach	Mann–Whitney U	1122.000	1343.000	1382.500	1123.000	1373.500
	p-value	0.061	0.133	1.000	0.018*	0.886
Teaching experience	Kruskal–Wallis H	12.704	2.563	0.000	9.070	2.212
	p-value	0.005*	0.464	1.000	0.028*	0.529
Preferred teaching modality	Kruskal–Wallis H	14.806	0.676	0.000	1.857	4.247
	p-value	0.001*	0.713	1.000	0.395	0.120
Digital training course	Mann–Whitney U	959.000	1001.000	1012.000	936.000	946.000

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	Continuation of Table 1					
	p-value	0.655	0.625	1.000	0.398	0.220
Experience in online teaching	Mann–Whitney U	1287.000	1443.000	1462.500	1434.000	1459.500
	Next	0.219	0.471	1.000	0.792	0.963

* Statistical significance

The results of the Mann–Whitney test made it possible to establish statistically significant differences in the specific competencies related to socialization activities in terms of the university where the participants taught (U = 1123.000; p = 0.018). Whereas the application of the Kruskal-Wallis statistic showed significant differences (p < 0.05) in global competence when grouped according to the time of experience in teaching work and the preferred teaching modality, as well as in the specific competence referring to socialization activities, grouped according to experience as a professor (H = 9.07; p = 0.028). In the other variables, no significant differences (*p* > 0.05) were observed between the groups (Table 1).

Table 2. Frequency distribution of competence according to grouping variables where significant differences were observed (Developed by the authors)

Grouping variable	Scale	Competition				Total	
		No		Yes			
		f	%	f	%	f	%
Socializing activities							
Academic environment	UNACH	8	10.13	71	89.87	79	100.00
	UGR	11	31.43	24	68.57	35	100.00
Teaching experience	1-5	6	12.50	42	87.50	48	100.00
	6-10	--	--	18	100.00	18	100.00

	Continuation of Table 2					
	11-20	10	31.25	22	68.75	32	100.00
	> 20	3	18.75	13	81.25	16	100.00
Global							
Preferred teaching modality	Face-to-face	38	55.88	30	44.12	68	100.00
	Blended	7	19.44	29	80.56	36	100.00
	Online	2	20.00	8	80.00	10	100.00
Teaching experience	1-5	20	41.67	28	58.33	48	100.00
	6-10	1	5.56	17	94.44	18	100.00
	11-20	17	53.13	15	46.87	32	100.00
	> 20	9	56.25	7	43.75	16	100.00

At the National University of Chimborazo, there was a higher percentage of those who reached a score that indicated they had the competence to develop activities that involve socialization during the online teaching modality (89.87%). Regarding the time of experience as a university professor, the highest frequency was shown among those who achieved global competencies (94.44%) and socialization activities (100%), who had 6-10 years of performance in that function. Among the respondents who stated that they preferred the face-to-face modality, only 10 teachers out of 114 participants (Table 2) did not qualify with global competence predominated, noting that the online teaching modality was the least indicated as a favorite.

Table 3. Binary logistic regression analysis criteria summary (Developed by the authors)

DV: GC	X^2	df	*p*-value	-2 Log-likelihood	Cox and Snell R Square	Nagelkerke R Square	Forecast	
							Yes	No
Values	30.16	17	0.025	124.351[a]	0.232	0.313	79.1	63.8

Notes: GC - global competence in digital teaching; df - degrees of freedom; DV - dependent variable; X^2 - chi-square

The chi-square test (X^2 = 30.16; *p* < 0.05) showed statistical significance regarding the general association of variables related to academic components concerning the global competence for teaching in the digital modality. The values of Cox and Snell R Square (0.232) and Nagelkerke R Square (0.313) showed indicators of a low level of goodness of fit; however, the highest percentage was established in favor of the forecast level of the subsequent detailed analysis (79.1%). Therefore, the processing was performed for each independent variable (Table 3).

Table 4. Predictability by independent variables established by binary logistic regression (Developed by the authors)

Independent variables	B	*p*-value	Exp (B) = odds ratio	95%. CI. for EXP(B)	
				Lower	Higher
Preferred teaching modality	-0.383	0.037*	0.092	0.010	0.870
Teaching time	1.098	0.090	2.998	0.844	10.652
Teaching category	-19.68	1.000	0.000	0.000	0.000
Teaching knowledge area	-1.776	0.299	0.169	0.006	4.482
Experience in online teaching	-0.614	0.240	0.541	0.194	1.509
Course on digital training	0.228	0.725	1.256	0.353	4.466
Problems when teaching online	0.425	0.441	0.654	0.222	1.927
University where they practice	1.101	0.538	3.006	0.091	99.579

Notes: B - beta; EXP(B) - exponential beta-odds ratio; CI - confidence interval

The only independent variable that showed statistical significance in its predictability value concerning the dependent variable was the preferred teaching modality (*p* = 0.037). However, the odds ratio value (0.092) indicated that this was not a conditioning factor for the state of global competence for digital teaching in the investigated context. The values of the remaining dimensions did not show statistical significance (p > 0.05) in the context (Table 4).

4. Discussion

Pozos-Pérez and Tejada-Fernández (2018) found

that modern teaching requires university professors with solid digital pedagogical training.

López Gaibor (2018) stated the presence of insufficiencies related to digital skills in Ecuadorian professors, who had to assume the training process of students who use online technology naturally.

Coincidentally with the results observed in this study, Cateriano-Chávez et al. (2021) found the most significant weaknesses in interaction and educational relationship skills, reporting difficulties in more than 50% of the professors in their population. Similarly, Romero-Azuero et al. (2022) showed that the quality of the pedagogical practice depends on digital competencies related to cooperative work ($X^2 = 246$; $p < 0.05$).

Among the participating professors, the group with a teaching experience between 6 and 10 years presented the highest frequency of members with digital competencies. In this regard, Valdivieso-Guerrero and González-Galán (2016) mentioned that the generations of professors who grew up during the development and use of new technologies with a time of academic exercise that guarantees the formation of pedagogical skills have greater probabilities of better performance in digital teaching.

Ruiz-Ramirez et al. (2020) established that training programs could not be carried out for professors to assume the online teaching modality due to the sudden way in which the epidemiological situation due to COVID-19 worsened. Thus, professors were forced to adapt their teaching methodology and develop self-training strategies that significantly increased their digital competencies, reaching levels very similar to those who had received training in using ICTs for educational purposes.

In this study, there were only significant differences in competence for online teaching according to the preferred teaching modality and experience as a professor. However, a comparison report between professors from Europe, Chile, and Colombia showed significant differences between the groups according to communication and collaboration, problem-solving, professional commitment, and digital resources, among others (Cabero-Almenara et al., 2020).

On the other hand, Portillo et al. (2020) determined statistical significance between the competence for online teaching with the educational institution of origin of the professor ($p = 0.004$); as well as the competence for online teaching with training in the use of digital technology and age ($p < 0.001$).

In the study, it was found that previous training did not constitute an element with a predictive capacity concerning the state of competence for online teaching; however, Rojas Flores et al. (2018) observed a significant improvement in these skills in professors who received a digital literacy module, obtaining a chi-square value of 12.19, which was higher than the critical value ($X^2 = 3.84$).

Regarding the presence of variables with significant forecast value about the competence for digital teaching, Guillén-Gámez et al. (2022) reported results very similar to those obtained in this research; however, these authors got a $p = 0.443$ value of X^2 that indicated a lack of global association. The contexts' particularities and the professors' individualities make it challenging to establish variables with the corresponding collective predictive statistical potential.

Cabero-Almenara et al. (2022) analyzed the predictive capacity of different variables on the level of digital competence, obtaining values very similar to those observed in this investigation (Nagelkerke = 0.374) and the Cox and Snell coefficient (0.266), which allowed them to infer that their model explained between 26% and 37% of the variability. Hämäläinen et al. (2021) mentioned that teacher training could positively influence the acquisition and development of digital competence.

Other researchers address the possible influence of sociodemographic variables such as age and gender on teacher digital competence, reporting that the youngest tend to have more extraordinary computer skills, although, with a low value of the Nagelkerke coefficient (0.13) (Hinojo-Lucena et al., 2019; Roussinos & Jimoyiannis, 2019).

5. Conclusion

The comparison of the results of the global competence indicated the existence of statistically significant differences when grouping according to the time of experience in teaching work and the preferred teaching modality. A similar situation was established concerning the specific competence for developing socialization activities in the university where each participating professor worked and the time of experience as a professor.

Although the chi-square test allowed establishing a significant association of the set of variables related to academic components for the global competence for teaching in the digital modality, the values of Cox and Snell R Square and Nagelkerke R Square indicated a low level of goodness of fit, with a higher percentage in favor of the forecast level of the subsequent detailed analysis.

The preferred teaching modality was the only independent variable with a statistically significant predictability value. However, its odds ratio figure indicated that it was not a conditioning factor for global competence in digital teaching in this higher education environment under study.

The results generated the necessary data for the design of teacher improvement plans aimed at developing digital competence, in addition to laying the foundations for undergraduate and postgraduate curricular studies in pedagogical and didactic training.

6. Limitations and Further Study

The research had limited diversification of the study population regarding the training scenario from which the participants came. Additionally, there was an

essential difference in the sample size of the UNACH concerning the UGR. It is not feasible to generalize the results to other higher education contexts because it is a multidimensional phenomenon.

Acknowledgments

Authors' Contributions

Conceptualization, Y.R.-H. and S.A.-G.; methodology, G.P.-G. and M.C.-L.; formal analysis, Y.R.-H., S.A.-G, G.P.-G., M.C.-L and D.T.-L.; investigation, Y.R.-H., S.A.-G, G.P.-G., M.C.-L; writing—original draft preparation, Y.R.-H.; writing—review and editing, D.T.-L.; supervision, Y.R.-H. All authors have read and agreed to the published version of the manuscript.

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