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Didactic Use of Virtual Reality in Colombian Universities: Professors' Perspective

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Abstract: This paper presents quantitative research on the perception of the didactic use of virtual reality by university professors in Colombia, with special attention to the differences according to their area of knowledge, as the main variable, and gender and digital generation, as secondary variables. The study involved 204 professors from different Colombian universities. As an instrument, a survey designed for this purpose was used with four scales that were used to measure, on a Likert scale, different dimensions involving the participants' perception of the use of virtual reality in the classroom. The answers were analyzed statistically and the differences in the perceptions have been identified by means of parametric statistical tests according to the following: (i) area of knowledge, (ii) gender, (iii) digital generation of the participants. The results showed that the participants expressed high valuations of virtual reality, despite having intermediate or low levels of digital competence. Gaps were identified in terms of area of knowledge, gender, and digital generation (digital natives or immigrants) with respect to opinions of virtual reality and digital competence. The highest valuations of virtual reality are given by professors of Humanities, and by digital natives. It is suggested that Colombian universities implement training plans on digital competence for professors and that these plans be aimed at strengthening knowledge of virtual reality.

Keywords: virtual environments; learning; didactic use; educational technologies; Colombia

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1. Introduction

Virtual reality (VR) is a set of computer technologies that allow the creation of interactive sensory experiences in the user, based on the three-dimensional simulation of real environments [1]. VR has proven to have multiple applications in very diverse areas of knowledge, including engineering [2], psychology and medicine [3,4], experimental sciences [5], social sciences [6] and the study of art [7]. VR has also been shown to be an effective didactic resource for teaching different areas of knowledge at all educational levels, especially in higher education [8]. In fact, in recent years, there has been an increasing number of publications in the field of higher education that propose VR technologies as a resource that increases student motivation and involvement in the classroom, and enhances academic performance and the meaningfulness of learning, due to the realistic and interactive experience of learning that it generates in students [9–12]. Regarding the didactic use of VR in higher education, there is currently a powerful line of research that studies the opinions of students about their learning experiences through VR, or the assessments that teachers make of these types of technologies applied to training. Some studies show, for example, that professors of Health Sciences and Engineering give high valuations of VR as a teaching resource, but there are significant gaps in these assessments according to academic level, age, or experience of the participants [13,14].

In Colombia, which is precisely the field in which this study is developed, there is evidence of applications, based on VR for training purposes both at the university teaching level and at the level of training in professional subjects, since 2004, when VR was introduced [15]. Thus, some examples of the use of VR in Colombia are focused on the field of Engineering [16–20], others in the fields of Health Sciences [21–26], marketing and journalism [26–29], biology [30–33], and education [34–38], and there are even examples in the military field [39] or in Physical Education [40]. Given the experience accumulated by Colombian universities in the use of VR in the classroom, it is possible to conduct an exploratory study of the perceptions of professors in this regard. In addition, Colombia is a country with an intermediate level of digitalization within its geographical area, which makes it a representative country, in terms of digital development, of a large part of the countries in its area.

To measure Colombia's digital development, the Global Innovation Index (GII) has been used, which is an index that evaluates on a scale of 0 to 100 the economic and innovative power of 130 countries around the world, using, as key criteria, the strength of their technological and digital development [41,42]. The GII distinguishes seven geographical areas in the world, within each of which there is a certain homogeneity in terms of the digital and technological level of the member countries. Thus, the Latin American and Caribbean area has intermediate levels of technological development, since it is behind Europe and North America in the GII, but ahead of East and Southeast Asia, South Asia, North Africa, and Sub-Saharan Africa [41]. The 2021 GII data [41], which are the first to consider the impact of the COVID-19 pandemic on country development, indicate that the GII declines relative to 2020 [43] in all Latin American and Caribbean countries except Brazil and, very slightly, El Salvador (Table 1). In this sense, the variation rates indicate that Colombia is, together with Paraguay, the country in which digital and technological development has suffered the least among all the countries in the Latin American region that have seen their GII decrease. The data in Table 1 also show that Colombia is representative of the countries in the region that have an intermediate-high level of development. In fact, the average GII in Latin America and the Caribbean is 29.22, with a standard deviation of 4.45. If the intermediate-high values are taken as the indices that oscillate between the mean (29.22) and the sum of the mean plus the standard deviation (33.67), it turns out that Colombia's GII is in the median of this interval. Consequently, Colombia has a medium GII index within the countries with an intermediate-high level of technological and digital development within the states in its area.

Table 1. GII indices for Latin American and Caribbean countries in 2021 and 2020 (ordered by GII of 2021) and annual variation rates for 2021 with respect to 2020.

Country	GII 2021	GII 2020	Variation Rate (%)
Chile	36.10	36.64	−4.20
Mexico	34.50	36.06	−4.33
Costa Rica	34.50	36.13	−4.51
Brazil	34.20	33.82	1.12
Uruguay	32.20	34.32	−6.18
Colombia	**31.70**	**33.00**	**−3.94**
Peru	31.20	32.93	−5.25
Argentina	29.80	31.95	−6.73
Panama	28.00	31.51	−11.14
Paraguay	26.40	27.09	−2.55
Ecuador	25.40	26.56	−4.37
El Salvador	25.00	24.89	0.44
Guatemala	24.10	25.07	−3.87
Bolivia	23.40	24.76	−5.49
Honduras	22.80	25.48	−10.52

Numerous studies show that the digital generation is a strongly influential variable in digital competence or in the perception, or frequency of use, of digital resources among professors [44,45]. According to Prensky's theory [46,47], two main generations can be distinguished, in terms of degree of connection with digital technologies (Figure 1): (i) digital natives and (ii) digital immigrants. Digital natives are those who were born and raised in a digitalized environment, so that computational media are routine for them, as if they were their mother tongue, in Prensky's terms [46]. Digital immigrants, on the other hand, have not grown up linked to digital technologies, but have been incorporated into them, so that they have learned them, as one learns a second language. Prensky identifies a chronological distinction between the two generations, so that those born before 1980 would be digital immigrants and those born after 1980 are digital natives. There may be sociological and cultural aspects that condition the digital generation of individuals beyond the year of birth. For example, a person born after 1980 could be considered a digital immigrant if, having grown up in a depressed or rural area, in terms of access to technological resources, he or she was deprived of the regular use of digital media during his or her youth. However, many studies consider 1980 to be the objective chronological boundary between digital immigrants and digital natives [48–53].

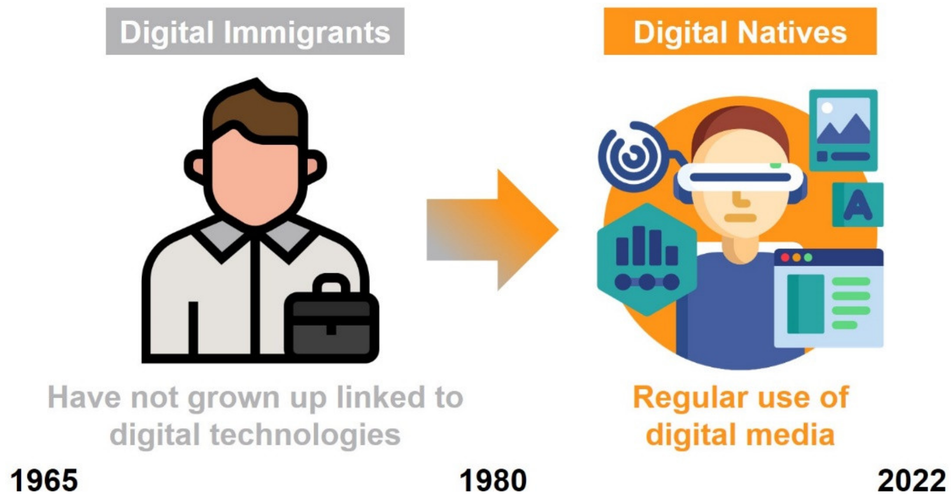

Figure 1. Main generations in terms of the degree of connection with digital technologies.

This criterion is also assumed in this work, given that, as the research was carried out among a population of university professors, it is possible to assume that their social and economic environment is of intermediate or high level and, consequently, there are no reasons to think that there are socio-cultural circumstances, such as those mentioned, that alter the chronological criterion that distinguishes the digital generations defined.

For more than 20 years, the need for the incorporation of virtual modalities in higher education has been raised in Colombia. La Rota [54] described a series of advantages of virtual university education and proposed a Virtual University project that sought to reduce inequality gaps in Colombia. The importance of digitalization in the transition from face-to-face to virtual scenarios has implied an enormous challenge for Colombian universities, especially during and after the COVID pandemic. Considering that, by 2020, Colombia had only 11% of higher education programs in virtual or distance mode, according to the latest statistics published by the National System of Higher Education Information—SNIES 2020 [55], it is evident that there is a need to strengthen the incorporation of digital environments in all the mission areas of universities (teaching, research, and extension). One of the scenarios where this transition has been most relevant is in internationalization processes. The drastic reduction in the mobility of students and professors has generated a high impact on research and teaching, which has been addressed with the incorporation of virtual tools and digitalization, resulting in the so-called "internationalization at home" [56]. This has the advantage of generating a greater democratization of higher education, given that the international focus and dimension can cover a much larger proportion of students and professors, in addition to reduction of the brain drain [57], through digitalization and the use of technological tools [56]. On the other hand, the analysis carried out by Pérez [58] showed great shortcomings and needs regarding digitalization in the formative processes of higher education in Colombia, concluding that the coverage of technological infrastructure must be expanded, since it is one of the main barriers to facilitating access of students in different parts of the country, in addition to strengthening technological competencies in professors.

Given the wide transcendence that VR applications are currently having in different areas of knowledge, this study aims to know and analyze the opinions of university professors in Colombia in relation to this technology, distinguishing opinions according to different variables: (i) area of knowledge; (ii) gender; and (iii) digital generation. In this way, the results obtained could help to identify the weaknesses and strengths of Colombian professors according to these variables in order to establish specific training lines.

2. Materials and Methods

2.1. Participants

The study involved 204 university professors from Colombia, who were chosen through a non-probabilistic convenience sampling process. They were contacted by e-mail to ask them to answer a GoogleForms^{TM} survey, which has been used as a research instrument. Previously, the professors participated in training in VR technologies and their didactic use in higher education, so it can be assumed that the participants had a homogeneous theoretical knowledge about the main concepts they were asked about in the survey. All participants answered the survey, and all answers were validated.

2.2. Objectives and Variables

The general objective of this research was to study the perception that university professors in Colombia have about the didactic employability of VR technologies and the differences that exist, with respect to this perception, according to the professors' areas of knowledge. In particular, the following specific objectives were pursued: (i) to analyze the perception of Colombian university professors about their digital competence and their assessment of VR from technical and didactic points of view and of the disadvantages of its use; (ii) to identify gaps in the above perceptions by reason of the professors' area of knowledge; and (iii) to study the influence of the professors' gender, and their digital generation, on their perception of the didactic employability of VR technologies.

The following dependent variables were considered in the study (Figure 2): (i) self-concept of participants' competence in the use of digital and virtual technologies; (ii) assessment of the technical aspects of VR; (iii) perception of the level of drawbacks of VR for its employability in university classrooms; (iv) perceived didactic and academic benefits of using VR. All the dependent variables were considered quantitative variables and measured on a Likert-type scale from 1 to 5, where 1 means the lowest valuation and 5 means the highest valuation. The dependent variables were selected to cover the perception of the different aspects involved in the didactic use of VR in higher education, following the line of other previous works in this regard [13,14].

The following independent variables, which affect the sociological and academic profile of the participants, are also considered: (i) area of knowledge; (ii) gender; and (iii) digital generation. The area of knowledge is taken as the main independent variable. The variables of gender and digital generation are dichotomous, while the area of knowledge is polytomous. The different areas of knowledge have been extracted from the International Standard Classification of Education (ISCED), which is the classification established by the United Nations Educational, Scientific and Cultural Organization (UNESCO) [59]. In this classification, the area of Education has been integrated within the area of Social and Legal Sciences, and the area of Health within the area of Health Sciences. Thus, the following areas of knowledge are distinguished: (i) Arts and Humanities (specifically, philosophy, philology, literature, history and art; hereafter, Humanities); (ii) Pure and Health Sciences (specifically, mathematics, physics, chemistry, natural sciences and medicine; hereafter, Science); (iii) Social and Legal Sciences (specifically, sociology, geography, law, political science, economics, communication, pedagogy and psychology; hereafter, Social Sciences); and (iv) Engineering and Architecture (which covers the different specialties of technical education; hereafter, Engineering).

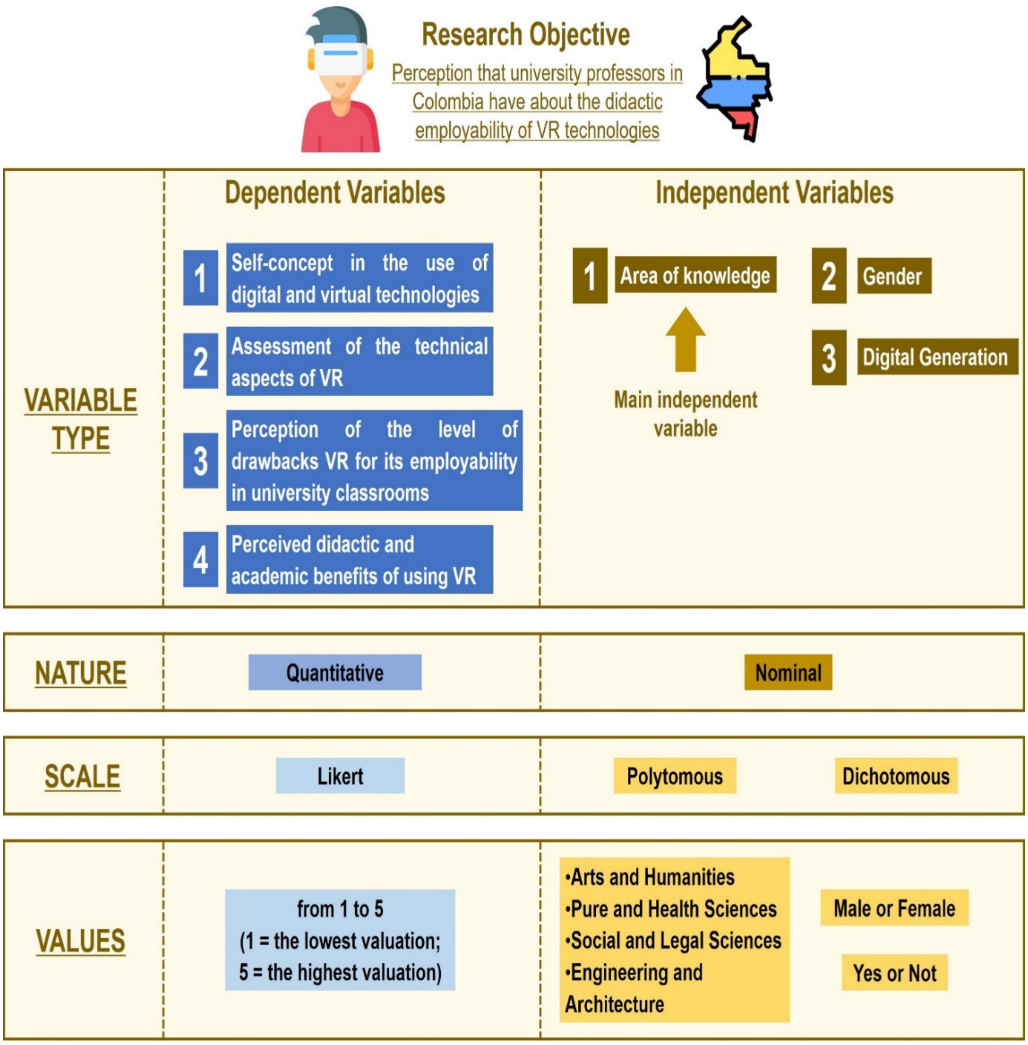

Figure 2. Variables considered in this study.

2.3. Instrument

To measure the values of the dependent variables, a 17-question survey was used which asked the participant to assess each of the aspects of VR mentioned in the definition of the dependent variables (Table 2). The survey was adapted for the purposes of this research from the instrument developed in [14]. The adaptation was done without questions involving the distinction between immersive VR and non-immersive VR, or perspectives on the future use of VR technologies; aspects that are not the subject of the present study. The questions in the survey were distributed in the following subscales, each one corresponding to one dependent variable: (i) self-concept of digital competence (questions 1 to 3); (ii) rating of the technical aspects of VR (questions 4 to 10); (iii) perception of the drawbacks of VR (questions 11 to 13); and (iv) valuation of the didactic benefits of VR (questions 14 to 17). All assessments were measured on a Likert-type scale from 1 to 5, where 1 corresponds to the lowest assessment and 5 to the highest. For the questions on VR drawbacks, the lowest valuation indicates that the participant does not identify any drawbacks, while the highest valuation indicates that many drawbacks are observed with respect to the VR feature that is the subject of the corresponding question.

Table 2. Subscales and questions of the survey.

Subscales	Question
Perception of digital competence	Level of knowledge about VR VR training received at your institution Assessment of your digital skills
Assessment of the technical aspects of VR	3D Design User experience Usability Immersion degree Interaction Realism Didactic employability
Disadvantages of VR	Costs Space Faculty training
Didactic usefulness of VR	Increased student attention Improvement in the progress of the subject Increased motivation Increased academic performance

2.4. Procedure

This paper reports a quantitative descriptive research based on the data extracted from the answers to a self-designed survey on the use of VR technologies in university classrooms in Colombia. After an initial training session, that served to clarify and homogenize concepts about VR among the participants, they responded to the survey that was sent to them by e-mail. All the answers provided by the participants were validated because all the participants gave complete answers.

The statistics of the Confirmatory Factor Analysis (CFA) were used to validate the instrument and the definition of the subscales, according to the different dependent variables under consideration. Validation of the instrument's consistency was carried out using Cronbach's alpha and composite reliability (CR) parameters, which were computed for each subscale of the survey. Convergent validity was obtained from the average variance extracted (AVE) and an analysis of the Pearson correlations of the different subscales with each other and between each of them with the global scale.

The analysis of the results obtained was carried out through the descriptive statistics of the answers. Finally, to identify gaps in the perceptions measured when the participants were distinguished by the different values of the independent variables, the ANOVA test was used for the knowledge area variable, which is the main variable of the study, and the multifactor ANOVA test (MANOVA) when the answers within each knowledge area were differentiated by the values of the rest of the independent variables. The mean comparison tests were performed with Welch's correction without assuming equality of variances. For comparison of the standard deviations of the answers when the participants were differentiated by areas of knowledge, Levene's test statistics were computed. All tests were carried out with a statistical significance level of 0.05.

3. Results

3.1. Sample of Participants

As can be seen in Table 3, most of the professors are specialists in Engineering or Social Sciences, with Humanities being the least frequent in the distribution of participants. Males are slightly more frequent than females overall (51.96% vs. 48.04%), although females are more frequent than males in the Science area. By digital generation, digital natives are slightly more frequent than digital immigrants (53.92% vs. 46.08%). In all areas there are more digital native professors than digital immigrants; except in Science, where the proportion of digital immigrants is higher than that of natives.

Table 3. Percentage distributions of participants by areas of knowledge and differentiating by the values of the other independent variables.

		Humanities	Science	Soc. Sci.	Engineering
Area of knowledge		12.8%	22.5%	31.4%	33.3%
Gender	Female	46.2%	73.9%	43.8%	35.3%
	Male	53.8%	26.1%	56.2%	64.7%
Digital generation	Immigrant	38.5%	60.9%	46.9%	38.2%
	Native	61.5%	39.1%	53.1%	61.8%

3.2. Validation of the Instrument

In Table 4 it is shown that the definition of the subscales that was carried out explained a total of 58.50% of the variance. These subscales correspond to the dependent variables under study: (i) perception of one's own digital competence (questions 1 to 3); (ii) assessment of the technical aspects of VR (questions 4 to 10); (iii) disadvantages of using VR technologies (questions 11 to 13); (iv) assessment of the didactic benefits of VR in higher education (questions 14 to 17). The CFA indices support the definition made for the subscales (chi-square = 207.3637 with a p-value = 0.0000). The incremental fit indices are adequate (AGFI = 0.7986; NFI = 0.7942; TLI = 0.9697; CFI = 0.8918; IFI = 0.8945) and the absolute fit indices also indicate that the model is acceptable (GFI = 0.8226; RMSEA = 0.0909; AIC = 287.3637; chi-square/df = 1.8351).

Table 4. Proportions of the variance explained by the defined subscales.

	Digital Competence	Technical Aspects	Disadvantages	Didactic Usefulness
Proportion Variance	0.087	0.241	0.092	0.165
Cumulative Variance	0.087	0.328	0.420	0.585

The composite reliability parameters and Cronbach's alphas (Table 5) assume that the defined instrument has high levels of internal consistency, since all parameters exceeded 0.7. Likewise, all the AVE statistics exceeded 0.5, which confirm convergent validity. Finally, from the Pearson correlation coefficients (Table 6) it follows that the different subscales of the survey were weakly correlated, but the correlation between each subscale and the global scale was moderate or high. All correlations were statistically significant.

Table 5. Cronbach's alpha, CR and AVE parameters.

Subscale	CR	Cronbach's Alpha	AVE
Digital competence (DC)	0.6986	0.7063	0.5712
Assessment of technical aspects (TA)	0.8903	0.9078	0.6947
Disadvantages of VR (D)	0.7232	0.7290	0.6129
Didactic usefulness of VR (DU)	0.8741	0.8792	0.6657

Table 6. Pearson correlations between the subscales and with the global scale.

	DC	TA	D	DU	Global
DC	1	0.0781	−0.0010	0.0691	0.6789
TA		1	0.2262	0.4131	0.8926
D			1	0.0511	0.7022
DU				1	0.7627
Global					1

3.3. Analysis of the Answers

The mean valuation of VR by the participants was high, both in its technical and didactic aspects (Table 7). These valuations were given with smaller deviations than the rest of the subscales, which proved that the responses were more homogeneous than those given to digital competence and to disadvantages of VR. However, the perception of the disadvantages was intermediate-high, which means that professors found limitations in the didactic employability of these technologies, despite the benefits they recognized. In this respect, the deviation was higher, so the answers were more disparate. The participants also expressed having intermediate levels of digital competence, although the perceptions were, in this sense, heterogeneous among the surveyed population, given the high standard deviation.

Table 7. Overall descriptive statistics (out of 5) of the answers to the survey.

Subscale	Mean	Standard Deviation
Digital competence	2.68	1.19
Assessment of technical aspects	4.17	0.95
Disadvantages of VR	3.44	1.25
Didactic usefulness of VR	4.19	0.92

The high dispersion in the VR disadvantages subscale is due to the fact that the participants identified, to a greater extent, economic cost (mean of 3.75 out of 5), technological obsolescence of the university's equipment (3.73 out of 5), and lack of specific training for professors (3.74 out of 5). The shortage of space was mentioned, to a lesser extent (mean of 2.84 out of 5), as a disadvantage of VR. Regarding dispersion in the answers on digital competence, these were due to the low evaluation given by the participants of the training offered by their respective universities (2.20 out of 5), as opposed to their digital skills (3.28 out of 5) and their knowledge of VR (2.56 out of 5).

By areas of knowledge, Science professors were those who expressed a lower mean value of digital competence and technical aspects of VR, Social Sciences professors identified, to a lesser extent the drawbacks of VR and recognized less didactic benefits, and Humanities professors were those who expressed the highest values in all subscales (Table 8). As for the deviations (Table 9), Science professors presented the greatest heterogeneity of answers—except in the subscale of digital competence, in which the greatest heterogeneity corresponded to the area of Engineering—and Humanities professors the least, except in the subscale of digital competence.

Table 8. Mean answers (out of 5) and ANOVA test statistics when differentiating participants by area of knowledge.

	Humanities	Science	Social Science	Engineering	ANOVA	*p*-Value
DC	3.00	2.52	2.82	2.53	8.2002	0.0000 *
AT	4.42	4.07	4.15	4.15	10.6800	0.0000 *
D	3.74	3.38	3.30	3.51	4.5865	0.0036 *
DU	4.37	4.10	4.06	4.29	7.7841	0.0000 *

* $p < 0.05$.

Table 9. Standard deviations (out of 5) and Levene's test statistics when participants are differentiated by area of knowledge.

	Humanities	Science	Social Science	Engineering	Levene's F	*p*-Value
DC	0.96	0.96	1.11	1.31	8.1405	0.0000 *
AT	0.79	1.02	0.98	0.91	6.3485	0.0000 *
D	1.06	1.36	1.32	1.17	6.0607	0.0001 *
DU	0.71	0.91	1.05	0.83	6.5336	0.0000 *

* $p < 0.05$.

The MANOVA test statistics found statistically significant gender gaps in the perception of digital competence in the different areas of knowledge (Table 10). Specifically, females reported higher digital skills in Humanities, Social Sciences, and Engineering, and lower in Science. Males gave significantly higher ratings than females for the technical aspects of VR and its didactic benefits in all areas, except in Social Sciences and Engineering, where females gave higher ratings. In addition, females found more disadvantages in the didactic use of VR than males in all fields, except Humanities. Digital generation is a discriminative variable in all subscales of the survey (Table 11).

Table 10. Mean answers (out of 5) and MANOVA test statistics when participants are differentiated by area of knowledge and gender.

Gender	Area of Knowledge	Mean Values			
		DC	AT	D	DU
Female	Humanities	3.22	4.33	3.51	4.21
	Sciences	2.47	3.98	3.59	3.96
	Social Sciences	2.93	4.33	3.38	4.50
	Engineering	3.39	4.21	3.69	4.31
Male	Humanities	2.81	4.49	3.95	4.50
	Sciences	2.67	4.31	3.00	4.50
	Social Sciences	2.74	4.01	3.24	3.72
	Engineering	2.61	4.12	3.41	4.28
		MANOVA			
		DC	**AT**	**D**	**DU**
Chi-square		2.3661	7.9204	2.8551	24.0060
p-Value		0.0310	0.0000 *	0.0228 *	0.0000 *

* $p < 0.05$.

In Humanities and Social Sciences, the perception of digital competence was higher in digital immigrants than in digital natives, while in Sciences and Engineering, natives reported higher digital competence than immigrants. Digital natives rated the technical aspects of VR higher but the didactic benefits lower than digital immigrants in all areas of knowledge (except Social Sciences, where digital natives rated both technical and didactic aspects higher than digital immigrants). Finally, digital natives were the ones who identified more disadvantages of VR in all areas except in Science, where digital immigrants perceived a higher level of disadvantages in VR than digital natives.

Table 11. Mean answers (out of 5) and MANOVA test statistics when participants are differentiated by area of knowledge and digital generation.

Generation	Area of Knowledge	Mean Values			
		DC	AT	D	DU
Digital immigrants	Humanities	3.07	4.34	3.47	4.45
	Sciences	2.07	3.89	3.55	4.16
	Social Sciences	3.04	3.71	2.84	3.58
	Engineering	2.41	4.12	3.44	4.38
Digital natives	Humanities	2.96	4.46	3.92	4.31
	Sciences	3.22	4.35	3.11	4.00
	Social Sciences	2.63	4.53	3.71	4.49
	Engineering	2.60	4.17	3.56	4.24
		MANOVA			
		DC	**AT**	**D**	**DU**
Chi-square		13.1440	21.9370	14.2900	33.0340
p-Value		0.0000 *	0.0000 *	0.0000 *	0.0000 *

* $p < 0.05$.

4. Discussion

The results obtained show that the perception that Colombian university professors have of their own digital competence is intermediate, in general (Table 7). In any case, their assessment of VR technologies and their didactic benefits is much higher than the training they express for their use in the classroom. This is in line with numerous studies that indicate low level of use of digital technologies, or the Internet, in the Latin American context [60]. Although the use of digital environments has increased during the COVID-19 pandemic, the projection that the use of this type of resources has experienced still seems to be scarce in Latin America, especially in higher education, due, in part, to the need for specific training in this regard by professors, and due to the economic demands posed by the implementation of these technologies [61–63]. However, there is a growing perception of the benefits of the use of digital teaching technologies among university faculties, which leads to the design of proposals and research on teaching experiences in this regard. The specialized literature supports the view that these types of experiences are being developed in Latin American universities [64,65] and in other geographical areas, such as Spain and Portugal [11,66] and Italy [67,68]. In this sense, there are works that show that VR technologies can be integrated into different Latin American learning systems, although their implementation is still weak [69,70]. In the specific case of Colombia, the use of VR technologies in digital learning environments has attracted the interest of numerous researchers, who have verified the increase in motivation and learning experience of students caused by the use of VR [71,72] and the increase in self-esteem and technological skills of students due to the use of VR [73]. All this may be causing the excellent valuations of the didactic benefits of VR obtained in this study, even though self-concept about digital competence is less valued.

The participating professors also assessed the level of disadvantages posed by VR as intermediate–high (Table 7). In this sense, professors especially highlight the technological obsolescence of the equipment, the economic cost, and the lack of specific training for professors. These results are in line with previous research works [74], which indicate that the difficulty expressed by a set of Colombian university professors in the use of certain VR tools is their greatest difficulty. In other different geographical areas, technological obsolescence of equipment has also been found to be a notable disadvantage of VR, which shows that this observation is not strictly local [75].

Regarding the influence of the area of knowledge and the rest of the independent variables, it has been shown that Colombian professors of Humanities are those who manifest greater digital competence and better assessment of VR, in general (Table 8). With respect to the differences by areas of knowledge in the valuation of VR as a teaching resource, there are discrepancies between the different works in previous literature carried out on geographical areas, other than the one in this study. Some studies do not find differences between professors in areas such as Humanities and Engineering [76] or Heath Sciences and Engineering [13], while those that do find differences indicate that Humanities professors are the ones who encounter more obstacles and limitations to the use of these technologies in the classroom [77]. The results found in this research point precisely in the opposite direction. Colombian Humanities professors are the ones who gave higher valuations to VR, which suggests that there is a geographical or cultural component that affects the professors' perceptions of VR. These results are novel in the literature, which is an element of originality of the present research. Typically, published work in this area focuses on a specific area of knowledge [78–81], or on the identification of other variables that influence the perceptions analyzed, such as the country of origin [82].

This research has shown that there is a gender gap in the perception of digital competence so that, in the areas of Engineering, Humanities, and Social Sciences, females express higher levels of digital competence, while in Science it is males who express having greater digital skills (Table 10). This fact reveals that Colombia shares, with its neighboring countries, the gender gap that exists in the digital training of Latin American professors in university education [83,84] and it is proposed as a line of future research to explore the reasons why the gender gap in the area of Science benefits males in terms of digital competence, rather than females, as in the rest of the areas. Moreover, this result is in line with those described by previous works in which gender gaps in digital competence in a population of Latin American university professors were identified [13]. Gender gaps were also found in terms of perceptions of the technical aspects, didactic benefits and drawbacks of VR. This fact disagrees with previous works [13] where the perceptions on similar aspects in a population of Latin American university professors were studied, although only in the case where professors were from the fields of Health Sciences and Engineering. This work has shown that male professors in all areas of knowledge value the technical and didactic aspects of VR more than females. In addition, females find more disadvantages in the use of VR in all areas, except in Humanities. In contrast, there are previous works where no significant gender gaps were identified in the assessment of VR when the population was reduced to professors of Health Sciences and Engineering [13].

With respect to age, digital native professors are those who report having greater digital competence in the areas of Science and Engineering. This fact is consistent with those of other works [14], where it is shown that the perception of digital competence decreases with age among Engineering professors. In contrast, in the areas of Humanities and Social Sciences, the highest self-concepts in this regard are digital immigrants (Table 11). In addition, digital natives report higher valuations of the technical dimensions of VR, but lower valuations of its didactic benefits, than digital immigrants in all areas, except Social Sciences, where digital natives also outperform immigrants in valuing the didactic benefits of VR. This fact may reveal that younger generations of professors in Science and Engineering are acquiring training in digital technologies that previous generations did not receive, but this digitization effort in professor training is not developing at the same pace in the humanistic-social areas. However, the high valuations of VR among digital native professors of Humanities and Social Sciences manifests that, despite having a lower self-concept of their digital competence, these professors see VR technologies as applicable to their teaching activities. The perception of their own digital competence, higher among digital native professors, are in line with the results of previous works on digital competence in higher education in Latin America [85]. However, in this work it was found that the highest valuations were concentrated, above all, in scientific-technical areas. With respect to the valuation of VR technologies in the specific case of university professors in Colombia, the present work is novel in the literature and, consequently, constitutes an original contribution.

5. Conclusions

The participating professors consider their level of digital competence to be intermediate-low, but rated VR very highly, both in its technical aspects and in its didactic benefits in higher education. However, they understand that the incorporation of VR technologies into university classrooms in Colombia poses disadvantages, mainly due to the technological obsolescence of university equipment, the economic cost and the lack of specific training for professors. With respect to the above perceptions, gaps have been identified in terms of area of knowledge, gender, and digital generation. In particular, the highest valuations of VR are expressed by digital natives, and by professors of the area of Arts and Humanities. Female professors in Humanities, Social Sciences, and Engineering report higher digital competence than males, contrary to what happens in the area of Science.

There are some future lines of research opened up from the present study. In particular, it would be interesting to explore whether the gap that exists in areas of knowledge concerns aspects linked to the nature of the area itself and the applicability of VR or, rather, with the previous training of the professors in each area. It would also be useful to explore the reasons why the gender gap in the area of science is contrary to that of the rest of the areas. Specifically, it would be useful to explore to what extent the reasons for the above behaviors arise from sociological or academic characteristics of Colombia or whether they can be extrapolated to other countries in the region with a similar level of technical and digital development. This could be corroborated by extending the study to other countries in Latin America and the Caribbean. It would also be interesting to compare the case of Colombia with that of countries in different areas with a higher (Europe or North America) or lower (Asia or Africa) level of digitization. In addition, it is suggested that universities design specific training actions on the use of VR technologies and their didactic employability, especially in the humanistic-social areas, and that these trainings have a specific focus for each area of knowledge.

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