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Higher Education in the Pacific Alliance: Descriptive and Exploratory Analysis of the Didactic Potential of Virtual Reality

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Abstract: In this paper, we conducted descriptive quantitative research on the assessment of virtual reality (VR) technologies in higher education in the countries of the Pacific Alliance (PA). Specifically, differences between PA countries in terms of the above perceptions were identified and the behavior of the gender and knowledge area gaps in each of them was analyzed. A validated quantitative questionnaire was used for this purpose. As a result, we found that PA professors express high ratings of VR but point out strong disadvantages regarding its use in lectures; in addition, they have low self-concept of their digital competence. In this regard, it was identified that there are notable differences among the PA countries. Mexico is the country with the most marked gender gaps, while Chile has strong gaps by areas of knowledge. We give some recommendations towards favoring a homogeneous process of integration of VR in higher education in the PA countries.

Keywords: reality–virtuality; digital resource; digital technologies; higher education; quantitative research; instructional technology

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1. Introduction

1.1. Context and Approach

Virtual reality (VR) is a set of computational technologies that allow, through specific software and hardware, the design of realistic simulated situations with which the user can interact [1]. Although the origin of these technologies dates back to the late twentieth century and their commercialization increased significantly from 2015 onwards, from 2020 onwards their use intensified to the point of being positioned as one of the reference technologies of the so-called metaverse [2]. In the field of training, VR technologies have been evidenced to be a versatile digital resource at all educational levels and in different areas of knowledge, as well as a sustainable resource [3]. In fact, from 1990 to 2021, the literature records the existence of 1074 indexed research articles related to the use of VR in education [4]. In this sense, USA and China lead the world list of scientific productions, but Spain is in third place and there is a Latin American country (Brazil) among the top ten [4]. The literature also shows how the convergence of technologies, including VR technologies, and education positively influences the academic performance of Latino students in higher education [5].

The Pacific Alliance (PA) is an organization formed in 2012 and currently made up of four Latin American countries—Mexico, Colombia, Peru, and Chile—that carries out measures that favor regional integration and the joint development of their economies, mainly through the establishment of trade relations with the Asia-Pacific region [6]. For this objective, the PA seeks to strengthen its knowledge economy, understood as the set of professional skills oriented to the productive economy [7] which, according to the Knowledge Assessment Methodology (KAM), is measured through six main scales [8]: (a) performance; (b) economic incentives; (c) information infrastructure; (d) innovation system; (e) education, innovation, and human resources; and (f) gender equality. To strengthen these dimensions, the PA has, among its objectives, full digital integration, including the digitization of education, and gender equality [9]. Although homogeneous levels of the different categories measured by the KAM were found throughout the PA area, the greatest weaknesses were found in the aspects of innovation and infrastructure, which are those that have suffered the most after the height of the COVID-19 pandemic in the PA countries, having increased, moreover, the gaps in this regard between countries [10]. One of the most pronounced effects of the pandemic affected the digital skills of professors [11]. Hereinafter, the term professor is used in this paper to include all academic ranks of university educators: full professor, associate professor, assistant professor, and lecturer.

In this paper, we conducted quantitative research on the self-concept of digital skills and the assessments of VR in the PA countries. The main objective was to describe the state of the art and the existence of gaps in this regard among the PA countries. In particular, the behavior of the gender and knowledge area gaps in each of the countries studied was analyzed. Regarding areas of knowledge, a distinction was made between professors in scientific-technical areas and professors in humanistic-social areas. Following the International Standard Classification of Education (ISCED), established by the United Nations Educational, Scientific and Cultural Organization (UNESCO) [12], the humanistic-social areas incorporate humanities, arts, economics and business, law, sociology, and geography, while the scientific-technical areas incorporate the areas of mathematics, physics, statistics, experimental, natural, and health sciences. With the above objectives, this paper aims to analyze whether the policies of convergence in education and digitization of the PA reach convergence in the perceptions of university professors. Another objective of this paper is to identify specific weaknesses in the process of integration of VR in higher education in the different countries of the PA to provide recommendations to help this integration process.

1.2. Literature Review

Although VR technologies allow for very versatile and diverse designs, the literature gathers a family of technical or usability characteristics common to all of them [13,14]: (a) 3D design, referring to the sensation of three-dimensionality experienced by the user; (b) immersiveness, or the degree to which the user is immersed in the simulated environment; (c) realism of the experience; (d) interactivity with the simulated environment and other users; (e) user experience; and (f) employability. Regarding the concept of immersiveness, the literature presents divergent concepts. The most classic VR taxonomy [15], posits immersiveness as a gradual continuum of virtual experience, but the most current classification by Vergara [16] distinguishes VR between immersive VR (IVR), based on the replacement of physical reality by a three-dimensional computational one, and non-immersive VR (NIVR), which employs images projected by a screen. In this work, the more modern classification [16] is used, which was also clearer for the participants to understand.

Likewise, the didactic usefulness of VR in higher education refers to its employability as a didactic resource, which not only involves technical knowledge of VR on the part of the professor, but also specific training in techno-pedagogical skills, availability of adequate spaces and technologies in universities, and access to these technologies by the entire educational community [17,18]. In this sense, the literature identifies deficient training in digital and techno-pedagogical competencies as one of the main limitations to the use of VR in lectures [19]. In the Latin American region, the costs of technological equipment for the use of VR, the technical and space requirements of universities, and the obsolescence of available equipment [20] and social inequalities in access to technologies [21,22] are also identified as strong limitations for the integration of VR in higher education. These limitations are perceived unequally in different Latin American countries. Although there are no studies that have differentially explored this matter, it has been found that some countries, such as Mexico, stand out for their strong inequalities in terms of access to technologies, university funding or the degree of digitization of universities, which affects the assessment that teachers make of digital technologies for teaching use [23,24].

Regarding the digital skills of Latin American professors, the literature reveals that self-concept in this regard is low [25,26], regardless of the area of knowledge [17,18]. These low ratings are very uniform among faculty, especially in technical areas [18], although with a greater dispersion in areas such as health sciences [27]. Despite low self-concepts of their digital competence, professors in the Latin American region give high valuations to VR, especially to its employability in the classroom [28,29], its didactic benefits [30,31], and, to a lesser extent, its technical aspects [18], with these technical features being mainly valued by professors in technical areas [20].

The literature identifies some explanatory variables of professors' assessments of VR tools. Among them, gender is especially highlighted, because the Latin American region suffers from a persistent gender gap that disadvantages females in terms of access to technologies and their knowledge [32–34]. In this sense, the preceding literature does not present differential studies by country of gender gaps in the valuations of digital teaching technologies, but there are studies that analyze the situation in specific countries. In this regard, the results are different in different countries. It was found that there are structural problems of gender inequality in technological training in Mexico [35] and Chile [36,37], but Peru is the Latin American country in which the literature finds stronger digital gender gaps [38], although there are no studies, as far as it has been possible to explore, that study how this gap affects the valuations of technologies such as VR. In Colombia, female professors rate VR higher than males [20]. The behavior of these gender gaps is different according to the country or geographic region, with the level of digitalization of the country having been identified as one of the explanatory variables of these differences [20], but without the literature being able to give, so far, a much broader description of the socioeconomic variables that explain the gender differences in the valuations of digital teaching technologies in the area.

Finally, it should be noted that the didactic use of VR in higher education classrooms has some disadvantages that the specialized literature reports. Among them, the costs that teachers attribute to the implementation of VR technologies that hinder their integration in higher education stand out [18]. In addition, the use of interactive virtual environments generates a source of visual and auditory stimuli that can have a distracting effect on the student and distract them from the learning objectives, which is why devices have been designed to monitor the use of VR to control student distractions [39].

1.3. Research Objectives

The general objective of the present research is to analyze the perceptions of professors in the PA countries about the technical and pedagogical dimensions of the didactic use of VR technologies in higher education. This general objective is concretized in the following specific objectives: (a) to describe the self-concept of professors from PA countries about their digital skills for the use of VR technologies; (b) to analyze the perceptions of professors from PA countries about the technical, usability, and didactic characteristics of VR, its disadvantages, and the future prospects for the use of VR in higher education; (c) to identify differences in the above perceptions among professors in the different countries of the PA; (d) to analyze the behavior of the gender gaps and areas of knowledge with regard to the responses obtained in each of the countries of the PA.

2. Materials and Methods

2.1. Participants

The sampling process was non-probabilistic by convenience. The target population consisted of professors attending a training course on technical and didactic aspects of VR given by the authors and repeated every two weeks between January and June 2022 for practicing university professors from universities in the Pacific Alliance countries. This training sought to meet the following objectives: (i) to present the basic concepts of VR technologies, their types and applications; (ii) to develop the main technical characteristics of VR; and (iii) to develop practical didactic cases of VR use in higher education. Thus, it can be assumed that the participants had sufficient and homogeneous knowledge about VR and its didactic applications. The criteria for inclusion in the study were the following: (i) being a practicing university professor at a university in Mexico, Colombia, Peru, or Chile and (ii) having attended the training session on VR given by the authors. The members of the target population were sent the questionnaire that was used as the research instrument and were asked to participate after being informed of the research purposes of the questionnaire. This process was carried out in accordance with the Helsinki Declaration and without collecting personal data that could identify the participants. Responses were voluntary, free, and anonymous. A total of 638 professors responded to the questionnaire, and 633 responses were validated, so the final number of participants was 633. The participants had no previous experience in the didactic use of VR technologies.

Participants were homogeneously distributed by country (chi-square = 0.9652, df = 3, p-value = 0.8097): Mexico (26.54%), Colombia (24.64%), Peru (24.96%), and Chile (23.85%). However, the gender distributions were not equivalent in the different countries (Figure 1), since, while in Chile, Colombia, and Peru the participants were distributed approximately homogeneously by gender, in Mexico there was a significant majority of females (chi-square = 12.6430, df = 3, p-value = 0.0055). Likewise, the participants in Colombia and Mexico were distributed approximately homogeneously by areas of knowledge, with a slight majority of teachers from humanistic-social areas, while in Chile and Mexico there were more professors from scientific-technical areas, this majority being larger in Peru (Figure 2). These differences between countries in the distribution of participants by knowledge areas are statistically significant (chi-square = 17.3230, df = 3, p-value = 0.0006).

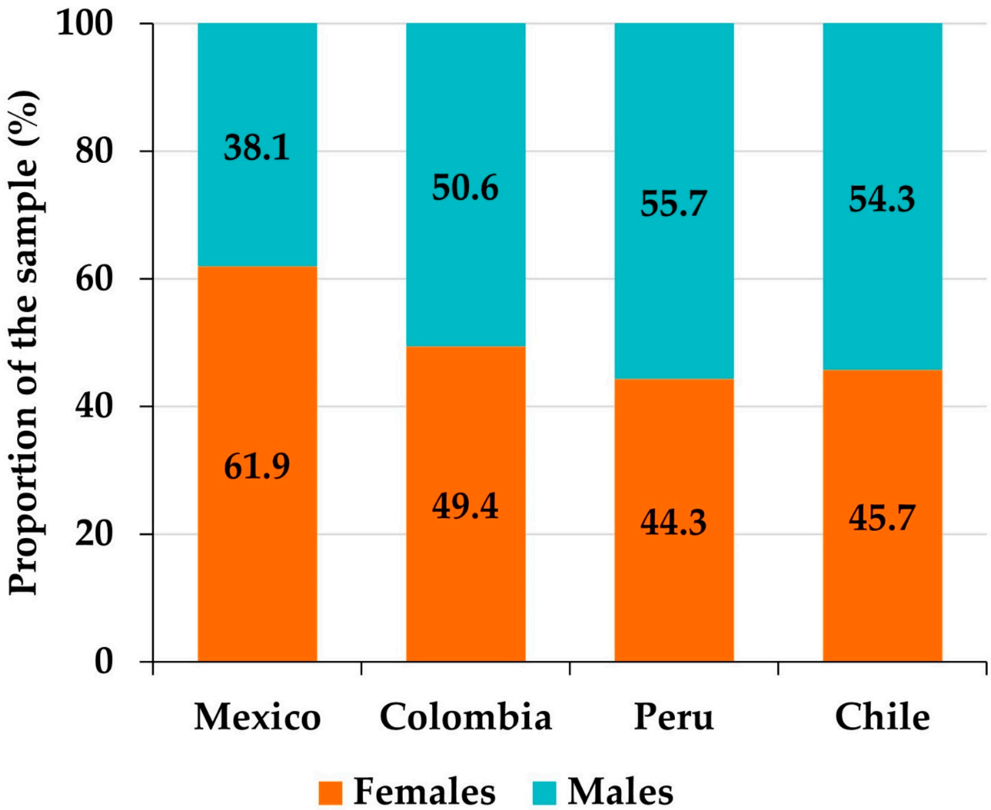

Figure 1. Distribution of participants by country of origin and gender.

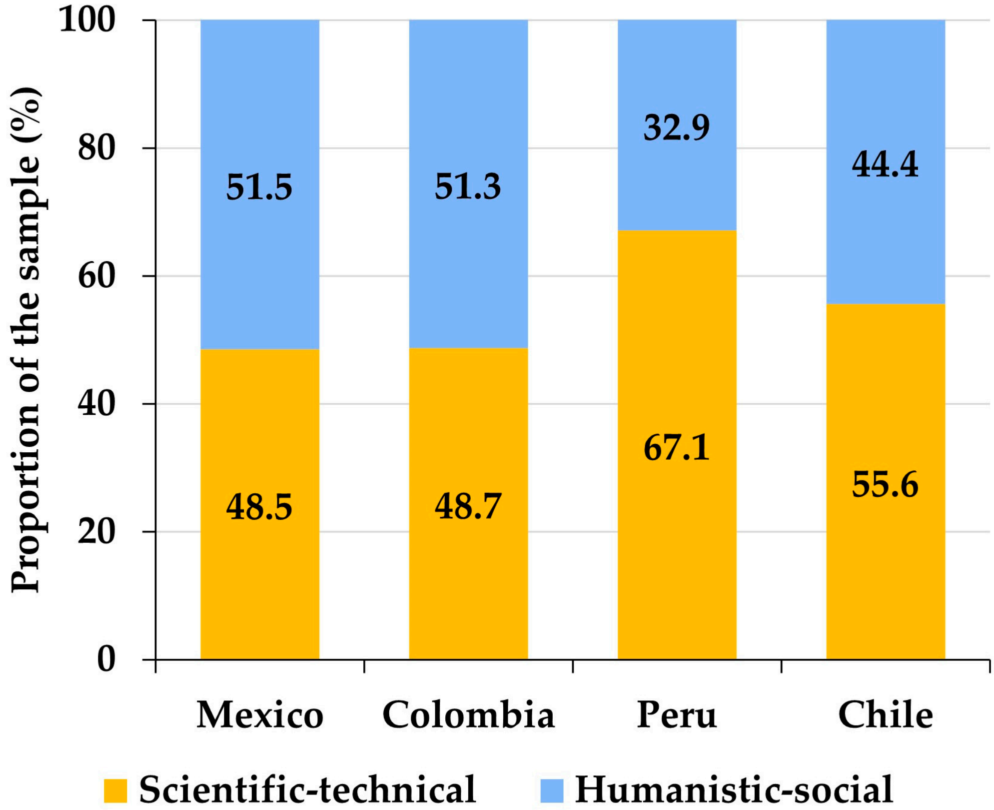

Figure 2. Distribution of participants by country of origin and knowledge area.

2.2. Research Variables

For the purposes of this research, the country of origin of the professors was considered as the main explanatory variable, which is a nominal polytomous variable with possible values Mexico, Colombia, Peru, and Chile. Likewise, the following secondary explanatory variables were defined as nominal dichotomous variables: (i) gender, females and males, and (ii) knowledge area, scientific-technical and humanistic-social.

2.3. Instrument

For the purposes of the present research, a validated questionnaire on the perception of university professors about the didactic use of VR in higher education was used [18]. The questionnaire consisted of 22 questions that asked participants to rate different aspects of VR on a Likert-type rating scale from 1 to 5, where 1 means no rating, 2 means low, 3 means intermediate, 4 means high, and 5 means very high. The factor analysis carried out on the questionnaire identified 6 factors that allowed for explanation of the questionnaire, leading to the definition of the following families of questions: (i) digital competence on the use of VR—items 1 to 3, on digital skills, knowledge, and training received on VR; (ii) usability of VR—items 4 to 6, on interaction, user experience, and employability; (iii) assessment of technical aspects of VR—items 7 to 9, on 3D design, immersiveness, and realism; (iv) assessment of the level of disadvantages of VR—items 10 to 14, on costs, space requirements, technical requirements, faculty training requirements, and technological obsolescence of equipment; (v) future projection of VR use in higher education—items 15 and 16, on immersive VR, and non-immersive VR; and (vi) didactic aspects of VR—items 17 to 22, on didactic usefulness, possibilities of implementation in the university, acceptance by students, academic performance increasing, student motivation increasing, and improvement in the progress of the class activities. The composite reliability parameters and Cronbach's alphas computed on the responses to the questionnaire show that they have a high level of internal consistency (Table 1).

Table 1. Composite reliability (CR) and Cronbach's alpha parameters.

Variable	Cronbach's Alpha	CR
Digital skills	0.7464	0.7001
Usability	0.7834	0.7392
Technical aspects	0.8670	0.8266
Disadvantages	0.7804	0.7528
Future projection	0.8081	0.7991
Didactic aspects	0.8337	0.7947
Digital skills	0.7464	0.7001

The confirmatory factor analysis (CFA) statistics confirm the theoretical model just defined. Indeed, the incremental fit indices are adequate (AGFI = 0.8208; NFI = 0.8238; TLI = 0.8188; CFI = 0.8478; IFI = 0.8487) and the absolute fit indices are good (GFI = 0.8626; RMSEA = 0.0891; AIC = 1284.5120; chi-square/df = 6.0129).

2.4. Design and Statistical Analysis

This paper develops descriptive quantitative research on the self-concept of professors in the PA countries about their digital skills and their assessments on the use of VR technologies in their lectures. For this purpose, a validated questionnaire was used and the following research phases were followed: (i) formulation of the objectives and definition of the research variables; (ii) design and delivery of the initial training session and the sampling and data collection process; (iii) statistical analysis of the responses obtained; and (iv) drawing of conclusions.

For the statistical analysis of the responses, descriptive statistics were obtained for the different families of questions, both globally and differentiating by the countries of origin of the participants within the PA. The dependence between the different families of responses was analyzed by computing Pearson's correlation coefficients. The Welch F-test was used, without assuming equality of variances, to compare the mean responses given by the professors from the different countries of the PA to each of the families of responses. Finally, to analyze the behavior of the gender and knowledge area gaps in the different PA countries, the multifactor analysis of variance test was used. A significance level of 0.05 was used in all hypothesis testing.

3. Results

The average self-concept about the participating professors' own digital competencies was found to be low (below 3 out of 5 in the average score). However, the ratings of VR technologies were high (above 4 out of 5) in both usability and didactic aspects and intermediate (between 3 and 4 out of 5) in technical aspects and in terms of their future projection (Table 2). Participants also gave intermediate ratings to the level of disadvantages offered by the use of VR in lectures. The highest variations, in terms relative to the size of the mean scores, were found in the responses about the self-perception of digital skills, followed by the ratings about the disadvantages of VR, because these families had the highest coefficients of variation (Table 2). Therefore, it can be assumed that the assessments that the participants made of VR reaced a consensus that, however, did not occur in the self-perception of digital skills, where a greater difference in level is observable.

Table 2. Composite reliability (CR) and Cronbach's alpha parameters.

Variable	Mean (Out of 5)	Std. Deviation (Out of 5)	Coef. Variation (%)
Digital skills	2.72	1.13	41.46
Usability	4.09	0.93	22.63
Technical aspects	3.91	0.94	24.13
Disadvantages	3.62	1.17	32.18
Future projection	3.72	1.00	26.89
Didactic aspects	4.04	1.00	24.72

The self-concept of digital skills was positively and significantly correlated with participants' assessments of VR usability, its disadvantages, and its future projection (Table 3). Consequently, a higher self-perception of digital skills led not only to a better assessment of the usability characteristics of VR and its future projection, but also to a greater awareness of the disadvantages of its use. On the other hand, the assessment of technical aspects was strongly correlated mainly with the assessment of the usability of VR technologies, with positive correlation, since the corresponding correlation coefficient was found to be positive, significant, and the highest of all (Table 3). This means that valuation of VR usability is strongly linked to valuation of its technical characteristics. Another noteworthy aspect is that the assessment of the didactic aspects of VR was found to be positively correlated with the assessment of the technical and usability aspects of VR and the assessment of its future projection, but negatively correlated with the assessment of the disadvantages of VR (Table 3). In fact, the latter was the only statistically significant negative correlation established between the different families of responses. It follows that a higher self-concept of digital skills and higher ratings of the technical and usability characteristics of VR are linked to a higher awareness of its disadvantages, but this level of disadvantages leads to a lower rating of the didactic effectiveness of using VR.

Table 3. Pearson correlation coefficients between the different families of responses.

Variable	Digital	Usability	Technical	Disadv.	Future	Didactic
Digital skills	1	0.0859 *	0.0268	0.1436 *	0.1509 *	0.0284
Usability		1	0.5363 *	0.1197 *	0.3472 *	0.1798 *
Technical aspects			1	0.1011 *	0.3687 *	0.1775 *
Disadvantages				1	0.1087 *	–0.1644 *
Future projection					1	0.1898 *
Didactic aspects						1

* $p < 0.05$.

We found significant differences among the four PA countries in all the families of responses (Table 4). Specifically, Mexico is the country whose professors have the lowest self-concept of digital competence, and it is also the country with the lowest assessments of the technical, didactic and usability characteristics of VR, the one that gives these technologies the lowest projection for the future, and the one that finds the highest level of disadvantages in their use in higher education (Table 4).

Table 4. Mean of the responses differentiating by country and Welch F-test statistics, without assuming equality of variances.

Variable	Mexico	Colombia	Peru	Chile	F-Statistic	*p*-Value
Digital skills	2.61	2.69	2.77	2.82	3.88	0.0089 *
Usability	3.84	4.20	4.25	4.05	18.78	<0.0001 *
Technical aspects	3.53	3.99	4.10	3.99	38.28	<0.0001 *
Disadvantages	3.77	3.57	3.71	3.46	12.42	<0.0001 *
Future projection	3.45	3.79	3.90	3.72	12.62	<0.0001 *
Didactic aspects	3.83	4.08	4.09	4.13	20.45	<0.0001 *

* $p < 0.05$.

The statistics of the multifactor analysis of variance test allow us to assume that there are no significant differences between countries in terms of the behavior of the gender gaps in the responses to the families of questions on self-concept of digital skills and assessment of the usability of the VR (F = 0.2240, *p*-value = 0.8798 for self-concept of digital skills; F = 2.0584, *p*-value = 0.1038 for usability). Specifically, males expressed a slightly higher self-concept of their digital skills, on average, than females in all PA countries while, at the usability level, it was not possible to assume that there were significant gender differences in any of the countries (Figure 3).

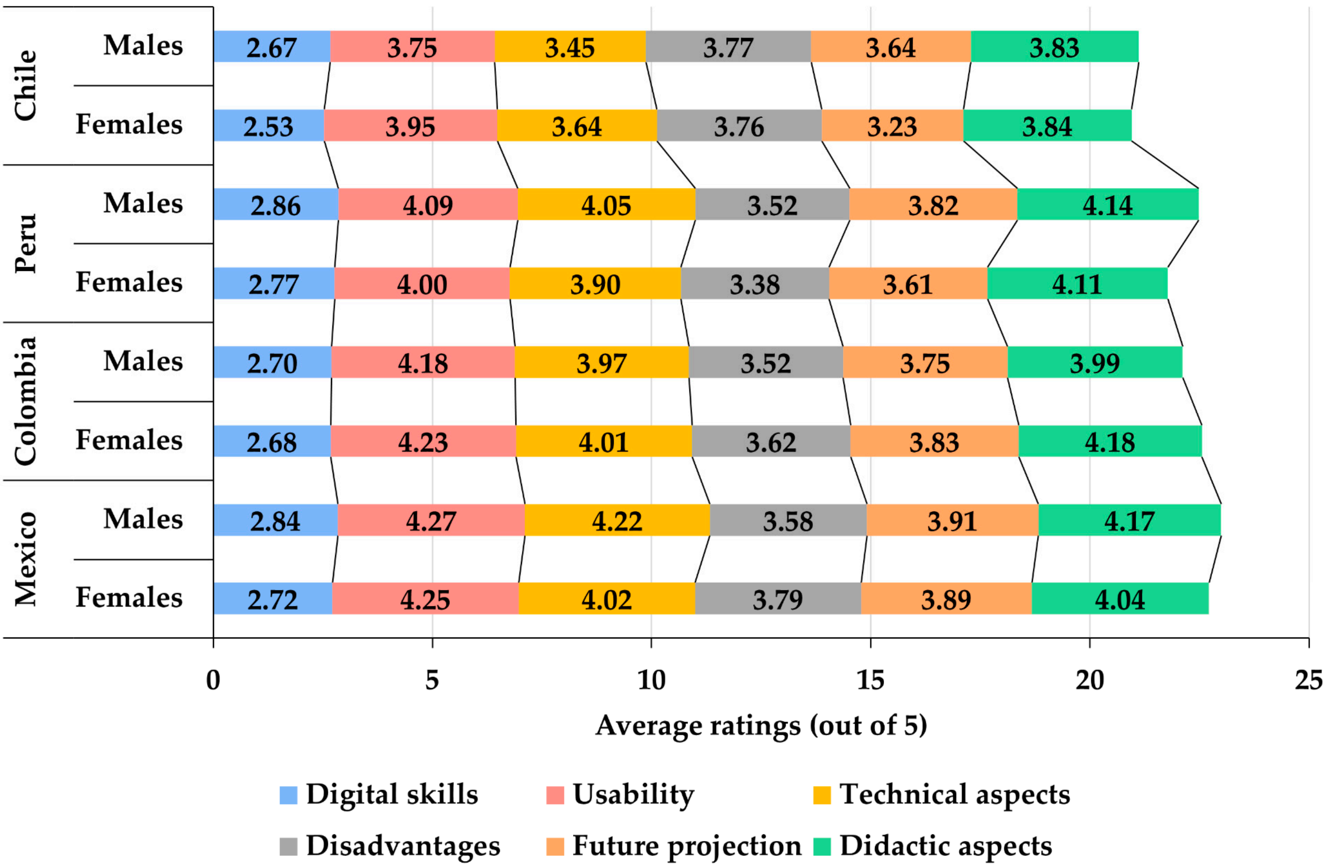

Figure 3. Average responses (out of 5) differentiating by country and gender.

As for the ratings of technical and didactic aspects, the gender gaps behaved significantly differently in the different countries (F = 4.4299, *p*-value = 0.0041 for technical aspects; F = 4.2879, *p*-value = 0.0050 for didactic aspects). Specifically, in Mexico and Peru, male professors gave higher ratings to technical and didactic aspects than females, while in Colombia and Chile it was female professors who gave higher ratings to these technical and didactic characteristics (Figure 3). Male professors perceived a greater future projection for VR than females in all countries except Colombia (F = 3.7393, *p*-value = 0.0108). Finally, males perceived fewer disadvantages than females in the use of VR in Mexico and Colombia, but more in Peru and Chile (F = 3.0905, *p*-value = 0.0260).

The area of knowledge was an explanatory variable for all the families of responses obtained (Figure 4). Professors from humanistic-social areas expressed higher self-concepts of their digital skills than professors from scientific-technical areas in all PA countries except Mexico (F = 4.4621, *p*-value = 0.0004). Regarding the ratings of the different dimensions of the RV, participants from scientific-technical areas in Chile gave higher ratings than their colleagues from humanistic-social areas—36.4% more in technical aspects, 11.0% more in disadvantages, 34.9% more in future projection, and 23.6% more in didactic aspects—while in the rest of the PA countries there was a balance in the ratings given by professors from the two areas analyzed (Figure 4).

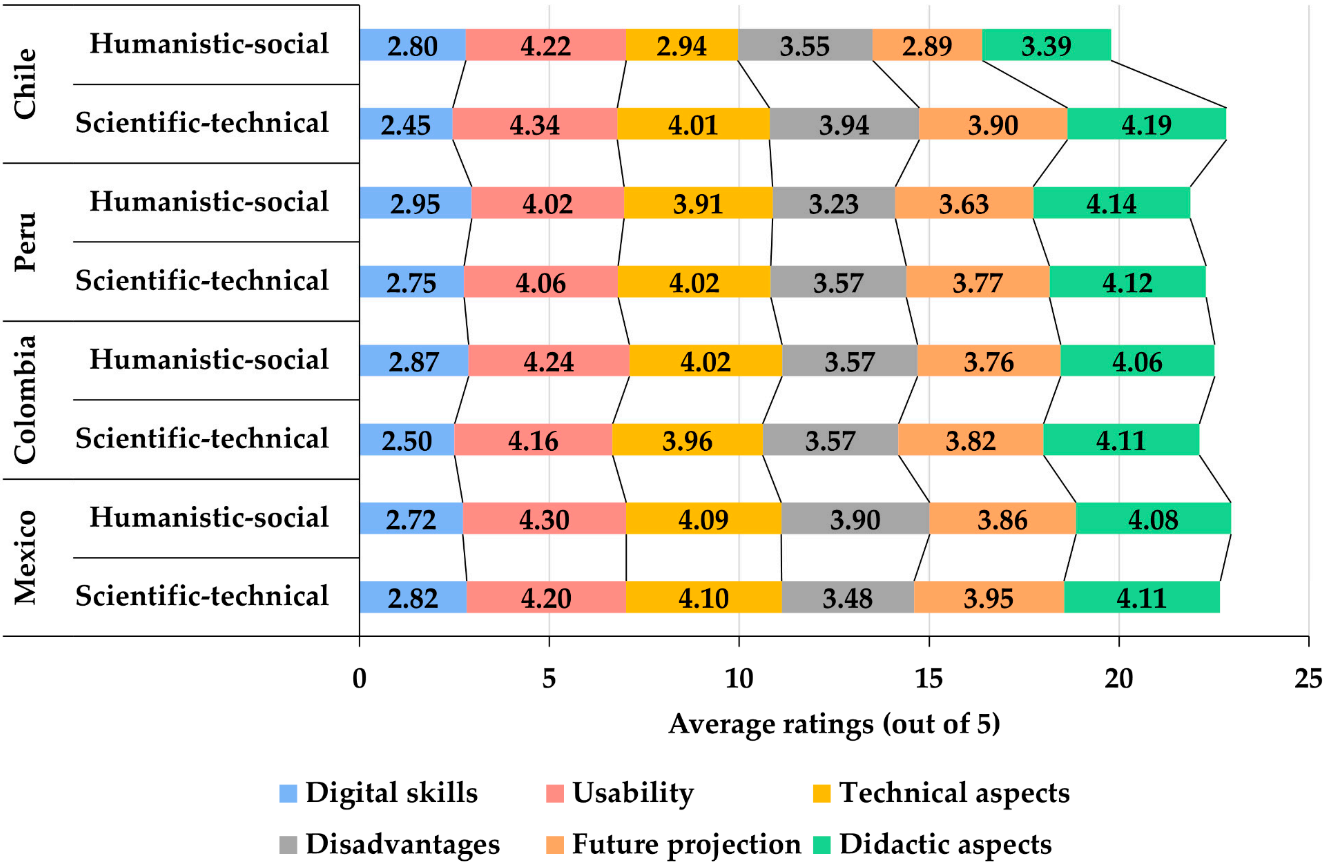

Figure 4. Average responses (out of 5) differentiating by country and knowledge area.

4. Discussion

The self-concept expressed by PA professors about their digital skills was low (Table 2). These results are in line with the self-concepts of digital competence of professors in the entire Latin American and Caribbean region [17,18,25,26], which shows that there are no significant differences between the perceptions of digital competence of professors in the PA countries with respect to professors in the countries of the region. The results obtained here show that professors' ratings of their digital skills are much more dispersed than the VR ratings (with a coefficient of variation of 41.26%, compared to variations of no more than 30% in the VR ratings). This shows that there are strong gaps between the self-concepts of digital competence of professors in PA countries, contrary to what is shown by other studies focused on the area of engineering [18], but in line with results demonstrated for specific areas of knowledge such as health sciences [27].

The didactic and usability aspects of VR are the features most highly valued by PA professors (Table 2). These results are consistent with those of previous studies regarding usability as one of the main advantages of VR [28,29] and its didactic benefits [30]. In fact, these high ratings are in line with the high ratings received by the didactic use of digital technologies at all educational levels in the Latin American region [31]. The technical aspects of VR only stand out among the most highly valued by professors when the population is restricted to engineering professors [18]. In contrast, it has been shown here that, indeed, this valuation of technical aspects is lower when considering a population of professors from PA countries in all areas, despite the fact that the responses on technical aspects are strongly positively correlated with the responses on usability (Table 3). However, it has also been found that professors in the PA region who are specialists in scientific-technical areas give higher ratings of technical aspects than professors in humanistic-social areas, except in the case of Colombia, where the superiority of the ratings of professors in humanistic-social areas barely exceeded the ratings of professors in scientific-technical areas by 1.5% (Figure 4). In the other countries, the scores given by professors from scientific-technical areas to the technical aspects of VR exceeded those of professors from humanistic-social areas by up to 36.4% in the case of Chile, the country in which the gap was greatest (Figure 4). Consequently, the results obtained regarding the assessment of the didactic dimensions of VR in the PA countries are in line with those of the previous literature for the Latin American and Caribbean region as a whole on the assessment of VR by engineering educators [18,20].

Despite the high ratings of VR technologies among professors in the PA countries, the results reveal that the level of disadvantages that professors find in the didactic use of VR is also high (Table 2). Moreover, the disadvantages analyzed—requirements of access to technologies, availability of spaces and digital training—correlate with a decrease in the assessment of the didactic effectiveness of VR (Table 3) so that the disadvantages of VR are linked to a decrease in the didactic assessment of VR. These results provide a quantitative confirmation of the concern, reflected by previous literature, about the growth of inequalities that the process of digital integration may bring about in the Latin American region due to differences in access to technology [21,22].

Among the main novel results of the present research is the discovery of a gap in the assessments offered by professors from the different PA countries. Specifically, as can be observed in Figure 5, Mexican professors stand out for being those who express a lower self-concept of their digital skills, lower ratings of VR, and for being those who find the most disadvantages of VR within the PA (Table 4). The literature reveals that VR technologies have been introduced in Mexico in recent years in higher education with good learning effects and adequate acceptance by the agents involved in the teaching–learning process [24]. However, the literature also finds that in Mexico there are structural asymmetries, mainly inequalities in terms of access to technologies, faculty training and unequal funding of private and public universities, that hinder the integration of VR tools and make professors wary of their use [23]. This paper offers, as a novelty, the confirmation of these results in a quantitative way and in a differential way with respect to the rest of the PA countries. Likewise, from Figure 5 it can be deduced that the PA countries whose professors give higher ratings to VR technologies are Peru and Chile. These high ratings are consistent with the results of previous literature [29], but the differential results between countries are novel in the literature.

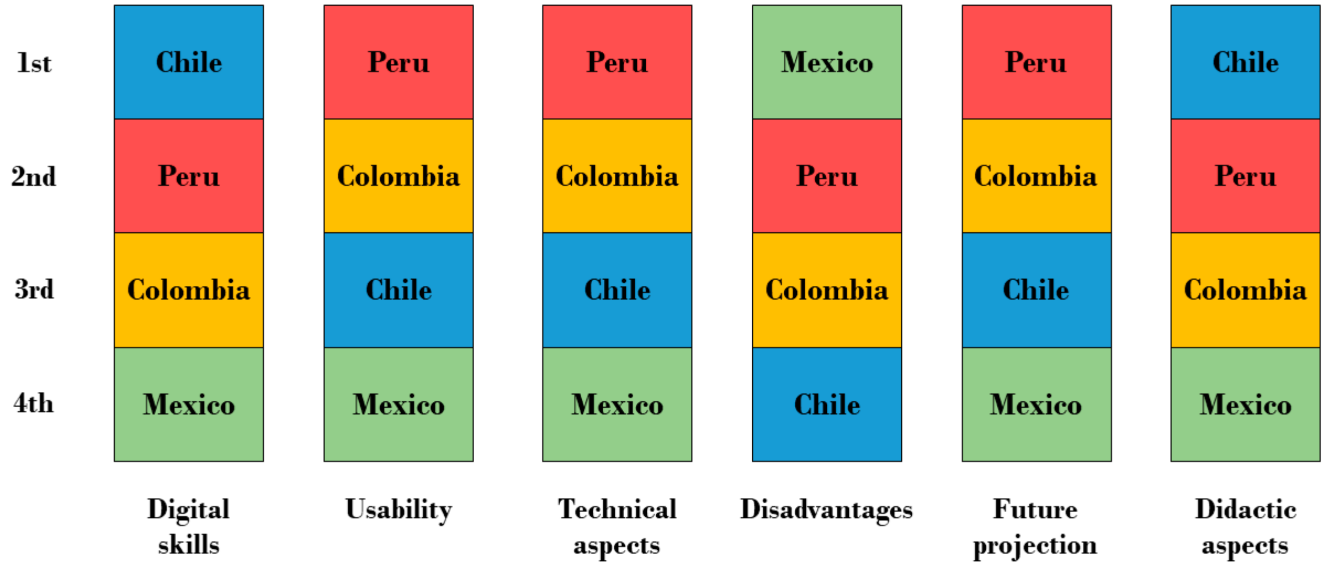

Figure 5. Ranking of the PA countries according to the average scores given in each of the families of questions in the questionnaire.

The digital gender gap that disadvantages females that occurs in general in Latin America [32–34] manifested in all PA countries, as male professors expressed higher self-concepts of their digital skills than females in all of them (Figure 3). However, this paper evidences, as a novel and original result, that the behavior of the gender digital divide in terms of VR ratings is different depending on the PA country in question. Specifically, in Mexico and Peru, male professors rate the technical and didactic aspects of VR higher than females, while in Colombia and Chile it is female professors who rate VR higher (Figure 3). In Mexico, male professors are those who perceive more future projection and fewer disadvantages for VR, while in Peru, males perceive more disadvantages.

The few studies in the previous literature that studied the gender digital divide in a differential way in the PA countries focused on the general population and determined that the most notable gender gaps were found in Peru [38]. In contrast, the results obtained here indicate that the most strongly marked gender gap to the detriment of female professors is in Mexico, which shows that the digital gender gap is more marked in the sector of university professors. In this sense, the asymmetries regarding the digital gender gaps between Mexico and countries in Far East Asia, such as Japan, are confirmed [35].

Finally, we also found that Chile is, among the PA countries, the country with the widest gap between areas of knowledge in terms of VR ratings (Figure 4). Specifically, professors from scientific-technical areas give higher scores to VR than those from humanistic-social areas, up to 36.4% more in technical aspects or 23.6% in didactic aspects (Figure 4). As far as it has been possible to explore, there are no results in the previous literature that analyze this gap by areas of knowledge in the valuation of digital tools by the agents involved in higher education in Chile, so these results are novel and original. In this sense, preceding studies note the existence of inequalities in access to technologies derived from social inequalities in Chile [37] and gaps derived from the persistence of social gender stereotypes [36].

5. Limitations and Lines of Future Research

It is recommended that a similar study be carried out, but with samples of participants distributed homogeneously by gender and area of knowledge in each of the countries analyzed to avoid possible biases that may arise from the lack of homogeneity. Likewise, as future lines of research, we suggest carrying out a comparative quantitative analysis of the situation of the PA with respect to the rest of the countries in the Latin American region and completing the results obtained here with a qualitative study to identify the causes that explain the behavior of the observed gender and knowledge area gaps.

6. Conclusions

Professors in the PA countries consider their digital skills to be deficient and give high ratings to VR, especially in terms of its didactic and usability aspects, but also find that its high costs and the technical and specific training requirements are a strong limitation for its integration in lectures. The assessments of VR are more homogeneous than the self-concept of digital competence, which incorporates a dispersion above 40% of the mean, showing that in the PA countries, there is a greater gap in terms of self-concept of the digital skills of professors than in the rest of the Latin American region.

There are strong gaps among the PA countries in terms of the assessments of VR. Specifically, Mexican professors are those who give the lowest ratings and are more pessimistic about the future projection of VR, and Mexico is also the country with the widest gender gap, which is detrimental to females (the ratings given by males to VR were around 5% higher than the average scores of females). Chile has the largest gap between areas of knowledge (professors in scientific-technical areas gave ratings between 11% and 36% higher than those of professors in humanistic-social areas).

To favor the integration of VR in higher education in PA countries, it is recommended to increase university funding for technical equipment and design specific training sessions for the development of technical and techno-pedagogical skills of professors. These training sessions should be designed to favor the use of technologies by female professors, especially in Mexico, where the gender gap is greater, and meet the technical and didactic needs of professors in different areas of knowledge, mainly in Chile, where the gap in this regard is greater.

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