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Perceived Benefits of Future Teachers on the Usefulness of Virtual and Augmented Reality in the Teaching-Learning Process

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Abstract: Virtual and augmented reality technologies are increasingly being implemented in education and there is a growing body of evidence on their usefulness for training academic and non-academic skills among student with different education levels and diverse educational needs. To fully benefit from their use, teachers need to know the different existing tools and their potential, as well as be trained and motivated in their use. The current study aims to evaluate the factors that promote and hinder the use of virtual and augmented reality in future teaching professionals. Data were gathered by means of an online questionnaire from a total of 422 Spanish students from the Universidad Pontificia de Salamanca (Spain). Instrumental analyses (Cronbach's Alpha, and CFA) were performed, together with descriptive, correlational, and inferential tests (Manova, Anova, and Student's T test) to contrast the hypotheses. Results indicate that participants show favorable attitudes towards these technologies, but have little knowledge of them. Age, year of study, and knowledge are associated with a higher perception of usefulness as tools for teaching and learning and for promoting inclusion. The results support the relevance of providing knowledge, and enhancing skills, thus fostering positive attitudes towards these technologies.

Keywords: virtual reality; augmented reality; education with VR/AR/MR; attitudes; pre-service teachers; inclusion

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1. Introduction

Virtual and augmented reality technologies have made their appearance in the education sector. Virtual reality (VR) could be defined as an environment created by a computer system that simulates a real situation. Whereas virtual reality uses artificial environments, augmented reality uses the real world and completes it with digital information. Therefore, presence, immersion, interaction, user involvement and immediacy can be regarded as the main characteristics of VR. Augmented reality (AR) has three main characteristics. Firstly, it combines the real and the virtual. Secondly, the interaction takes place in real time, and thirdly, the registration of the virtual to the real in 3D [1]. AR has been utilized in the education sector since the beginning. AR is an interactive technology that utilizes applications of computer units (PC, Tablet, smartphone, etc.), in order to enhance users' perceived physical environment by incorporating virtual objects and other digital data on the real word thus generating a mixed reality in which virtual and real objects co-exist [2]. There are at least three main differences between virtual and augmented reality [1]: First, while VR creates new environments that are completely computer generated, AR adds virtual elements to enhance the user's experience of the real world. Second, the level of immersion of VR is 100%. Users are fully detached from the real/physical world. In contrast, users are fully connected with the physical world in AR. Third, as a general estimation, VR is 10% real and 90% virtual, whereas AR is 75% real and 25% virtual [1]. However, it is important to note that there is not clear consensus on the limits and definitions of both technologies and some authors argue that, within VR technology, it is possible to distinguish between non-immersive virtual reality (NIVR) and immersive virtual reality (IVR) [1]. In the case of NIVR, the user is not immersed in a virtual world, as the user's senses, except for sight and hearing, receive sensations from the real world. In contrast, in IVR, the user's senses receive more stimuli inputs from the computer, typically through a VR glasses system known as a head-mounted display (HMD, increasing the degree of immersion and interaction in the virtual world [3].

2. Literature Review

Although both technologies are progressively being implemented in the education field, it is relevant to reflect on their advantages and disadvantages. For example, concerning AR, a recent systematic review finds that the key benefits of using AR in e-learning included support of kinesthetic (tactile) learning, collaborative learning, distance/remote learning, learner-centered learning, and creative learning. Studies also reported that AR enhanced students' engagement, motivation, attention/focus, interactivity, verbal participation, concentration, knowledge retention, and spatial abilities, as well as information accessibility. The findings suggest that challenges associated with AR in e-learning include information and cognitive overload, lack of experience in using the technology, resistance from teachers, complex technology, costly technology, and technical issues, such as connectivity problems [4]. In addition, meta-analytic studies have shown that 3D virtual environments and augmented reality applications have moderate levels of effect on learning achievement [5]. There are a significant number of systematic reviews that support the benefits of AR in medical training [6–9]. Research on the pedagogical usefulness of immersive technologies is also increasing in other areas within health and social care education [10]. For example, some studies shown that having students design AR experiences resulted in high levels of independent thinking, creativity and critical analysis [11]. Nevertheless, other studies report that while in some instances AR can reduce cognitive load, in other cases AR is cognitively demanding and can lead to poorer performance [12]. In the field of special education, AR has proven its usefulness for teaching daily living skills [13] and language [14,15] for students with intellectual disabilities and provides tactile perception to blind students [16]. In sum, AR is being increasingly incorporated in the area of inclusive education to foster learning through discovery and experience for all [17].

Meanwhile, VR has proven useful in training the classroom management ability of pre-service teachers [18,19]. Additionally, some evidence finds that this technology is not necessarily more effective than pen and paper and video viewing approaches for learn socio-emotional competences in teenagers [20]. Another review indicates that mixed-reality simulation in particular has the potential for contributing to teacher education, because it offers the potential for learning in various contexts when compared to traditional didactic teaching practices [21]. Generally speaking, systematic reviews underscore the lack of methodologically sound studies to fully recommend the introduction of immersive technologies in different education and training fields, although results are promising [22–24]. In the field of special education, VR has been successfully utilized to teach academic skills [25], daily living skills [26], and social skills [27,28] in students with autism and other developmental disabilities, spatial remediation in children with physical disabilities [29], communication skills in children with autism spectrum disorders [30], reading and writing skills in students with speech-language pathologies [31,32], and vocational training skills in persons with intellectual disabilities [29]. In the field of teachers' training, the evidence suggests that simulation, including physical and mixed-reality types, could be used as a tool to increase confidence, self-efficacy, classroom management skills and communication among pre-service teachers [21]. Likewise, VR can help raise empathy, awareness, and the creation of a classroom environment that is conducive to learning for all students [25,33–35].

As more and more of these technologies are being included in educational settings, it is important to reflect on the advantages and disadvantages of this technology in initial educational contexts, as well as on the advantages and disadvantages perceived by the professionals responsible for teaching at pre-school and primary school levels. That is, the extent to which teachers capitalize on the potentials of VR and AR in the future depends on their perceptions towards them and their behavioral intentions when using them [34]. This is especially important considering that a recent study has demonstrated that although educators perceived many benefits of VR in education, teachers of the future may not have strong intentions to use it due to the many concerns and uncertainties that they hold [34]. In line with this finding, recent studies reveal that digital native professors feel themselves more competent in the use of virtual reality and value its technical and didactic aspects more highly, although they also identify more disadvantages in its use than digital immigrant professors. Hence, the relevance of preparing pre-service and in-service teachers to take advantage of the many educational benefits that this technology can offer while reducing perceived risks associated with its use. As Bower at al. point out [28], this will necessarily involve helping educators to not only develop their skills in using the emerging technology, but also addressing their beliefs concerning VR and its association to learning outcomes. Other studies find that pre-service teachers had greater awareness of the immersive and engagement potential of VR and less awareness about its potential to foster and promote collaborative learning [36]. Positive attitudes toward these technologies predict their use [34] and benefits with the learning experience [37,38].

As we have noted, VR and AR are demonstrating an increasingly high potential for conceptual, practical and social skills training for a growing diversity of learners, including student teachers themselves. However, as mentioned above, evidence suggests that student teachers are reticent about the use and effectiveness of these technologies, both in education in general and in the teaching and learning of students with specific or special educational support needs.

Given that favorable attitudes predict a positive behavioral intention towards a fact or an attitudinal referent, we set for ourselves the following objectives in the present study: (1) To evaluate the factors that promote and hinder the use of VR and AR in preschool and primary school pre-service teachers and other teaching professionals; (2) To identify the variables associated with different perceptions of their usefulness. We expect to find: (1) significantly different attitudes toward VR and AR according to levels of digital involvement; (2) significant differences in those attitudes between participants with and without experience with diverse population; (3) significant differences between participants with different educational background and profile.

3. Materials and Methods

3.1. Participants

Out of a population of 609 students in teaching-related studies, 422 participants (69.3%) took part in the study. Of these, 65 (98.5%) were studying preschool teaching; 105 (53.8%) were studying primary school teaching and 202 (72.4%) were studying Physical Activity and Sports Sciences studies. It should be noted that students of Physical Activity and Sport Sciences have teaching as a possible professional opportunity, but they can also dedicate themselves to the practice of sports or to management in related areas. All were students from the Universidad Pontificia de Salamanca, UPSA, (Spain). Of them, 260 (61.6%) were male, and 162 (38.4%) were female. Ages ranged from 17 to 35 (M = 20.2; SD = 2.4), with no significant differences in age between men and women (t = 1814; df = 420; p = 0.07). Students significantly differed in age by the year they were currently studying (F = 78.760; df = 3, 418; p < 0.001). Thus, first-year students were on average 18.6 years old, second-year students were 19.8, third-year students were 20.9 and fourth-year students were 22.1. Participants came from 16 different Spanish Autonomous Communities to study in the UPSA, with a majority (71.3%) coming from Castilla y León, followed by those from Extremadura (7.6%), and Galicia (4.5%). Percentages lower than 3% corresponded to the remaining Autonomous Communities, with the exception of Region de Murcia, Ceuta and Melilla that were not represented in this study. Table 1 summarizes additional information.

Table 1. Sociodemographic characteristics of the participants.

	Frequency	Percent
Previous University Degree		
No	339	80.3
Yes	83	19.7
Degree		
Physical Activity and Sport Sciences	252	59.7
Preschool	63	14.9
Primary School	107	25.4
Highest course enrolled		
1st	150	35.5
2nd	74	17.5
3rd	85	20.1
4th	113	26.8
Specialty		
Hearing and Language	8	1.9
Physical Education	43	10.2
Physical Activity and Sport Sciences	252	59.7
Preschool Education	65	15.4
Foreign Language: English	28	6.6
Special Education Needs	26	6.2

The analysis of the association between gender and studies revealed a significant association ($X^2 = 132.92$; $df = 2$; $p < 0.001$), and the inspection of adjusted residuals showed that there are significantly more men studying Physical Activity and Sport Sciences, while there are many more women studying preschool education. There was not a significant association between gender and course ($X^2 = 5.43$; $df = 3$; $p = 0.143$). However, there was a significant association between gender and having or not previous studies ($X^2 = 6.17$; $df = 1$; $p = 0.013$), and analyses revealed that it is more likely to be male and have a previous university education, while it is more likely to be female and have no previous university education.

Concerning experience with diverse population, summarized in Table 2, most of the participants lack of experience of any kind with diverse population. The most common relationship was family bonds, followed by training/work reasons. A significant percentage of participants affirm having a little experience and/or knowledge regarding VR/AR. In addition, the potential association between this knowledge and gender was not significant ($X^2 = 4.39$; $df = 2$; $p = 0.11$), denoting that this knowledge was independent of gender.

3.2. Design and Analyses

This is a descriptive-correlational study with ex post facto measures. It also adopts a cross-sectional design. To analyze the adequacy of the measures utilized for the current study, reliability test (Cronbach's alpha), and Confirmatory Factor Analysis (CFA) have been used. Additionally, descriptive statistics have been utilized. As deviations from normality were found in several variables, non-parametric tests, together with their parametric equivalents, were used to test our hypotheses. Given that sample size was large enough, the deviations from normality were not too substantial, and variances were homogeneous, so we employed both analyses. As results were the same in terms of statistical significance, we have included the parametric analyses in the current study to facilitate the interpretation of the data. As is well known, many parametric statistical tests are robust, which means that they maintain their statistical properties even when assumptions are not entirely met. Parametric tests are also robust in the presence of violations of the normality assumption when the sample size is large [39], and data transformations, such as rank-based inverse normal transformations, are not always useful [40]. Given the existing association between the factors of the different measures, to contrast some of the hypotheses, we have utilized multivariate analysis of variance (MANOVA), with Wilks' lambda test. The Manova procedure tests multiple dependent variables at the same time and it gives more statistical power when the dependent variables are correlated. Wilks' lambda test is a direct measure of the proportion of variance in the combination of dependent variables that is unaccounted for by the independent variable (the grouping variable or factor). When a large proportion of the variance is accounted for by the independent variable, this suggests that there is an effect from the grouping variable and that the groups have different mean values [41]. An alpha level = 0.05 was set for all the analyses.

Table 2. Percentages of contact with diverse population and with VR/AR technologies by the participants.

Type	Family	Training/Work	Leisure	Volunteer	No Relationship
Physical	19.0	13.3	6.4	5.5	55.9
Sensory	12.6	10.9	4.3	3.8	68.5
Intellectual	12.3	14.5	6.6	5.7	60.9
Mental health	23.7	10.9	7.8	3.6	54.0
Cerebral Palsy	5.7	10.7	5.7	2.4	75.6
SLD	6.2	14.0	5.7	4.3	69.9
ASD	6.6	17.3	7.8	4.0	64.2
ADHD	17.8	16.6	12.6	4.0	49.1
	None	A little	Somewhat	Quite a lot	A lot
VR/AR experience	31.5	37.2	27.3	3.8	0.2

3.3. Instruments

Data gathering was carried out by means of a survey that was included in Google forms to guarantee the total anonymity and confidentiality of the information (for those interested, the questionnaire can be accessed here: https://acortar.link/2f2wk0 accessed on 17 November 2022). The assessment dossier included a first section on sociodemographic variables (gender, age, educational background, etc.), as well as information on the use digital devices and contact with students with diverse specific educational needs. The second section gathered information on perceived advantages and disadvantages of virtual and augmented reality. In this section, two measures were utilized to assess the topic under study.

First, an adapted version of the 28-items measure utilized by Marín-Díaz in her study on perceived advantages and disadvantages of utilizing augmented reality for education purposes [17]. For the current study we have included the assessment of both VR and AU by adding the term VR in every item. The measure is answered in a five-point Likert-type scale, where 1 means total disagreement and 5 denotes total agreement. In addition, we included the response "don't know", to identify which issues would require more information or explanations for the students. For scoring purposes, these answers were later recoded as 3 in the 5-point scale.

Exploratory Factor Analysis was performed (extraction method: Principal Component Analysis) with Varimax Rotation. The analysis resulted in three factors that together explained 63.99% of total variance. The first factor, (Inclusion) with an eigenvalue of 14.58, is composed of eight items that assess the advantages of VR and AR for inclusive education (e.g., "VR and AR Enables the development of inclusive education"), and its reliability index was Cronbach's alpha = 0.91. The second factor (Learning), with an eigenvalue of 1.74, is composed of fifteen items that assess perceived advantages for the teaching-learning process (e.g., "VR and AR facilitates understanding of curricular content"), and its reliability was $\alpha = 0.95$. The third factor (Obstacles), with an eigenvalue of 1.47, is composed of five items that assess perceived difficulties associated with the use of VR and/or AR (e.g., "VR and AR promote a digital divide"), and its reliability was $\alpha = 0.80$. The reliability of the total measure was $\alpha = 0.96$. These data support the consistency of the measure, which is called here Perception of VR and AR in Educational Contexts, for the studied participants.

The second measure consisted of an adapted version of the tool utilized in the study by Ariza-Carrasco and Muñoz-González [42] to assess pre-service teachers' expectations towards the use of augmented mind map in puzzle technique, in the teaching-learning process. Again, for the purposes of the current study, we change the term 'mind map' for the term 'Virtual and Augmented Reality" and we have called the measure: VR and AR in Learning Process. As the original authors, we included 12 items to assess the perceived benefits on the development of three skills: (1) Personal Skills (e.g., "VR/AR allows students to learn autonomously"; α = 0.93, for the current study); (2) Interpersonal Skills (e.g., "VR/AR facilitates discussion among students"; α = 0.89); and (3) Learning-Focused Skills (e.g., "VR/AR promotes a better understanding of the contents", α = 0.91). Total reliability of the measure was α = 0.96. As with the previous measure, a five-point Likert-type scale was used, where 1 means total disagreement, 5 denotes total agreement and the response "don't know" was included and later recoded as a 3 score.

A confirmatory factor analysis (CFA) was performed, considering the χ^2 test/degrees of freedom, the comparative goodness-of-fit index (CFI), the incremental fit index (IFI) comparative goodness-of-fit index (CFI), incremental fit index (IFI), normed fit index (NFI), Tuker-Lewis index (TLI), root mean square residual of approximation (RMSEA) and expected cross-validation index (ECVI). The following values were obtained: $\chi^2 = 241.218$; 51; $p < 0.001$; $\chi^2/df = 4.73$; CFI = 0.96; IFI = 0.97; NFI = 0.95; TLI = 0.95; RMSEA = 0.09, and ECVI = 0.76. Taken together, these indexes support the three-dimensional structure of the measure, and reliability analyses support its internal consistency.

3.4. Procedure

The questionnaire was available in the first term of the 2022–2023 academic year. The data collection procedure required the approval and collaboration of the Pontifical University of Salamanca, as well as the colleagues responsible for teaching in the different degrees and training levels. The authors of this study were responsible for disseminating the survey, guaranteeing confidentiality and anonymity as well as voluntary participation in the study. All potential participants were sent a link to the questionnaire or a QR code to access it. Participants had to expressly state their consent to participate in the study. Of the total number of questionnaires received, nine were discarded for not having given consent.

4. Results

4.1. Perceived Benefits of VR and AR and the Sociodemographic Profile

The analysis of mean scores on the subscales and scales utilized revealed medium-high average scores ranging from 3.3 to 3.9 which, in a five-point scale, denote elevated perceived benefits of VR and AR in educational settings. The highest score corresponded to Personal Skills ($M = 3.90$, $SD = 0.92$), followed by Learning-Focused ($M = 3,85$; $SD = 1.01$), and Skills Development ($M = 3.74$; $SD = 0.88$), Inclusion ($M = 3.74$, $SD = 0.88$), Learning ($M = 3.75$; $SD = 0.91$), Interpersonal Skills ($M = 3.50$; $SD = 1.05$), and Obstacles ($M = 3.30$, $SD = 0.91$). In contrast, the ten items with the highest percentages of uncertainty (i.e., "don't know" responses) obtained referred to VR/AR: favoring the digital divide (12% of "don't know" responses), being used by the visually impaired (11.5%), being used to prevent bullying situations (9.3%), facilitating the development of discussions among students (7.5%), being used by people with intellectual disabilities (6.9%), helping to develop confidence in sharing ideas with peers (6.9%), promoting cross-curricular teaching of content (6.5%), helping students develop their argumentation skills (6.5%), being used by people with physical disabilities (6.3%), and being used by people with high abilities (6%). In total, 5.2% of the responses ($n = 878$), denoted uncertainty about the potential use of the VR/AR in educational settings.

A MANOVA test was run to compare means by gender of the participants, and there were no significant differences in perceived benefits of VR/AR for teaching purposes (Wilks' Lambda = 0.977, $F = 1.606$; $df = 6$; $p = 0.144$). Second, Pearson's correlations between age and scores in the measures and factors revealed significant and positive associations between age and Inclusion ($r = 0.143$; $p < 0.01$), Learning ($r = 0.115$; $p < 0.05$), Personal Skills ($r = 0.122$; $p < 0.05$), Learning-Focused Skills ($r = 0.130$; $p < 0.001$), as well on Total measure on Perception of VR and AR in Educational Contexts ($r = 0.119$; $p < 0.05$), and on VR and AR in Learning Process ($r = 0.119$; $p < 0.05$). These results suggest that regardless the age, the older the participants, the more positive the attitudes toward virtual and augmented reality technologies.

4.2. Attitudes toward VR and AR and Experience with Diverse Population

A series of MANOVA tests were used to compare the means in the factors of the measures on perceptions toward VR and AR of participants based on the type of contact (family, work/training, leisure, voluntary) with different specific support needs (physical, sensory, intellectual, mental health, cerebral palsy, specific language disorder, autism spectrum disorder —ASD-, and Attention deficit hyperactivity disorder —ADHD-). First, the multivariate result was not significant for contact with persons with physical disability (Wilks' Lambda = 0.933, $F = 1.205$; $df = 24$; $p = 0.225$), thus, participants were not significantly different in their judgments about the usefulness of VR and AR regardless their previous experience with persons with physical disabilities. Likewise, the multivariate result was not significant for contact with persons with sensory disability (Wilks' Lambda = 0.952, $F = 0.845$; $df = 24$; $p = 0.683$), intellectual disability (Wilks' Lambda = 0.960, $F = 0.710$; $df = 24$; $p = 0.846$), mental health issues (Wilks' Lambda = 0.61, $F = 0.693$; $df = 24$; $p = 0.862$), cerebral palsy (Wilks' Lambda = 0.922, $F = 1.417$; $df = 24$; $p = 0.087$), ASD (Wilks' Lambda = 0.934, $F = 1.184$; $df = 24$; $p = 0.245$), and ADHD (Wilks' Lambda = 0.959, $F = 0.717$; $df = 24$; $p = 0.838$). In contrast, multivariate analysis was significant for contact with persons with specific language disorders (Wilks' Lambda = 0.901, $F = 1.671$; $df = 24$; $p = 0.022$), and univariate tests revealed significant differences on the factors Learning ($p = 0.029$) and Obstacles ($p = 0.037$). Concerning Learning scores, those participants with leisure contact scored significantly higher than those participants with training/work relationship. Regarding Obstacles, those with family contact scored significantly lower than those with other types of relationship.

4.3. Attitudes toward VR and AR and Digital Involvement

A MANOVA test was performed to compare the scores of the participants based on their experience with VR/AR. Before performing the analysis, responses were recoded into three groups (none, a little, somewhat or more experience) to ensure similar subsample sizes. Multivariate analysis was significant (Wilks' Lambda = 0.946, $F = 1.952$; $df = 12$; $p = 0.026$), and univariate tests revealed significant differences in Learning-Focused Skills ($F = 5.429$; $df = 2, 419$; $p = 0.004$). Games-Howell pairwise comparisons showed that those who did not have previous experience with VR/AR score significantly lower ($M = 3.63$; $SD = 1.10$) than the remaining two groups ($M = 3.9$; $SD = 0.92$ for the subgroup with a little experience, and $M = 4.02$, $SD = 0.98$ for the subgroup with some experience) in this factor.

4.4. Attitudes toward VR and AR and Background Profile

Manova analysis of differences on the scores in the measures, and previous or not university studies showed a lack of significant differences (Wilks' Lambda = 0.986, $F = 0.997$; $df = 6$; $p = 0.427$). Concerning differences based on the current undergraduate studies, multivariate test was significant (Wilks' Lambda = 0.943, $F = 2.066$; $df = 12$; $p = 0.017$), so we performed univariate test that revealed significant differences in Obstacles, Interpersonal Skills, and Learning-Focused Skills. As Figure 1 depicts, participants of preschool teaching studies score higher than the remaining groups and these differences were statistical significant between them and the students from Physical Activity and Sport Sciences in the domains of Interpersonal Skills and Skills development.

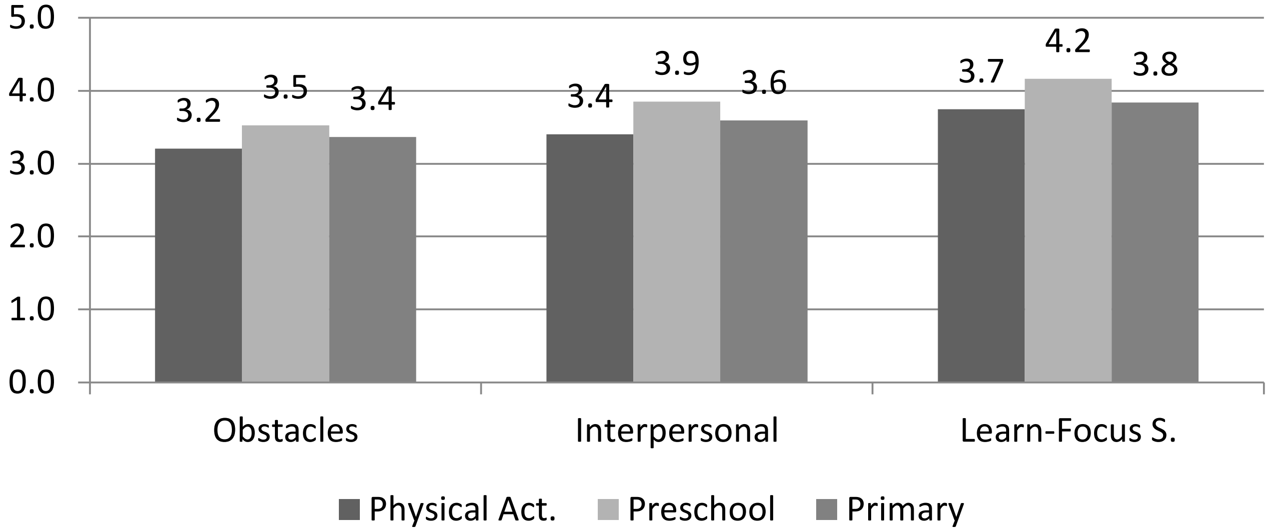

Figure 1. Average scores in selected variables of participants from different undergraduate studies.

5. Discussion

This study shows that current pre-service teachers are digital natives' and utilize and perceive VR and AR technologies in a quite positive way. Probably 'digital immigrants' would not have scored that high, as some studies suggests [43]. However, it is important to note that the highest percentages of "don't know" responses corresponded to items that asked about the potential use of these technologies with persons with different disabilities. Even though there is a significant corpus of research supporting the utility of this technology with students with diverse educational needs [13,44–47], some pre-service teachers are not convinced of their benefits and may be reluctant to use them [4]. As positive attitudes toward this technology may predict their use [34] and benefits with the learning experience [37,38], it is important to invest efforts during teachers' training in order to demonstrate the utility of these technologies with those students. In turn, the use of these technologies is, by itself, a powerful strategy to improve attitudes, empathy, and awareness toward educational inclusion of students with different special needs [33,35].

Findings also suggest a significant and direct association between age and perceived benefits of VR /AR. This result could be explained as a consequence of being trained during their university years in technologies and their use in educational contexts as well as a tool for inclusion. As our data suggest, participants in undergraduate studies where subjects on technologies and supports for students with disabilities are included (i.e., teaching studies), rate the benefits of these technologies higher than participants in degrees where no specific subjects about it are included (i.e., physical activity and sport sciences).

The usefulness of these technologies is not just a matter of opinion but a reality for which there is growing evidence, as we have summarized in the literature review. The benefits of VR as a training tool has been explored with special education teachers [19]. In university contexts, it has been determined that the apps for AR contribute significantly to the improvement of digital competence of university students while enhancing their learning motivation [48]. The relatively high percentage of participants who admit not being familiar with AR/VR, as well as not having contact with diverse population, offers us an excellent opportunity to combine both topics, namely technology and diversity, to improve knowledge, attitudes, and skills in these domains. According to our findings, the more familiar one becomes with VR/AR technologies, the more one appreciates their potential as tools for developing learning-focused skills.

Another interesting result relates to perceived usefulness of these technologies for persons with disabilities, which receives a broad consensus, regardless the type of contact with this population. Focusing on students with specific language disorders, previous literature has shown that technology-assisted language learning is a useful tool to improve reading and writing skills [31], and VR has been successfully applied in the field of speech-language pathology, although further evidence in this regard is advisable [32]. The finding that those participants with leisure relationship with this population find these tools significantly more useful for learning purposes may be suggesting the potential use of these tools to acquire skills through non-traditional ways; that is, through gamification or similar. In other words, participants may have shared experiences of using VR and AR tools together in a playful context. As these tools allow access to information and learning through non-traditional means, they can enhance learning motivation and frustration tolerance among students who otherwise would experience school failure [25]. Similarly, it may provide alternative means for students with ASD to acquire communication and social skills [28]. While there is some evidence for this, more research is needed on this issue [49].

In sum, the present study contributes to the growing evidence that VR/AR is increasingly seen as a useful tool for teaching and learning and for the inclusion of diverse learners. The acceptance of these technologies is affected by the degree of prior knowledge or use of these technologies, both in general terms and in their use as assistive technology. Hence, it is important to promote the inclusion of these contents in the training curricula of future teachers. This might improve not only their attitudes towards their use, but also their competence. These improvements might, in turn, increase the possibilities for inclusion of students with very different educational support needs.

Future studies, with larger and more diverse samples, as well as designs that allow for monitoring progressive changes in knowledge, skills and attitudes towards VR/AR, and with evaluation strategies that combine quantitative and qualitative approaches, will corroborate or qualify the present findings.

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