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How to bring immersive VR into the classroom: German vocational teachers' perception of immersive VR technology

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ABSTRACT: Affordances of immersive Virtual Reality (iVR) technology for learning (e.g., presence, immersion, interaction with 3D objects) and challenges of embedding this technology in teaching concepts are widely discussed. However, information on how German vocational teachers in the technical domain perceive iVR technology and if they intend to embed iVR in a classroom setting is still limited. Thus, the aim of the current study is to bring some insight into how these teachers perceive the value of iVR and to what extent their beliefs can be used as predictors for future intention to use. We conducted a study (n = 55) based on the Unified Theory of Acceptance and Use of Technology (UTAUT) containing items regarding performance expectancy, effort expectancy, social influence and facilitating conditions as determining factors as well as prior experience as a moderator for the intention to use. The main result we observed was that only performance expectancy significantly predicted the intention to use iVR in the classroom (β = 0.445, p = .001). In contrast to UTAUT, we also observed that prior experiences with VR headsets did not have an effect as a moderator variable, but it did have a direct effect on three of the determining factors of intention to use. Based on our results, we discuss implications for future embedding of immersive VR technology in classroom learning settings.

Keywords: Immersive Virtual Reality, Vocational Teachers, Technology Acceptance, Vocational Education

Wie kommt immersive VR in den Unterricht: Wahrnehmung immersiver VR Technologie durch Berufsschullehrkräfte

ZUSAMMENFASSUNG: Die Vorteile von immersiver Virtual Reality (iVR)-Technologie für das Lernen (z.B. Präsenz, Eintauchen, Interaktion mit 3D-Objekten) werden vielfältig diskutiert. Es gibt jedoch nur wenige Informationen darüber, welche Erwartungen Lehrkräfte an berufsbildenden Schulen im technischen Bereich an iVR-Technologie haben und ob sie beabsichtigen, iVR in den Unterricht einzubinden. Ziel der vorliegenden Studie ist es daher, Erkenntnisse darüber zu gewinnen, inwiefern Lehrkräfte im gewerblich-technischen Bereich iVR-Lernanwendungen wahrnehmen und inwieweit ihre Erwartungen an die Technologie als Prädiktoren für künftige Nutzungsabsichten dienen können. Zur Untersuchung dieser Fragestellung wurde die Unified Theory of Acceptance and Use of Technology (UTAUT) herangezogen. Als Ergebnis der vorliegenden Studie (n = 55) kann festgehalten werden, dass vor allem der erwartete Nutzen von iVR-Technologie, die Absicht, iVR im Unterricht einzusetzen, signifikant vorhersagte (β = 0,445, p = .001). Weiterhin waren Vorerfahrungen mit VR-Headsets ein entscheidender Einflussfaktor auf die einzelnen Determinanten der Nutzungsabsicht. Im Beitrag werden die Ergebnisse präsentiert und erörtert, welche Implikationen sich für die künftige Einbindung von iVR-Technologie in den Unterricht ergeben.

Schlüsselwörter: Immersive Virtual Reality, Berufsschullehrkraft, Technikakzeptanz, Berufliche Bildung

1 Introduction

Germany's technical Vocational Education and Training (VET) system is highly relevant for industry and trade in Germany. Approximately 500,000 young people are in a dual VET program in a STEM (Science, Technology, Engineering, Mathematics) field each year (BIBB 2020). During their training, apprentices attend a vocational school and work at a company on a rotation basis. Compared to regular schools, the vocational school is dedicated to theoretical and practical content related to the chosen apprenticeship. The apprentices at a vocational school have already completed the intermediate secondary school and are therefore usually older, mostly between 16 and 25 years of age. Training lasts between two and three-and-a-half years depending on the profession. In vocational school these apprentices learn about theoretical background information and basic technical competencies. At vocational schools they are taught by vocational teachers. German vocational teachers have studied a vocational subject at university related to the professional field (e.g., metal engineering) in addition to a teaching subject also taught at regular schools (e.g., politics, mathematics). At the company, apprentices are taught by supervisors and they learn how to apply these competencies in real time and work on actual machines in the technical domain. However, when working on site at a company, work with real machines is limited due to apprentices' low level of experience. Thus, vocational schools step in and provide training experiences. Not all machines are available for various reasons, such as safety concerns, the expense of the machines or that they are too large. Instead, individual technical components are used for training purposes to provide apprentices with practical experience. Such practical experiences in autonomous learning environments are essential for developing professional skills in technical vocational education (Barabasch & Keller 2020).

Due to the recent rapid development of high-quality Virtual Reality (VR) technology, it would now also be possible for machines or plants to be experienced virtually. VR can be accessed through various technical systems. In a very broad sense, VR may simply refer to a computer-mediated virtual environment which could be provided through a conventional desktop PC set-up. The user *looks at* the virtual environment shown on screen and interacts via keyboard and mouse. Some authors refer to this form as desktop VR (e.g., Slater & Sanchez-Vives 2016). However, the present article is addressing modern head-mounted-display (HMD)-based systems where participants are *fully immersed* in VR. These systems can be described as immersive VR (iVR) (e.g., Makransky & Petersen 2021, Slater & Sanchez-Vives 2016). In iVR apprentices could practice skills on virtual machines, explore complete technical systems, and experience consequences to learn from them. As previous studies have already shown, iVR technology can be beneficial for learning (e.g., Azhar, Kim & Salman 2018, Radianti et al. 2020, Kaplan et al. 2021). Plass et al. (2022) point out these affordances of iVR can be described as unique opportunities that come with the technology itself such as a feeling of presence, interacting with 3D objects in a virtual space, or the emotional design through multisensory features. For instance, as a part of a SWOT analysis, Azhar, Kim, and Salman (2018) highlighted strengths and opportunities of iVR learning applications in the field of construction education such as providing real scenarios, being interactive, or reducing dependencies of field visits. And, as Söderström et al. (2020) observed, especially apprentices can benefit from the autonomous learning situations found in computer-generated virtual experiences regarding performance and self-reflection. Thus, iVR technology might be a promising approach for technical VET (see also Stender, Paehr & Jambor 2021, Spilski et al. 2019, Abdel-Wahab 2011).

In the past, due to the excessive costs of high-quality immersive VR technology such as the HTC-Vive (about 1,200 Euro per headset, plus suitable PCs at about 1,500 Euro each), the use of iVR via head-mounted-display (HMD) in schools was the exception rather than the rule. For instance, to equip an entire class of about twenty apprentices with a set of HMDs in high resolution plus a corresponding PC, such as the HTC-Vive, would have cost about 60.000 Euro. Now, with technological solutions that are available in a lower cost segment as such as Oculus/Meta Quest, Pico, Valve Index or Samsung Gear VR (starting between 300 and 600 Euro), the purchase of such equipment has become more affordable and is comparable to equipping a schools' computer lab with new computers or giving a class a set of tablets.

Within the various issues affecting the actual use of iVR and the attitude of teachers toward the educational technology, there is little known about the question how vocational teachers assess the affordances of iVR applications as educational tools and whether they intend to implement iVR learning applications in a classroom setting (Pletz & Zinn 2018, Spilski et al. 2019, Schmitz & Mulders 2021). Besides iVR technology still not being common in schools, teachers might also face practical challenges such as safety issues or limited facility resources (Dahl, Fjørtoft & Landmark 2020, Radianti et al. 2020, Hellriegel & Čubela 2018, Southgate et al. 2019).

Against this background the aim of the current study is to shed some light on how vocational education teachers perceive the value of iVR and to what extent their beliefs can be used as predictors for future intention to use. Thus, based on the technology acceptance model (TAM) by Davis (1989) and the Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh et al. (2003), we will investigate German vocational teachers' VR technology acceptance in the technical domain (n = 55). Based on our results, we will discuss vocational teachers' perception of iVR. With this approach, we want to contribute to the discourse on factors that influence the decision of vocational teachers to implement iVR in an actual classroom setting.

2 Learning with iVR applications in vocational education

Virtual Reality can be explored through different displays (e.g., computer, CAVE, head-mounted-display) that differ in their degree of immersion. In line with the Cognitive Affective Model of Immersive Learning (CAMIL, Makransky & Petersen 2021), we will refer to immersive Virtual Reality (iVR) because we focus specifically on the use of head-mounted-displays (HMD) in schools. The term iVR is used to distinguish the technology from other systems (e.g., 3D environments explored through a desktop computer, CAVE) which are typically characterized as less immersive (e.g., Slater & Sanchez-Vives 2016). Immersive VR technology provides users with a computer-generated experience that can be perceived as real. In iVR the user can dive into a virtual reality that feels as present as if they were experiencing it for real and precipitate the same reactions of the 'brain-body system' as a situation would in reality (Slater 2018, p. 432).

Head-Mounted-Displays have become more affordable for contexts outside of research labs, such as the entertainment and industrial sector as well as educational contexts. As shown in previous studies, iVR technology can foster cognitive, emotional or behavioural learning outcomes (e.g., Kaplan et al. 2021, Pellas et al. 2021, Radianti et al. 2020, Wu, Ju & Gu 2020, Hu-Au & Lee 2017, Merchant et al. 2014). However, little is known about actual teacher experiences with using iVR technology in a classroom setting. There are limited research findings on successful embedding of iVR using HMDs in a natural classroom environment (Southgate et al. 2019, Hamilton et al. 2021). To date, there have been many pilot studies but few overall approaches to implementing iVR in educational settings (Guilbaud, Guilbaud, & Jennings 2021, Hamilton et. al 2021). Radianti at al. (2020) state that "future research should assess whether developed applications reflect the users' needs, from the perspective of both teachers and students" (p. 22).

Orchestrating the implementation of iVR headsets into a classroom setting also implies embedding the technology in a teaching concept. The relevance of teachers embedding the use of the technology in their lessons has been observed in earlier studies regarding instructional games and technology integration in teaching. Within the input-process-outcome game model established by Garris, Ahlers, and Driskell (2002), the authors argue that a debriefing process of playing an instructional game can be crucial for a learning outcome. The authors state that with instructional support, the gap between virtual experience and real-world practice can be closed. Within the TPACK framework by Mishra & Koehler (2006), three types of knowledge have been described as a foundation to implement educational technology in the classroom: technological knowledge (TK), pedagogical knowledge (PK) and content knowledge (CK). And, in line with Kapp et al. (2019), debriefing and the context (e.g., technical equipment, local barriers) must be considered in order to foster a cognitive, metacognitive, motivational, emotional, motoric, or social learning process when using iVR in education. This can be done by embedding the technology within the overall teaching strategy. Furthermore, Southgate et al. (2019) observed that when implementing iVR learning applications in school, teachers face safety issues in addition to dealing with facilitating conditions. Comparable findings have been shown by Cattaneo, Antonietti & Rauseo (2022). While assessing vocational teachers' digital competence, the authors identified curriculum support as an influential factor for building digital competence besides personal and contextual factors. Embedding iVR in a classroom setting also requires a comparatively high effort: software must be installed on around 20 devices, a sufficient number of play spaces (around 5sqm) must be set up (often with the help of taping off the spatial boundaries on the floor as orientation for students), and, if the classrooms are too small, more rooms and supervisors need to be organised.

Another challenge for successful implementation of iVR headsets in the classroom is the yet limited availability of effective iVR applications. Currently, only a limited number of available VR applications exist that aim at appropriate learning objectives in line with German curricula of the relevant VET domain. Stender et al. (2021) identified two VR applications developed especially in the field of VET in electrical, metal and mechatronic engineering: the applications VILA and MARLA. VILA is a virtual 3D learning and working environment for mechatronic technicians and electronics technicians in the field of automation technology (Zinn et al., 2016). Another application is the game-based iVR learning application "MARLA-Masters of Malfunction" (Spangenberger et al. 2021). MARLA has been developed to foster troubleshooting competence in the field of metal and electrical engineering. Using the Oculus/Meta Quest, apprentices operate as skilled workers on a virtual offshore wind energy plant and systematically diagnose an error in the hydraulic brake system. A VR application that has been developed for metal engineering is the mixed-reality application MARVEL. It has been developed as a virtual task to control and maintain a full-scale solar plant, configure a robot system, and diagnose and maintain a modular production system (Mueller & Ferreira 2003). In addition, the aim was for groups to share their progress and experiences on a virtual learning platform. Further iVR applications have been developed to foster learning objectives in other VET domains such as a painting simulator or a VR learning platform (e.g., Mulders, Buchner & Kerres 2020, Zender et al. 2020, see also Gavish et al. 2015). However, most of the applications have been developed in research contexts, target skilled workers at industrial work sites, require extensive equipment, or have not been distributed for teachers to use independently at schools. Additionally, content creation for iVR applications is complex and often requires programming. Teachers themselves will therefore rarely be in a position to develop their own iVR applications. Even though some authoring tools already exist, their use is rare and time-consuming. Thus, the limited availability of iVR software is another constraint for successfully embedding this kind of technology in the classroom.

3 IVR Technology acceptance of vocational teachers

Teachers' personal attributes and attitudes can play a significant role in their use of digital technology within a classroom setting (Nelson & Hawk 2020, Lai & Jun 2021, Jang et al. 2021). While recent studies about advanced iVR technology in the educational context focused on the learning outcome, a few studies investigated teachers' perspectives on their experience with iVR technology via HMD in the classroom (e.g., Eutsler & Long 2021, Raja & Lakshmi 2020, Jang et al. 2021, Böhm, Stolzenberger, & Trefzger 2019). While Eutsler & Long (2021) examined stages of concern about integrating VR into science classes among preservice science teachers in the southwestern United States, Raja & Lakshmi (2020) examined the intention to use VR among teachers of different subjects (Tamil, English, Maths, Science, Social Science, Computer Science) in India. Jang et al. (2021) explored in-service elementary school teachers' willingness to use AR and VR technologies for learning scenarios in South Korea. Böehm et al. (2019) also observed a positive trend concerning the use of augmented virtual reality by German preservice teachers in the STEM field.

In scientific literature the concept of technology acceptance by employees in a work environment has been thoroughly examined based on the work of Davis, Venkatesh and colleagues (e.g., Davis 1989, Venkatesh & Davis 2000,Venkatesh et al. 2003). The authors argue that the intention to use a new technology at work depends mainly on a person's performance expectancy and effort expectancy. Performance expectancy describes the feeling of being convinced that the technology will be of great support for the output of one's daily tasks. Effort expectancy describes the ease of use of a new technology (see Venkatesh et al. 2003). The authors argue that if performance of a new technology is expected to be beneficial and its use is expected to be effortless, the intention to use and apply a new technology in one's work environment will increase. In the 'Technology Acceptance Model' (TAM), the authors present performance expectancy and effect expectancy as the main factors determining the intention to use a new technology. Since its development, the TAM model has been validated in a large number of studies worldwide (Venkatesh et al. 2003). Further adaptations of the model have been developed such as TAM2 (Venkatesh & Davis 2000) or Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003) to include more factors determining the intention to use new technology in the work context such as age, gender, subjective norms, prior experience or facilitating conditions (see figure 1). While TAM2 included subjective norms, UTAUT followed up on the results of TAM2 and TAM and further models on technology acceptance, finding four key factors that are relevant for users' technology acceptance and use of a new technology: "performance expectancy, effort expectancy, social influence, and facilitating conditions" (Venkatesh et al. 2003, p. 447). Testing the UTAUT, Venkatesh et al. (2003) observed that compared to performance expectancy, effort expectancy becomes less significant over time. Social influence, described as the opinion of one's relevant peer group on using a technology, might be more relevant in mandatory settings. Facilitating conditions are "…defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system" (p. 453) and can determine use behaviour directly. These four key factors can be moderated by four further variables such as age, gender, voluntariness and prior experiences. Self-efficacy, attitude and anxiety have been shown to have no direct effect on intention and were dropped from the final UTAUT model (Venkatesh et al. 2003). Recent studies have examined further variables that may be particularly relevant to the use of VR technology, such as motion sickness or pragmatic quality (Sagnier et al. 2020). TAM and UTAUT have also been applied among teachers and rated as an appropriate model to explain influential factors for teachers' intention to use technology (e.g., Teo 2011). Since then, TAM and

UTAUT have been used to investigate teachers' acceptance and intention to use for a variety of different technologies, such as AR and VR technology (e.g., Jang et al. 2021; Abd Majid & Mohd Shamsudin 2019), interactive whiteboards (e.g., Šumak & Šorgo 2016), the mobile internet (e.g., Nikolopoulou, Gialamas & Lavidas 2021), digital learning environments after hours (e.g., Bauwens et al. 2021) or teachers' general adoption of digital technology in educational contexts (e.g., Scherer, Siddiq & Tondeur 2019) – to name just a few areas existing research has investigated.

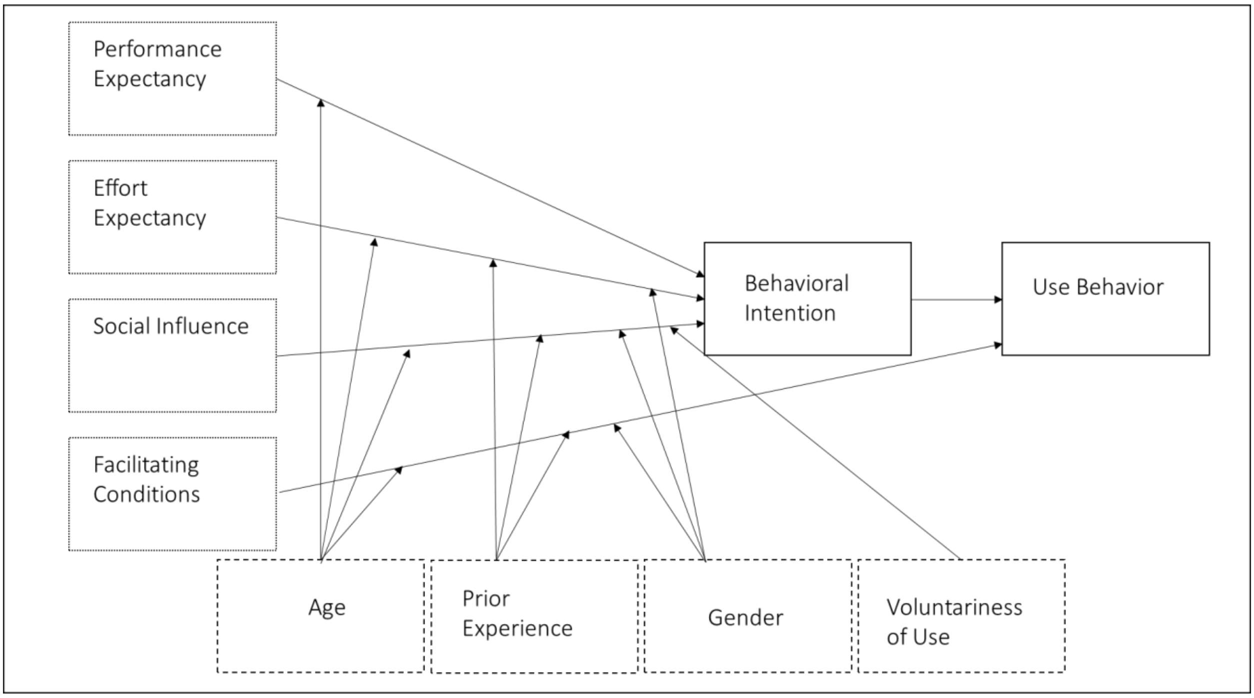

Fig. 1: "Research Model of the Unified Theory of Acceptance and Use of Technology (UTAUT)". Own illustration based on Venkatesh et al. (2003).

Two investigations concerning technology acceptance of VR in the technical domain of German VET have been conducted and are relevant in this context. A study by Pletz & Zinn (2018) examined technology acceptance in German technical domains, questioning 271 skilled workers in the industrial sector, e.g., engineers, service technicians, and information technologists. The authors found that age did not influence the intention to use iVR technology in the work context. Key determining factors for the intention to use VR for work-related contexts were the workers' performance expectancy and effort expectancy. Measuring group differences, the authors also showed that prior experiences with iVR technology directly influenced performance expectancy and intention to use compared to people without experience with iVR technology. Thus, it can be assumed that prior experience with iVR might also be relevant for German vocational teachers. Secondly, a study by Schmitz & Mulders (2021) surveyed a sample (n = 25) containing relevant stakeholders, such as employees of German chambers of commerce (n = 11), regarding determining factors for the use of VR learning applications and compared these results with the technology acceptance of apprentices (n = 14). The results showed no difference in technology acceptance between the target groups. Both groups reported a high relevance of enjoyment as a determining factor for the intention to use iVR as well as facilitating conditions. Furthermore, only a few participants had prior experiences. Vocational teachers were not part of the sample in either study. In light of this background, it remains uncertain how vocational teachers perceive the use of iVR technology in the classroom and what aspects influence their intention to use iVR.

4 Current Study

The first aim of this study is to give insights into how vocational education teachers perceive iVR technology and to what extent they rate the technology useful for their classes. Thus, we collected descriptive data on how teachers evaluate performance expectancy, effort expectancy, social influence, schools' facilitating conditions as well as intention to use. Based on UTAUT we assumed that vocational teachers' intention to use iVR is determined by performance and effort expectancy, social influence and the school's facilitating conditions. To that extent we formulated the following hypotheses:

- H1a: The perceived performance expectancy is positively related to intention to use iVR in the classroom.
- H1b: The perceived effort expectancy is positively related to intention to use iVR in the classroom.
- H1c: The perceived social support is positively related to intention to use iVR in the classroom.
- H1d: The perceived facilitating conditions are positively related to intention to use iVR in the classroom.

In case of the moderator variables, we slightly adapted UTAUT to a teacher's work environment because the German VET school system is a work environment with unique characteristics for its employees:

Voluntariness: The German curricula for vocational training professions set the main learning objectives and indicate learning content in a specific time frame (e.g., per year of apprenticeship). While the learning content is regulated by the federal states, the choice of which learning method to use such as project work or digital tools is up to the teacher. Thus, despite a common understanding of modern teaching methods, the final decision on which teaching method will best achieve the learning objective will vary from teacher to teacher. This means that the use of iVR technology is voluntary. Based on this background, voluntariness of using iVR headsets in the classroom is a given in the German vocational school systems, and not a relevant variable for our investigation.

Facilitating conditions: In the original UTAUT, facilitating conditions have a direct influence on use behaviour. In German vocational schools, facilitating conditions such as the teacher's technical equipment depends on the school's budget, e.g., the support of its headmaster. Against this background, we considered perception of facilitating conditions as a determinant variable of the intention to use iVR in the classroom in contrast to the original UTAUT (see Figure 2).

Age and Gender: Age and gender have been evaluated as control variables. Directly in relation to the dependent variables, there were no significant differences depending on age and gender. Prior studies on the technology acceptance of iVR applications of employees in the technical domain in Germany also found no difference based on gender or age, thus, we excluded these moderating variables from our model (Pletz & Zinn 2018, Schmitz & Mulders 2021).

Prior Experience: The investigations by Pletz & Zinn (2008) showed that perceived prior experience of employees in the technical domain influenced performance expectancy and effort expectancy of iVR technology directly. Based on this background, we tested prior experience as a moderating variable as well as a direct determinant of performance expectancy, effort expectancy, social support and facilitating conditions using the following hypotheses:

- H2: Prior experience is a moderating variable on intention to use.

- H3: Prior experience determines performance expectancy, effort expectancy, social influence and facilitating conditions directly.

4 Methods

4.1 Participants

55 participants answered the questionnaire and were part of the analysis. They were between 19 and 75 years old (M = 47.80, SD = 12.01; n = 55). Nine participants were female, 46 participants were male. 26 participants taught in the field of electrical engineering, 25 participants taught in the field of metal engineering and 19 participants reported miscellaneous fields, including multiple answers. Answering the questions about the kind of institution at which participants gained their teaching experience, 32 participants answered German vocational school, 19 participants answered German apprenticeship institution, while 10 chose miscellaneous, including multiple answers. Nine participants had a master craftsman degree, six participants reported having a skilled worker degree, 15 participants reporting a degree from a university of applied sciences as well as 29 participants with a pedagogical degree and three miscellaneous, including multiple answers. 31 participants (56.4 %) had prior experience with iVR technology against 24 (43.6 %) that reported no prior experience with VR technology.

4.2 Procedure

The questionnaire was provided via an online survey platform called SoSci Survey and sent out to vocational teachers in Germany or to multiplicators (such as researchers in the field). The call to participate was also published on the project webpage and reposted on several German webpages in the field of vocational education and teaching. Thus, participants were from different vocational schools or apprenticeship institutions in Germany. They took part voluntarily. Participation was accompanied by an incentive (winning a spot in an online seminar about iVR and learning).

4.3 Measurements

Performance expectancy and effort expectancy. To measure these two aspects of technology acceptance, we used the German version of items from the TAM model (Vekantesh et al. 2003) adapted to VR technology developed by Pletz & Zinn (2018). This included four items on performance expectancy (e.g., ‘I would find VR technology useful in my job’ or ‘Using VR increases my productivity’; Omega ω = .922) and four items on effort expectancy (e.g., ‘I would find VR technology easy to use’, or ‘Learning to operate VR is easy for me’; Omega ω = .896).

Positive social norm towards iVR. To measure further influential factors, we added four items on social influence (e.g., ‘The headmaster has been helpful in the use of VR technology’; Omega ω = .798), and four items on facilitating conditions (e.g., ‘I have the resources necessary to use VR technology’; Omega ω = .552) in line with the UTAUT model, adapted from the German version translated by Harborth & Pape (2018). Harborth & Pape presented and validated a German translation of the questionnaire of the Unified Theory of Acceptance and Use of Technology 2

(UTAUT2) regarding the intention to use Pokémon-Go. All items had to be rated on a Likert scale from 1 (1=I strongly disagree) to 5 (5= I strongly agree).

Intention to use. To measure the intention to use VR in the classroom, we chose a scale from 1 to 10, answering the question "How likely is it that you will use VR technology in the classroom in the future?".

Prior experience. The question on prior VR experience was formulated in terms of application: "I have used VR headsets in a private (e.g., games) or professional environment (e.g., simulations)." Providing a yes or no option to answer.

Demographic data. We also added questions on demographic data, such as age and gender, academic degree, teaching institution and field of teaching.

Statistical analysis. To test hypothesis H1a-H1d and H2 we used multiple regression analysis. To test hypothesis H3 we used the Mann-Whitney U test. We tested for normal distribution (not found for all variables). Thus, we calculated group differences using Mann-Whitney-U-test.

5 Results

Using multiple linear regression analysis, we found that performance expectancy significantly predicted the intention to use VR in the classroom ($\beta = 0.445$, $p = .001$). We found no significant effects of effort expectancy, social influence or facilitating conditions on the intention to use. The linear model yielded a variance explanation of 31.30 % ($R2 = .313$) for the intention to use (see table 1). Thus, H1a cannot be rejected while H1b-H1d have to be rejected. Results show that prior experiences did not moderate the relationship between the (four) independent variables and the intention to use (see table 1). The overall model was significant, $F(9, 42) = 15.372$, $p = .010$, predicting 24.6 % ($R2 = .246$) of the variance. Thus, H2 has to be rejected.

Tab. 1: Results of multiple regression analysis using SPSS. *p < .05; ** p < .01; *** p < .001.

	Beta		
	β	**t**	**p**
Predictors		17.012	0.000
Prior Experience	0.518	1.012	0.317
Performance Expectancy_Cen	0.601	3.867	0.000***
Effort Exptecancy_Cen	0.077	0.474	0.638
Social Influence_Cen	0.083	0.556	0.581
Facilitating Conditions_Cen	0.081	0.576	0.568
INT_PER*PRIO	-0.197	-1.298	0.201
INT_EFF*PRIO	0.016	0.106	0.916
INT_SOC*PRIO	0.259	1.800	0.079
INT_FAC*PRIO	-0.575	-1.151	0.256

Dependent Variable: Intention to use iVR

Note: PER_Cen=Performance expectancy centralised, EFF_Cen = Effort expectancy centralised, SOC_Cen=Social influence centralised, FAC_cen=Facilitating conditions centralised, INT_PER*PRIO=Interaction term performance * prior experience, INT_EFF*PRIO=Interaction term effort * prior experience, INT_SOC*PRIO=interaction term social influence * prior experience, INT_FAC*PRIO=Interaction term facilitating conditions * prior experience

Regarding the question whether prior experience with iVR influenced the determining factors of intention to use, groups differed significantly regarding their perception of performance expectancy, effort expectancy, and social influence. Perception of performance expectancy in participants with prior iVR experiences (Mdn = 31.87) differed significantly from participants without prior experience (Mdn = 23), U = 492; z = 2.053, p = .04, r = .27. Perception of effort expectancy in participants with prior iVR experiences (Mdn = 33.81) differed significantly from participants without prior experience (Mdn = 20.5), U = 492, z = 3.087, p = .002, r = 0.4. Perception of social influences in participants with prior iVR experiences (Mdn = 30.55) differed significantly from participants without prior experience (Mdn = 21.39), U = 451, z = 2.175, p = .03, r = 0.3. We found no significant difference of prior experiences on schools' facilitating conditions and on intention to use.

Descriptive Results: On average, all participants of our sample had a mid-range performance expectancy (M = 3.15; SD = 1.01; n = 55) and a rather high effort expectancy towards VR technology (M = 3.55; SD = 0.85; n = 55). In contrast, social support was perceived as rather low (M = 2.66; SD = 0.96; n = 52) as was the support by schools' facilitating conditions (M = 2.46; SD = 0.72; n = 52). Also, participants had a relatively high intention to use VR in the classroom (M = 6.62; SD = 2.675; n = 52). The reason for the differences in the number of participants is that three subjects skipped the items on social norms and facilitating conditions.

6 Discussion

A first notable finding is that the intention to use iVR was rather high in our sample. Secondly, as a key determining factor for the surveyed vocational teachers' intention to use iVR, we identified their perception of performance expectancy. It was directly related to future intention to use. Furthermore, among the teachers surveyed, there was no correlation between effort expectancy, social influence or facilitating conditions with the intention to use iVR in the classroom.

We therefore argue that in our sample, vocational teachers in the technical domain mainly based their decision to implement iVR in a classroom setting on the extent to which it enables the achievement of learning goals. Performance expectancy - describing the expectation that the technology will perform meaning and contribute to the educational processes of the lecture - seemed to be highly relevant. As a success factor for intention to use iVR in practice, supplementary material on future iVR applications should contain information on learning objectives in line with school curricula and declare effects on learning outcome. The promotion of learning objectives in line with curricula also applies to other types of schools. This means that both the design of iVR learning applications and the embedding of these applications must be aligned with the learning objectives of the respective school subjects concerned.

As there were no effects of effort expectancy on the intention to use, it can be assumed that for teachers in a technical field, the use of new technologies is part of their daily tasks, and the effort involved is not perceived as an obstacle to use. Implementing new technologies in general might be more common in the technical domain and, in line with Vekantesh et al. (2003), effort expectancy has already become less over time for the specific target group of technical VET teachers. This result might be completely different when surveying vocational teachers in non-technical fields. At the same time, effort expectancy might not yet be associated with practical effort due to the teachers' lack of experience (e.g., setting up several play spaces, need for large classrooms) or the lack of possibilities for content creation in iVR learning applications. As mentioned before, there are only a limited number of German iVR applications available that could be used in a classroom setting. Teachers have rarely already had experiences with students using large iVR sets. Furthermore, teachers might want to create their own content using authoring tools, which is even more time consuming. With more practical experience, and if functional authoring tools are available, future studies might yield different results regarding effort expectancy.

Facilitating conditions were not relevant for intentions, which might be partly explained by the overall perceived low relevance of facilitating conditions in our sample. Facilitating conditions might play a minor role within this specific target group. Most vocational schools in the technical field already have established workshops, which leads to a greater self-confidence in the ability to procure new technologies. In order to meet the constantly changing requirements in technical training occupations, e.g., due to new machines, teachers have to take up new technology more frequently and schools replace existing technical equipment if necessary. Hence, spending money on technical equipment such as iVR might be more common for vocational schools in the technical domain compared to regular schools. At the same time, teachers are usually quite free in their choice of using digital media. It is unlikely that there would be a compulsion to use iVR in the school context. Furthermore, it will probably take some time for this technology to become as common as the use of computers or tablets in a classroom setting.

Social support was not particularly relevant in our sample. Here, we assume that teachers of a technical domain might need less support than colleagues in other domains regarding the implementation of a new technology. Instead, teachers of a technical domain might even be seen as experts themselves within their peer group on questions related to technical equipment. This observation therefore might differ in the case of teachers in non-technical fields.

Furthermore, we observed that prior experience with iVR technology does not influence intention to use iVR as a moderating variable in our sample. However, prior experience with VR headsets seems to be such a vital factor for our sample that it influenced three of the constructs directly: perception of effort expectancy, performance expectancy and social influence. The previous experience inquired about in our questionnaire referred to use in the private or school spheres. It can only be assumed here that the experiences with iVR must have been positive. Our results support the observation by Pletz & Zinn (2018) for prior experience being directly and positively correlated with performance expectancy as well as effort expectancy. In order to promote the use of iVR by teachers in the long term, vocational teachers might be given the opportunity to familiarise themselves with the technology and gain experience to increase performance expectancy. However, the use of VR headsets in the classroom in our sample might be in the distant future for some of the surveyed teachers. Thus, more research is needed on the question to what extent prior experience actually leads to implementation.

There are also limitations regarding our sample. At first, our sample consisted of 55 vocational teachers from the field of metal and electrical engineering in Germany. Our sample cannot be seen as representative for all teachers due to the recruiting strategy. Because of the voluntariness of our study and the technical background of participation, a selection bias might have occurred. For instance, teachers who were already interested in iVR may have been more likely to complete the questionnaire than teachers who were less interested in the topic. That could have influenced our results in that teachers with a greater interest in iVR technology might need less social support by colleagues or the headmaster to consider using iVR in a classroom setting. Furthermore, as mentioned above, half of the sample had prior experience. The upside of this is that the evaluation of iVR by these teachers is mainly based on performance without the initial questions of understanding an innovative technology itself. Based on this reason, our results might reflect the strong relevance of performance expectancy for our sample. We also did not gain evidence on the actual use of iVR technology in the classroom. As pointed out by Southgate et al. (2019) and Hamilton et al. (2021), there is limited information on the actual embedding of iVR technology in teaching at vocational schools. As already outlined in the TPACK model, technological knowledge is necessary to use new digital media successfully in a classroom setting. But what does this mean in the case of iVR technology? Because iVR requires several play spaces or entails the risk of motion sickness, the implementation of iVR in a classroom setting might raise additional questions about classroom management which have to be further investigated. Despite falling prices, restrictions concerning data privacy are also still of concern. Future research should examine the extent to which intention is affected by actual experiences by vocational teachers in real classroom settings and what conclusions can be drawn about the prerequisites and conditions for a successful implementation in the long term.

Based on our results and in line with the rising empirical research on the use of iVR in learning settings, we assume that more applications will come in the future. Currently, we can observe an experimental phase in which various iVR design mechanisms and possibilities of use are still under consideration. Despite that, in our sample teachers were willing to use iVR technology, and we assume that this willingness might also be found among teachers who teach in other technical subjects regardless of school type. As the number of experimental results increases, it will become more clear which applications are best suited for VET and other subjects. What will be relevant, however, as for all other digital media, is that for iVR to be successfully embedded in teaching, the promotion of learning goals and the learning process is of great importance. For the highly elaborate and complex development of iVR applications, this requires close cooperation with educators to achieve this goal.

7 Conclusion

In our study, we provided insights into how vocational teachers perceive iVR technology and to what extent they rate the technology as being useful for their classes. We also provided information on determining factors of vocational teachers' intention to use immersive VR technology in the classroom. For the specific target group of technical VET teachers in our sample, it was vital that there is an advantage to using iVR technology in the classroom in terms of performance, e.g., learning outcome. Framework conditions and social group influence seem to be less of a barrier to implementation of iVR, at least in the technical subject domain. In addition, prior experience was highly relevant as an influencing factor for teachers' acceptance of iVR regarding perceived performance expectancy, effort expectancy and social influence. Our results imply that teachers might need opportunities to gain experience with iVR technology to increase the chances of implementation. Furthermore, the added value of iVR must be convincing and accessible to teachers without much additional effort. To date, suitable iVR applications aiming at learning objectives in the technical VET domain are still limited. Furthermore, teachers might face challenges such as time-consuming practical preparations, data privacy concerns or limited content creation possibilities. Future research on actual experiences with iVR in the classroom will show which iVR design mechanisms and possibilities of use are most promising for embedding iVR in the classroom.

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