Springer Proceedings in Business and Economics

M. Claudia tom Dieck
Timothy Jung
Yen-Soon Kim *Editors*

XR and Metaverse

Proceedings of the 8th International XR-Metaverse Conference 2023, Las Vegas, USA

Springer

Springer Proceedings in Business and Economics

Springer Proceedings in Business and Economics brings the most current research presented at conferences and workshops to a global readership. The series features volumes (in electronic and print formats) of selected contributions from conferences in all areas of economics, business, management, and finance. In addition to an overall evaluation by the publisher of the topical interest, scientific quality, and timeliness of each volume, each contribution is refereed to standards comparable to those of leading journals, resulting in authoritative contributions to the respective fields. Springer's production and distribution infrastructure ensures rapid publication and wide circulation of the latest developments in the most compelling and promising areas of research today.

The editorial development of volumes may be managed using Springer Nature's innovative EquinOCS, a proven online conference proceedings submission, management and review system. This system is designed to ensure an efficient timeline for your publication, making Springer Proceedings in Business and Economics the premier series to publish your workshop or conference volume.

This book series is indexed in SCOPUS.

M. Claudia tom Dieck · Timothy Jung ·
Yen-Soon Kim
Editors

XR and Metaverse

Proceedings of the 8th International XR-Metaverse Conference 2023 Las Vegas, USA

Springer

Editors
M. Claudia tom Dieck
Faculty of Business and Law
Manchester Metropolitan University
Manchester, UK

Timothy Jung
Faculty of Business and Law
Manchester Metropolitan University
Manchester, UK

Yen-Soon Kim
Department of Hospitality
University of Nevada, Las Vegas
Las Vegas, NV, USA

ISSN 2198-7246 ISSN 2198-7254 (electronic)
Springer Proceedings in Business and Economics
ISBN 978-3-031-50558-4 ISBN 978-3-031-50559-1 (eBook)
https://doi.org/10.1007/978-3-031-50559-1

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Paper in this product is recyclable.

Preface

We are experiencing transformative changes, a new era where reality and the digital realm co-exist in unprecedented ways. The International Association of Immersive Technology Innovation (IAITI) stands at the centre of this journey and it is with great excitement that we introduce this book, a compilation of the latest insights emerging from the 8th International XR-Metaverse Conference held in Las Vegas in June 2023.

On an annual basis, the International XR-Metaverse Conference brings together leading experts in the field of augmented reality, virtual reality, XR and the metaverse to discuss and explore the latest trends.

The XR and Metaverse sphere has undergone a rapid evolution over the last decade. What once seemed like distant possibility has now become a part of our daily lives and work environment. Augmented reality and virtual reality, and lately the concept of Metaverse, have not only reshaped how we experience the environment but also opened up new opportunities and challenges. This calls for new, cutting-edge and inspirational research in this area.

This book is a compilation of papers presented during the conference and we hope it will serve as a guidance for the latest XR trends, use cases and inspiration for industry and academia to join this transformative journey.

Scientific Committee

Christos Pantelidis, Manchester Metropolitan University
Marina Papalexi, Manchester Metropolitan University
Mário Passos Ascenção, Haaga-Helia AUS
Filipa Rosado-Pinto, ISCTE- Instituto Universitário de Lisboa and BRU
Shima Rezaei Rashnoodi, Breda University of Applied Science
Marion Rauscher, Hochschule Munich
Philipp A. Rauschnabel, Universität der Bundeswehr Muenchen
Caroline Scarles, University of Surrey
Katrin Schein, Universität der Bundeswehr Muenchen
Kay Schroeder, RWTH Aachen University
Michelle Schwarz, UniBw Munich
Michael Schwertel, Cologne Business School
Aline Simonetti, Universitat de València
Anneroos R. Smink, University of Amsterdam
Sebastian Stadler, Hochschule Ansbach
Jessica Symons, Visioning Lab
Alexandra Taylor, Manchester Metropolitan University
Aleksei Tepljakov, Tallinn University of Technology
Mariapina Trunfio, University of Naples Parthenope
Pasi Tuominen, Haaga-Helia AUS
Silviu Vert, Politehnica University of Timisoara
Gary Warnaby, Manchester Metropolitan University
Désirée Wieland, University of Bamberg

Contents

XR in Marketing and Business

Do You Recommend This? Exploring the Role of Presence, Self-efficacy, and Usability in the Willingness to Adopt and Recommend a VR Application

Marnix S. van Gisbergen(✉), Shima R. Rashnoodi, Miruna Doicaru, and Fabio Campos

BUAS - Breda University of Applied Sciences, Breda, The Netherlands
gisbergen.m@buas.nl

Abstract. Despite the market potential of many XR applications, numerous companies struggle to produce applications able to reach widespread adoption. Several studies indicate a connection between the willingness to recommend an XR application and the adoption of that application. However, the main variables involved in the willingness to recommend have not been studied much within the domain of XR. In this study, we focused on the willingness to recommend a Virtual Reality (VR) emergency training. General practitioners and elderly-care students used a VR training application, after which we measured XR assessment dimensions, such as presence, usability, attention, pleasure, learning, and adoption. The results revealed three dimensions able to explain 75% of the recommendation willingness: usability, usefulness, and joy. These dimensions can be used by researchers and developers to continuously and consistently compare XR training applications on market potential and decide to launch or first improve an XR application.

Keywords: XR adoption · VR · Market potential · Recommendation · Willingness to recommend

1 Introduction

Although Extended Reality (XR) applications have been used for years, their widespread adoption has been a hit-or-miss phenomenon. After many investments in XR content production around 2015–2016 (Wang 2016), the expected market increase did not happen, which resulted in a series of bankruptcies and a change of focus (Steiber 2017; Wu 2016). In the United States, tech-renowned companies changed their focus and closed their XR content production studios, such as Oculus in 2017 and Google in 2019 (Roettgers 2017, 2019). The time-intensive and therefore expensive process of XR production seemed to move the content production towards companies in countries with high expertise but low labour costs, such as China. But also, Chinese production companies were struggling to survive within the XR domain (Justine 2019; Lou 2018; Niels 2018). Therefore, a key question to the success of an XR application is the willingness of the users to

M. C. tom Dieck et al. (Eds.): XR 2023, SPBE 2024, pp. 3–15, 2024.
https://doi.org/10.1007/978-3-031-50559-1_1

adopt it. Several XR adoption dimensions have been identified within the domain of XR. For example van Gisbergen (2019) identified five important dimensions related to the 5-c model: (1) Channel, which relates to desired improvements in XR hardware and technologies; (2) Creation, which deals with improvements to make the XR production and content production tools more easy and cost-effective, (3) Content, which relates to having enough and easy to find and access content, (4) Connection, which relates to the prerequisite that it should be easy to share and communicate XR content; and (5) Cost reductions, in the sense that XR hard and software should have at least competitive prices compared to other mass media. Within these developments, the main question is what XR will add to existing media, and what the added value of for instance a VR training tool is above other media used for training. Currently, a key benefit seems to be the unique experience of being in a mediated simulation that ‘feels real’ (van Gisbergen 2016). The importance of (emotional) experience in the adoption of journalism content in VR over content in traditional media, was for instance shown in a study conducted by Nielsen and Sheets (2021). The COVID pandemic increased the importance of the connection dimension, operationalized as social interaction, for possible future VR adoption intentions (Ball et al. 2021). However, almost none of these dimensions have been investigated in their effect on the willingness of users to recommend a VR training application. This makes it difficult to forecast the adoption and market potential of XR training applications. The marketing field recognizes an established relationship between the willingness to recommend a product and its adoption (Aggarwal et al. 1998; Jiang et al. 2014; Singh et al. 2020). However, it remains unclear which VR evaluation variables influences the willingness to recommend a VR application. In this study, we try to bridge that gap by conducting research investigating the connection and explanatory power between presence, usability and self-efficacy and the willingness to recommend a VR application within the context of a training program.

2 Literature Review

Besides the urge for more proof in the success rate of VR health applications (Pandey and Vaughn 2021), more research seems needed on the variables that explain VR adoption. Despite the importance of the success of training or educational applications in VR, not much research has been conducted in which, variables can be used to track or improve the adoption potential. Most studies either concentrated on different domains, such as gaming or journalism, or the purchase of the devices, often using models based on the Technology Acceptance Model (TAM), Innovation diffusion model, or the Uses and Gratification perspective (e.g., Ball 2021; Kim et al. 2020; Lee et al. 2019). Within the health context, most studies concentrated on the barriers to be removed before adoption will occur such as fear of effects from specialists and patients, technological, organizational, and implementation challenges, the lack of knowledge and training in usage and time constraints (Laurell et al. 2019). Hence, a recurrent challenge within XR adoption research is to find a research design that can easily, cost-effectively, and in a uniform manner measure the adoption potential and how to improve it. Due to the experiential nature of XR applications, it is also preferred to be able to measure this within the VR experience itself, without having to leave the application. However, to be able to do this in a practical way, one needs a set of questions, that is short, validated, and with a high predictive power for adoption.

Marketing research often measures the willingness to recommend via the The Net Promoter Score (NPS), assuming a high correlation between NPS and adoption potential (Baquero 2022; Hyken 2016). NPS is composed of one question framed as "How likely are you to recommend our business/product to a friend or colleague?". It proposes to have a pulse on how a company or solution is performing and was introduced in 2003 by Reichheld and the marketing agency Bain and Company (2023). Although it is usually associated with a scale from 0 to 10, we opted for using it with a 7-point Likert scale for normalization purposes with the other scales used in this study. Further studies will explore the relationship between using it with the original scale and with the Likert scale. There are several works that explore the strong and weak points of the NPS, such as Fisher and Kordupleski (2019), Grisaffe (2007), and Baehre et al. (2022). A common theme that underlies the limitations or weak points elicited in these researches is the lack of actionable dimensions to complement or improve the information coming from the NPS, and this is the main objective addressed in our study. As we are especially interested in XR applications, we focused on the dimensions and variables usually associated with the assessment of XR experiences, such as presence, self-efficacy improvement, and usability. The questions comprising these scales also address attention, pleasure/enjoyment, and perceived performance.

3 Methodology

In this experiment, a survey was offered to general practitioners and elderly-care students-in-training, before and after using an emergency training VR app. Each participant received a short explanation about the experiment, signed the consent form, and filled in a short survey. Right after, the participants began experiencing the VR app, followed by filling out the experience evaluation part of the survey and participating in an in-depth interview. The research took place at the training facility Schola Medica, during ten training days in September, October, and November (2021). Schola Medica is the Medical Education Centre for Emergency Care in the Netherlands. Students come from all eight Academic Medical Centres in the country to the training location of Schola Medica to follow multi-day courses during their specialization period. Students are being prepared for emergency situations with real-life 'simulation scenarios' during which they are being trained in small groups of a maximum of six students with a teacher (a doctor) and a trained actor. Participants received a small incentive (socks) for their participation. During the experiment four researchers from BUas, divided over three VR glasses, assisted during the VR experience and surveys.

3.1 Materials

A Virtual Reality training application has been developed for Schola Medica, which has been labelled VR ABCDE, to be used as an addition to life training sessions. Besides the obvious advantages of learning in a life controlled environment with scenarios and trained actors, there are also some disadvantages of life training. Next to high costs and much organizational work, it also restricts a doctor in training to learn how to perform the necessary protocols in other, real-life situations for example outside the training facilities. Also, several scenarios are very hard to simulate with actors in real life. These considerations have led to the idea that VR might add value to real live simulation training and other educational instruments. VR might increase training efficiency as it adds different locations and scenarios (e.g., a scenario situated in the outside world). During a 20-min scenario, the student must be able to perform a strict protocol to assess and help a patient in an emergency. As such, the emergency training is based on the Airway, Breathing, Circulation, Disability, and Exposure (ABCDE) protocol. This protocol is widely accepted by experts in emergencies and designed to improve outcomes by helping healthcare professionals focus on the right procedure and not make mistakes during the most life-threatening situations, and as such can save valuable time and improve performance during immediate assessment and treatment (Thim et al. 2012) (Fig. 1).

Fig. 1. The ABCDE emergency protocol (taken from Franswa 2021).

The application is built for Oculus Quest 2 and contains a training program that includes thirty-four 360° recorded scenes and Multiple-choice questions that follow the ABCDE emergency protocol.

A concept test was conducted to define the learning goals, and training scenarios and define the expected added value compared to actor-based training and e-learning. The interviews and focus groups among training experts (x2), potential users (x5 students), technical and medical specialists (x9), and actors that portray the role of the patient in real-life simulation training (x13), revealed positive effects for VR (crating immersion with no sickness) and stressed the idea of creating a VR training tool for Autonomous (simulation) training (no teacher present). It also provided ideas for the scenario: the VR should be used to distract using new (small) environments and elements not available in real-life simulation training (e.g., distracting daughter of a patient and bathroom at an elderly care institution). It also reinforced the idea that the application should be developed as an added value and not as a replacement for the real-life simulations, aimed at extra repeated practice (Incedag 2019).

The VR ABCDE training program consists of a scenario where an old woman has fallen on the floor in the bathroom of an elderly care centre. The scene contains four actors: the doctor, the patient, the nurse, and the daughter of the patient. The trainee needs to assess what is going on, following the ABCDE emergency protocol, while being present in a very small room and while being distracted by the concerned daughter. After each scene, the trainee needs to answer a multiple-choice question within a certain time. When the time has passed, the trainee will see whether the given answer was right or wrong (red colour) and will be shown the correct answer (green) before the next scene starts to play. The time only starts to run when the gaze of the trainee is pointed at the question menu. In the experiment two versions were tested; one version with only 360° recordings, and another version that was composed of a combination of 360° content and the CG environment of the same content with volumetric captured (VolCap) characters being implemented (see Fig. 2). The VolCap version was based on a concept research (Amouzadeh 2020), among ABCDE training Experts of UMC Amsterdam (x3), Volumetric Capture Experts (x3), and Actors from Schola Medica (x2). Based on among others this this study, the scenario was slightly adapted (removing for instance scenarios that included objects hard to capture in VolCap). Four 360° scenes were selected to be replaced with the CG and Volumetric Captured scenes. However, for this study, we did not analyse differences between the two versions but aggregated the scores. After the data collection, the data set was processed by a statistical tool (SPSS) analyzing, the experience of the ABCDE VR app in general and the dimensions influencing the the Recommendation Willingness (RW) measure.

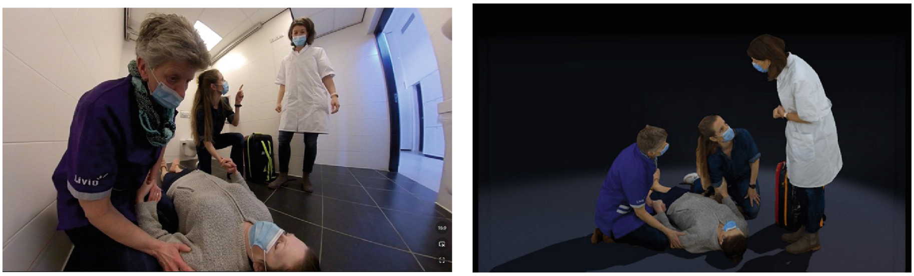

Fig. 2. 360 recorded actors (L) and VolCap created actors (R) within the VR App

3.2 Measures

The before the VR experience survey was composed of demographic questions plus the self-efficacy scales. The after experience survey consisted out of all the scales related to the evaluation and adoption measures, including a second round of the self-efficacy scale. The survey totalled 120 questions plus the automatic data fields from the tool used to apply the survey (Qualtrics) such as duration and completeness. Attention, perceived performance, and satisfaction measurements did not come from standard scales but from a set of questions created in our research involving XR applications. Several questionnaires and scales were used to measure the dimensions of presence (including co-presence and social presence), self-efficacy and factor solution, usability, perceived performance, satisfaction, and recommendation willingness.

Presence. To measure presence three scales were used, a subset of the SOPI scale (Lessiter et al. 2001), a revised presence scale from Witmer et al. (2005), and a co-presence and social presence scale adapted from Poeschl and Doering (2015). The SOPI is the de facto scale used to evaluate XR applications (Bernardet et al. 2011). It is composed of sets of questions related to spatial presence, engagement, naturalness, and negative effects (Piccione et al. 2019). In the original ITC-SOPI (Lessiter et al. 2001) there are 44 questions. We used in this research a subset of these questions, eliminating the questions that could represent semantic repetition with the questions from the other scales. The main reasoning behind the SOPI is the use of the sense of presence to evaluate the performance of an XR application. The scale from Witmer, Jerome, and Singer was used to include the presence measurement, the sub-dimensions of involvement, adaptation/immersion, sensory fidelity, and interface quality (Witmer et al. 2005). Their study indicates that immersion is greater for users who have an easier and faster adaptation to the XR environment (Witmer et al. 2005). To these two scales, we added the co-presence and social presence aspects present on the Poeschl and Doering (2015) scale, always removing the repetitive questions. In addition to these 3 scales, we used additional questions focused on co-presence and social-presence. These questions are often used to measure presence related to dimensions of reaction to virtual agents, the impression of interaction possibilities, and the co-presence of other people. The 15 questions used for that purpose came from the scales of co-presence and social presence (Bailenson and Yee 2006; Basdogan et al. 2000; Biocca et al. 2001; Nowak and Biocca 2003; Schroeder 2001; Usoh et al. 2000), GlobalED Questionnaire (Gunawardena and Zittle 1997), and para-social presence questionnaire (Kumar and Benbasat 2002).

Self-efficacy. The Self-efficacy theory is based on the relationship between the modification of personal expectations of performance, success (for example when executing a task), and change in behaviour (Sherer et al. 1982). There is evidence in the literature about a correlation between an increase in self-efficacy and the adoption and recommendation potential (Maddux et al. 1982). So, we added to our investigation the self-efficacy scale of Sherer et al. (1982) with the factor solution of Woodruff and Cashman (1993). This scale was used in the part of the survey applied before and after the use of the ABCDE VR app, to capture the differential in self-efficacy before and after the task/experience, as prescribed in the application protocol of Sherer et al. (1982).

Usability. The statements used in the survey were inspired by the questionnaire of Davis (1989) and similar usability scales such as SUS – System Usability Scale (Brooke 1996) and Wang and Senecal (2007). The subdimensions considered were perceived usefulness, ease of use, and enjoyment. We didn't make literal use of any of those scales, instead, we came up with statements consolidating them.

Recommendation Willingness (RW). RW was one question, based on the NPS question, asking students if they would recommend the VR ABCDE application to their peer students (1 = completely disagree, 5 = completely agree).

3.3 Participants

The participants reflected the main target group, consisting of general practitioners (in training) and elderly-care student practitioners. The survey was answered by 63 subjects (one participant did not fill in all the questions). The age of the participants ranged between 25 and 50 years, with an average of 31 years. Most trainees were female, which was also reflected in the study: 71% of the respondents were females. The participants, although being students, are experienced in emergency care: 91%, experienced real-life ABCDE emergency threats, of which 80% actively as a doctor and 20% as an observer. Almost 65% were involved in five or more emergency healthcare situations. Approximately two-thirds (65%) never experienced VR using a headset before. Those who have experience, only have limited experience (73% having used VR once or twice only). From participants with previous VR experience, most of them used VR for gaming (45%) or (27%) for different content not related to training: 14% for entertainment (viewing films, for example), 9% for other kinds of content, and 5% for social interaction.

4 Findings

In this section, we will summarize the results related to the appreciation, adoption, and recommendation willingness. All sets of questions pertaining to the same dimension exhibited a Cronbach Alpha equal to or bigger than 0.8.

4.1 Appreciation

Concerning appreciation, the survey presented questions connected with several dimensions, such as the app as a learning tool, the experience itself, and the intention to continue using it. The average of the answers of these dimensions resulted in the overall appreciation score. The respondents presented a high degree of appreciation for using the ABCDE VR application: 3.81 on the average of the dimensions, on a Likert scale with a maximum of 5 points.

4.2 Adoption Intention and Recommendation

The survey contained several variations of questions dealing with assessing the intention of adopting the ABCDE VR App, such as asking if the user would like to adopt the app as part of the regular training program, if the user would like to use it at home, etc. All the adoption-related questions presented a high correlation, above 0.8, with the recommendation willingness represented by the Recommendation Willingness (RW) question. The average of the RW question was 3.78, on a maximum scale of 5, revealing a high intention of recommendation. Consequently, due to the high correlation of the RW question with the adoption intention mentioned above and in the literature, the average of the adoption questions was very similar (their average difference is not statistically significant). Looking at the data in another way, the results indicate that 72% would recommend the VR ABCDE tool, and only 10% would not (18% is neutral).

4.3 Relationship between Presence, Adoption intention and Recommendation

Intention to use was measured using two questions: (1) I would like to practice my skills using the virtual simulator in the future and (2) I would like to use the VR simulator frequently. The two questions were combined to form one scale ($\alpha = .89$, 1 = completely disagree and 5 = completely agree). Students have the intention to use the VR ABCDE tool again (M = 3.8), especially when it concerns to practice with the tool in the future (M = 3.9). Confirming the importance of Presence in XR applications, there are statistically significant positive correlations between presence measured by the SOPI and Witmer and Singer scales and variables that capture the intention to use and recommend VR (Table 1). The correlations are stronger with the SOPI scale than with the Witmer and Singer scale, again showing why the SOPI use is the de facto scale of presence in XR research.

Table 1. Presence X intension of adoption and recommendation.

	Intention to use again	Intention to use frequently	Intention to recommend (NPS)
SOPI scale	0.638	0.622	0.723
Witmer and Singer scale	0.479	0.436	0.478

4.4 Main Dimensions and Questions Related to the RW Question

To investigate the relationship between the questions/dimensions and the RW question, we calculated the correlation between the RW and 115 questions (120 original questions, minus the RW question, minus four questions related to adoption due to their repetitive nature; a very high Cronbach Alpha with the RW question). The 115 questions (or assessment statements) pertained to the following categories: (a) traditional demographics (age, gender, medical specialization), (b) previous experience in emergency situations, (c) previous experience with VR, (d) self-efficacy, (e) presence (and its variations related to experience), (f) attention, (g) perceived self-performance and (h) usability and satisfaction. The results revealed 37 questions with statistically significant correlations ranging from 0.263 to 0.803. A factor analysis of this group of 37 questions revealed that the dimension which correlates the strongest with the RW question is Usability, followed by Presence on the SOPI scale. Self-efficacy and the experience as a doctor correlate negatively. From those 37 questions, we chose the ones with correlation in the upper half (better than 0.402), 20 items, to analyse in more detail. Two of those items were excluded due to their similarity with other of the chosen items. The 18 remaining items can be grouped into 6 categories with factors related to Usability, Learning, Fun and Joy, Presence, Engagement, and Self-efficacy, see Table 2.

Doing permutations with these statements to test the explanatory power (R^2) in linear regression, we got 3 statements (Table 3) which can explain 75.4% of the recommendation intention, Table 4.

All the statements from Table 3 came from the statements we designed consolidating the usability and experience scales. Based on these results the recommendation intention can be explained, in 75.4% of its results, by Eq. 1.

$$Recommentation = -0.34 + 0.195 * St.1 + 0.579 * St.2 + 0.338 * St.3 \quad (1)$$

Table 2. Adoption items with a correlation with the RW question above 0.4

	Correlate
Usability/Experience dimension	
My interaction with the virtual simulator is clear and understandable	**0.628**
I find it easy to get the virtual simulator do what I want it to do	0.423
I imagine many people would learn to use the system of this VR simulator very easily	0.587
How quickly did you adjust to the virtual reality experience?	0.558
Learning dimension	
Using the virtual simulator improves my learning performance	0.658
Using the virtual simulator enhances my effectiveness in my learning	0.570
I find the virtual simulator to be useful in my education	**0.803**
Fun/Joy dimension	
I find using the virtual simulator to be enjoyable	0.678
The actual process of using the virtual simulator is pleasant	**0.681**
I had fun using the virtual simulator	0.648
I enjoyed myself participating in the simulation	0.654
Presence dimension	
I had the sense of being in the scenes displayed	0.586
I felt that the characters and objects in the displayed environment could almost touch me	0.561
I felt involved in the displayed environment	0.492
Engagement dimension	
The content in the displayed environment seemed believable to me	0.494
Were there moments during the virtual reality experience when you felt completely focused on the environment?	0.452
Self-efficacy dimension	
How proficient in moving/interacting with the VR did you feel at the end of the experience?	0.452
How do you think you would perform in future simulations (in virtual reality)?	0.403

Table 3. Statements chosen due to their explanatory power.

	Correlation	p
Usability/Experience dimension		
St1. *My interaction with the VR simulator is clear and understandable*	0.628	<0.001
Learning dimension		
St2. *I find the virtual simulator to be useful in my education*	0.803	<0.001
Fun/Joy dimension		
St3. *The actual process of using the virtual simulator is pleasant*	0.681	<0.001

Table 4. R^2 for a linear regression using the 3 chosen statements.

	R	R^2	Std. error of the estimate
St.1, St.2, St.3	0.869	0.754	0.535

5 Conclusion

Although VR variables such as presence and engagement, measured through traditional scales such as SOPI and Witmer and Singer, continue to be useful to the general evaluation of a VR app, in which concerns the recommendation intention, it is possible to reach an effective evaluation (75.4% of explanatory power) based on a small subset of questions. The dimensions of usability, usefulness (learning factor in our experiment), and Joy/fun seem to be the most important ones, although we have to be aware that these encompassing dimensions receive influence from other traditional XR adoption-related factors, such as presence. A reason why presence did not belong to the top three related predictive statements, might have to do with an already high expected value of presence and or experience, as it is often described as the main factor that distinguishes VR from other media. The results show that the VR ABCDE tool produces a high level of presence over items such as naturalness, spatial presence, and engagement (in both scales used) and also low on the negative effects subscale. This might confirm that nowadays VR is able to and expected to create high levels of (positive) experience and presence and as such is not the key (conscious) driver for recommendation. An alternative explanation might come from the fact that the participants compared and positioned the VR application as an addition to the (non-mediated) real-life training for which presence and experience seem to be naturally higher compared to VR. Would be interesting to see if using the standard NPS question, that consists out of a 11-point scale, would be able to detect more variation. In addition, as this study concerns a VR *training* application, in which experience and presence are a means and not an end result, the two dimensions Usability and Learning seem logically more connected to the most important usage goals and the fun might be more related to the learning experience as engagement in the presence scale. Keeping these three dimensions, Usability, Learning, and Joy, into account and using their prediction power we have actionable aspects pointing to what can be improved or used in comparison to competitors, supplementing the recommendation willingness.

The results indicate that potential improvements in usability, learning usefulness, and enjoyment can have a positive effect on the recommendation willingness, and, consequently, on the adoption potential.

Surely, this evidence should be the subject of further research to confirm its validity by means of replicating this study for more (variety) of VR learning applications as well for different VR domains. Nonetheless, we have already used the main factors as a starting point to autonomously measure recommendation willingness within VR training applications.

Acknowledgements. We would like to thank Schola Medica, Chronosphere and RAAK for the financial, organisational, and testing support. We thank 4DR Studios and the Cradle team at BUas (Wilco Boode and Kevin Hutchinson) for the technical support.

References

Aggarwal, P., Cha, T., Wilemon, D.: Barriers to the adoption of really-new products and the role of surrogate buyers. J. Consum. Mark. **15**(4), 358–371 (1998)

Amouzadeh, S.: The Effect of Volumetric Capturing on VR/AR Health Scenario Training. Qualitative Research Among Actor, ABCDE Experts and Volumetric Capture Experts to Examine, Benefits and Drawbacks of Volumetric Capture Technology Compared to 360º Recording, Within an Emergency Actor Based ABCDE Training Scenario. Master's thesis, Breda University of Applied Sciences, Breda (The Netherlands) (2020)

Baehre, S., O'Dwyer, M., O'Malley, L., Lee, N.: The use of net promoter score (NPS) to predict sales growth: insights from an empirical investigation. J. Acad. Mark. Sci. 1–18 (2022)

Bailenson, J.N., Yee, N.: A longitudinal study of task performance, head movements, subjective report, simulator sickness, and transformed social interaction in collaborative virtual environments. Presence: Teleoper. Virtual Environ. **15**(6), 699–716 (2006)

Bain and Company: About the Net Promoter System (2023). https://www.netpromotersystem.com/about/

Ball, C., Huang, K.T., Francis, J.: Virtual reality adoption during the COVID-19 pandemic: a uses and gratifications perspective. Telemat. Inform. **65**, 101728 (2021)

Baquero, A.: Net promoter score (NPS) and customer satisfaction: relationship and efficient management. Sustainability **14**(4), 2011 (2022)

Basdogan, C., Ho, C.H., Srinivasan, M.A., Slater, M.: An experimental study on the role of touch in shared virtual environments. ACM Trans. Comput.-Human Interact. (TOCHI) **7**(4), 443–460 (2000)

Bernardet, U., Väljamäe, A., Inderbitzin, M., Wierenga, S., Mura, A., Verschure, P.F.: Quantifying human subjective experience and social interaction using the eXperience Induction Machine. Brain Res. Bull. **85**(5), 305–312 (2011)

Biocca, F., Harms, C., Gregg, J.: The networked minds measure of social presence: pilot test of the factor structure and concurrent validity. In: 4th Annual International Workshop on Presence, Philadelphia, PA, pp. 1–9 (2001)

Brooke, J.: SUS-A quick and dirty usability scale. Usability Eval. Ind. **189**(194), 4–7 (1996)
Davis, J.S.: Usability of SQL and menus for database query. Int. J. Man Mach. Stud. **30**(4), 447–455 (1989)
Fisher, N.I., Kordupleski, R.E.: Good and bad market research: a critical review of net promoter score. Appl. Stoch. Model. Bus. Ind. **35**(1), 138–151 (2019)
Franswa, P.: THRIVE—VR Medical Training With Volumetric Professionals. AIXR (2021). https://aixr.org/insights/thrive-vr-medical-training-with-volumetric-professionals/
Grisaffe, D.B.: Questions about the ultimate question: conceptual considerations in evaluating Reichheld's net promoter score (NPS). J. Consum. Satisf. Dissatisf. Complain. Behav. **20**, 36–53 (2007)
Gunawardena, C.N., Zittle, F.J.: Social presence as a predictor of satisfaction within a computer-mediated conferencing environment. Am. J. Distance Educ. **11**(3), 8–26 (1997)
Hyken, S.: How effective is net promoter score (NPS). Forbes Mag. 12–13 (2016)
Incedag, M.: ViR: Virtual Reality in Emergency Care Training for Elderly Care Physicians and General Practitioners in Training. Master's thesis, Breda University of Applied Sciences, Breda (2019)
Jiang, M., Cui, P., Wang, F., Zhu, W., Yang, S.: Scalable recommendation with social contextual information. IEEE Trans. Knowl. Data Eng. **26**(11), 2789–2802 (2014)
Justine: Eddie Lou: "VR is Booming in China" (2019). https://vrtl.academy/news/eddie-louvr-is-booming-in-china/
Kim, M.J., Lee, C.K., Preis, M.W.: The impact of innovation and gratification on authentic experience, subjective well-being, and behavioral intention in tourism virtual reality: the moderating role of technology readiness. Telemat. Inform. **49**, 101349 (2020)
Kumar, N., Benbasat, I.: Para-social presence: a re-conceptualization of 'social presence' to capture the relationship between a web site and her visitors. In: Proceedings of the 35th annual Hawaii International Conference on System Sciences, pp. 106–112. IEEE (2002)
Laurell, C., Sandström, C., Berthold, A., Larsson, D.: Exploring barriers to adoption of virtual reality through social media analytics and machine learning—an assessment of technology, network, price and trialability. J. Bus. Res. **100**, 469–474 (2019)
Lee, J., Kim, J., Choi, J.Y.: The adoption of virtual reality devices: the technology acceptance model integrating enjoyment, social interaction, and strength of the social ties. Telemat. Inform. **39**, 37–48 (2019)
Lessiter, J., Freeman, J., Keogh, E., Davidoff, J.: A cross-media presence questionnaire: the ITC-sense of presence inventory. Presence: Teleoper. Virtual Environ. **10**(3), 282–297 (2001)
Lou, E.: Why China Wants More Content|VR NOW Con & Awards 2018 (2018). https://www.youtube.com/watch?v=S0ApGx3uc_A&feature=share
Maddux, J.E., Sherer, M., Rogers, R.W.: Self-efficacy expectancy and outcome expectancy: their relationship and their effects on behavioral intentions. Cogn. Ther. Res. **6**, 207–211 (1982)
Niels: Eddie Lou on China's Answer to "The Magic Moment" (2018). https://vrtl.academy/news/eddie-lou-on-chinas-answer-to-the-magic-moment/
Nielsen, S.L., Sheets, P.: Virtual hype meets reality: users' perception of immersive journalism. Journalism **22**(10), 2637–2653 (2021)
Nowak, K.L., Biocca, F.: The effect of the agency and anthropomorphism on users' sense of telepresence, copresence, and social presence in virtual environments. Presence: Teleoper. Virtual Environ. **12**(5), 481–494 (2003)
Pandey, V., Vaughn, L.: The potential of virtual reality in social skills training for autism: bridging the gap between research and adoption of virtual reality in occupational therapy practice. Open J. Occup. Ther. **9**(3), 1–12 (2021)
Piccione, J., Collett, J., De Foe, A.: Virtual skills training: the role of presence and agency. Heliyon **5**(11), e02583 (2019)

Poeschl, S., Doering, N.: Measuring co-presence and social presence in virtual environments–psychometric construction of a german scale for a fear of public speaking scenario. Annu. Rev. Cyberther. Telemed. **2015**, 58–63 (2015)
Roettgers, J.: Facebook Is Shutting Down Its Award-Winning Oculus Story Studio (2017). https://variety.com/2017/digital/news/oculus-story-studio-shutting-down-1202409809/
Roettgers, J.: Google Shuts Down Its Spotlight Stories VR Film Studio (2019). https://variety.com/2019/digital/news/google-spotlight-stories-shutting-down-1203163117/
Sherer, M., Maddux, J.E., Mercandante, B., Prentice-Dunn, S., Jacobs, B., Rogers, R.W.: The self-efficacy scale: construction and validation. Psychol. Rep. **51**(2), 663–671 (1982)
Schroeder, R. (Ed.): The Social Life of Avatars: Presence and Interaction in Shared Virtual Environments. Springer Science & Business Media (2001)
Singh, N., Sinha, N., Liébana-Cabanillas, F.J.: Determining factors in the adoption and recommendation of mobile wallet services in India: analysis of the effect of innovativeness, stress to use and social influence. Int. J. Inf. Manag. **50**, 191–205 (2020)
Steiber, A.: VR/AR in China: An Emerging Giant? (2017). https://www.forbes.com/sites/charliefink/2017/12/19/vrar-in-china-an-emerging-giant/#4fd7d5647573
Thim, T., Krarup, N.H.V., Grove, E.L., Rohde, C.V., Løfgren, B.: Initial assessment and treatment with the airway, breathing, circulation, disability, exposure (ABCDE) approach. Int. J. Gen. Med. 117–121 (2012)
Usoh, M., Catena, E., Arman, S., Slater, M.: Using presence questionnaires in reality. Presence **9**(5), 497–503 (2000)
Van Gisbergen, M.S.: Digital deja vu known as virtual reality. In: Ketelaar, P., Aarts, J., Demir, S. (eds.) 23 Innovations in Digital Communication, pp. 319–323. BIS Publishers (2019)
Wang, J., Senecal, S.: Measuring perceived website usability. J. Internet Commer. **6**(4), 97–112 (2007)
Wang, S.: The Reality of VR Is That 90% Startups Have Been Adjudged Bankrupt (2016). https://www.huxiu.com/article/173507.html
Witmer, B.G., Jerome, C.J., Singer, M.J.: The factor structure of the presence questionnaire. Presence: Teleoper. Virtual Environ. **14**(3), 298–312 (2005)
Woodruff, S.L., Cashman, J.F.: Task, domain, and general efficacy: a reexamination of the self-efficacy scale. Psychol. Rep. **72**(2), 423–432 (1993). Ahn, S.J., Fox, J.: Immersive virtual environments, avatars, and agents for health. In: Parriott, R. (Ed.) Encyclopedia of Health and Risk Message Design and Processing. Oxford University Press (2017). https://www.researchgate.net/publication/316488936_Immersive_Virtual_Environments_Avatars_and_Agents_for_Health
Wu, J.: China's VR Industry Tumbles After Explosive Growth (2016). http://www.china.org.cn/business/2016-12/28/content_39999412.htm

Enhancing Customer Shopping Experience Through AR Mini-Games

Leif Oppermann[1](✉), Urs Riedlinger[1], Miriam Schmitz[2], Yücel Uzun[1], Constantin Brosda[1], Christine Syrek[3], and Simone Fühles-Ubach[2]

[1] Mixed and Augmented Reality Solutions, Cooperations Systems Fraunhofer FIT, Sankt Augustin, Germany
leif.oppermann@fit.fraunhofer.de
[2] Information Science Institute, TH Köln, Cologne, Germany
simone.fuehles-ubach@th-koeln.de
[3] Department of Management Sciences, University of Applied Sciences Bonn-Rhein-Sieg, Sankt Augustin, Germany
christine.syrek@h-brs.de

Abstract. In this research article we introduce an Augmented Reality (AR) application specifically designed to use in supermarkets. Our primary goal is to incorporate interactive AR mini-games that bring joy and digital engagement to customers during their visit. Additionally, we aim to investigate the impact of this campaign on brand awareness for both the featured goods and the supermarkets themselves. This paper presents the findings of a week-long user study conducted in two physical stores of a major retailer, involving a total of 431 participants. We analyse the impact of gameplay location and the game type (generic or product-specific) on the overall user experience. Furthermore, we investigate the impact of playing the mini-games on brand recall, which did not yield significant results during our observations. We found that our gamification approach for supermarket visits is particularly effective in attracting new customers rather than retaining existing ones.

Keywords: Mixed reality · Augmented reality · Shopping experience · Gamification · Empirical studies · User research

1 Introduction

Inspired by the hype surrounding Pokémon Go in 2016, which is analysed e.g. in Rauschnabel et al. (2017), we posed the question: How would a similar application fare if introduced within the supermarket environment? To answer this question, we implemented a system that allows users to play mini-games in the supermarket while shopping. Our objective was to address all age groups with our mini-games and target the widest possible range of users. We aimed to test our system under real-world conditions, and therefore implemented our system within an actual physical supermarket, with genuine customers. Also, we aimed to integrate our application with the cashier

M. C. tom Dieck et al. (Eds.): XR 2023, SPBE 2024, pp. 16–28, 2024.
https://doi.org/10.1007/978-3-031-50559-1_2

system, enabling us to provide customers with incentives in the form of real coupons, such as a chocolate bar or a dental care product for dogs. The system itself was described in Riedlinger et al. (2020). With this evaluation-paper, we hope to share some insights and lessons learned on AR applications in the supermarket environment, as well as possible effects of such technologies on marketing or brand perception. In order to best approximate the brand perception, for the user research we pursued a combination of questionnaires and observation methods to gain insights into what we labeled pragmatic, hedonic and demographic perspectives.

2 Literature Review

Prior research on bringing AR into the supermarket environment has mainly focussed on two more technical categories: indoor navigation and on-site recommendations. The idea of adding (mobile) technology to an offline, physical retail experience to generate additional value for either the retailer or the customer is not new. An early prototype of Asthana et al. proposes a wireless indoor system for personalised shopping assistance (Asthana et al. 1995). While this paper does not use AR views or similar features, it serves nonetheless as an example of bringing technology to the supermarket to enhance (or augment) human capabilities. Another example – this time an annotation of products with additional data – named “Object AURAs” can be found in Smith et al. (2004). Zhu and Owen present an AR shopping assistant with personalised information, the so-called “PromoPad” in Zhu et al. (2006). Recent examples are combining AR and deep learning to achieve indoor localisation in supermarkets (Cruz et al. 2019). Another field of application is the combination of topics like sustainability (Hormann et al. 2019) or health (Ahn et al. 2015) and shopping. Álvarez and Ziegler propose a Microsoft HoloLens based system that allows product comparison in physical retail environments. Their focus lays furthermore on the comparison of interaction methods and they evaluated their system in a lab environment (Álvarez Márquez and Ziegler 2019). Grewal et al. show the importance of new technologies such as the Internet of things, location-based services, as well as Virtual and Augmented Reality for the support of the shopping decisions of customers, empathising on the importance of their needs in general. However, the acceptance of such technologies on the retailers’ side is also an important point (Grewal et al. 2017). Scholz and Smith offer a framework for maximised consumer engagement through AR. They propose several impulses or important points marketers should be considering when creating AR programs. Especially the three forms of consumer engagement, namely user-brand, user-user and user-bystander engagement offer a classification of the user experience in supermarket environments (Scholz and Smith 2016). Dacko provides a comprehensive overview of Mixed Reality (MR) shopping applications along with a user survey. One finding of his work is that the main perceived drawbacks of MR shopping apps is that the user has to provide too much personal information and that the applications are not well integrated with the shopping experience. While some users expect to experience more entertaining shopping, this aspect is not the focus for the majority of users (Dacko 2017). Löchtefeld et al. compared two approaches for paper leaflets – that still play an important role in supermarket marketing – one for an AR guerrilla marketing and one for AR page navigation within the leaflet (Löchtefeld et al. 2013). Another study on participatory marketing is described in Conway et al. (2019).