

GAMIFIED VR SIMULATION IN NURSING EDUCATION: HOW TO GENERATE VALUE WITH VR IN NURSING EDUCATION

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ABSTRACT

A shortage in nursing staff in Switzerland has reached a high level, and forecasts see the problem growing for the next years as there is a lack of candidates who are willing to sign up for nursing education programs. Prior research suggests that virtual reality (VR) can have positive effects on motivation, learning outcome, and trust. Therefore, we examine if VR in nursing education can help raise the attractiveness of education programs and help raise the number of people signing up for education programs which incorporate VR in their training and education.

KEYWORDS

VR, Nursing Education, Self-Efficacy, Customer Value, Customer Satisfaction, Customer Trust

1. INTRODUCTION

Virtual reality (VR) is a technology that is immersive and hence helps to keep students focused (Loureiro et al., 2021). Furthermore, gamification is also a concept that is emerging in the field of education (Loureiro et al., 2021) and simulators as well as serious games have already been adopted in the field of medical education (Jiang et al., 2022). Not only is gamification a very enjoyable way of learning (Charlier & De Fraine, 2013) but it also positively affects knowledge retention (Brom et al., 2011). Related to the branch of medicine just mentioned is the field of nursing, which is one area that may be aided by VR. The nursing profession in Switzerland is understaffed by 11,000 jobs (Kryeziu, 2022), and until 2028, a serious lack of qualified nursing personnel in Switzerland is forecasted (Merçay et al., 2021). This lack of personnel is, on the one hand, due to staff not transitioning to the labor market after graduating (Merçay et al., 2021) as high stress levels are a reason for staff leaving (Kryeziu, 2022). On the other hand, the scarcity stems from low graduation rates in nursing programs in which there is a high dropout rate that negatively affects the work force available for nursing jobs (Dolder & Grünig, 2016). The combination of high stress, inadequate qualified personnel, and high responsibility (e.g., devastating consequences for patients resulting from a wrong drug administration or wrong dosing) is challenging. Therefore, education in this field should use available technology, such as VR, to help to tackle these challenges by attracting and keeping students in the profession, for this technology has shown positive effects (e.g., knowledge retention) in the past (Brom et al., 2011). Therefore, this paper aims to address this issue by testing for the effects VR may have on students' self-efficacy, satisfaction, word-of-mouth (WOM), loyalty, and trust to enhance the attractiveness of nursing education.

2. LITERATURE REVIEW

Garzon et al.'s (2019) meta-analysis on augmented reality (AR) showed positive effects of augmenting reality (an e.g., a heads-up display (HUD) in automobiles or an alarm clock that projects the time on the bedroom ceiling) on learning experiences, learning motivation, and learning effectiveness. Additionally, positive effects of AR on academic success were reported by Batdi and Talan (2019). AR has mainly been researched in the context of cognitive achievements such as communication skills, engagement, and language learning (Reisoğlu et al., 2017). Potential benefits such as positive effects on learning outcomes (Merchant et al., 2014)

as well as advantages of VR in education (Freina & Ott, 2015) can be identified. Additionally, Kavanagh et al. (2017) investigated application type as well as effects on motivation, and type of learning as well as hardware used was covered by Hamilton et al. (2021).

In customer management literature, positive effects of word of mouth (WOM) on purchase intentions have been reported (Babić Rosario et al., 2016). WOM could help acquire more nursing staff as this young target group tends to rely on online reviews or electronic word of mouth (eWOM; Erkan & Evans, 2016; Utz et al., 2012) as well as WOM. Furthermore, effects of VR on satisfaction were reported (Bryant et al., 2015; Jung et al., 2020) with higher satisfaction leading to positive WOM (Ladhari, 2007) or behavioral intentions such as promoting a product or experience (Trunfio et al., 2022). Thus, finding ways to improve satisfaction could help to acquire new nursing staff students. Furthermore, loyalty effects of satisfied students were reported in the education context as well (Munizu & Hamid, 2015).

In the specific context of public speaking and treating public speaking anxiety, positive effects of VR training were reported (Nazligul et al., 2017; Sakib et al., 2019; Yadav et al., 2020). These results are further confirmed by Reeves et al.'s (2021) meta-analysis and Daniels et al.'s (2020) systematic literature reviews. The roads to birth example where knowledge of anatomy is visualized with the help of this technology (Jones et al., 2019) is an example where VR is used to support learning.

Nevertheless, these advantages do not come without limitations such as barriers to using the technology including technical limitations, e.g. incompatible or missing cables, that pose an obstacle to using VR in higher education settings (Evans, 2019). Furthermore, the population (soldiers versus elderly people) or task type (cognitive, physical, or mixed) being trained can influence if VR/AR is an effective medium for training (Kaplan et al., 2021).

However, although prior research and meta-analyses have been conducted on AR and VR, the educational usefulness of the technology remains unclear (Radu, 2014). Furthermore, "Second Life" or quasi-experiments are very common in VR (Reisoğlu et al., 2017). Therefore, this paper closes this research gap by experimental means and extends the context of prior research to the nursing domain to check if VR is beneficial and valuable in this context.

VR training in medical education has been proven to have a positive effect on learning outcomes (Cohen et al., 2005). This finding is backed by a meta-analysis concluding that VR and AR have positive effects on motivation and learning success (Garzón et al., 2019) and can be applied in continuous education, for instance, in the form of edutainment (Fritz, 1997). Furthermore, VR training can be used to deliver speech training to children, who readily accept this form of training and who benefit as a result (Liu et al., 2017). The technologies also have limitations, however. Health and safety issues (Hicks, 2016), such as the risk of cybersickness (Meeri, 2019), are a possible obstacle in VR simulation and training.

Based on the literature mentioned, we conducted an extension of the systematic literature reviews and meta-analyses by analyzing further literature (see Table 1). We conducted a search with the keywords "nursing," "VR," "simulation," "virtual reality," "gamification," and "education." Out of 16 identified papers, eight were included as they were relevant to the research questions.

VR simulations are cost efficient and allow for delivering lectures or better training remotely (Aebersold et al., 2012). Furthermore, VR can contribute to the acquisition of knowledge, even though some studies find no difference compared to traditional methods of teaching (Chen et al., 2020), which contradicts previous research (e.g. Cohen et al. (2005)) as well as research found in this paper. Smith and Hamilton (2015) found positive effects of VR on students' learning performance as students benefitted from more time to practice and solve exercises in VR. Other studies such as that conducted by Dubovi et al. (2017) found that VR can be used to improve conceptual as well as procedural knowledge and hence close the gap between theory and practice in tertiary education.

Empirical evidence suggests that gamification works in an educational context, too (Hamari et al., 2014). In the content of nursing education, gamification can improve students' learning as well as motivate them (Castro & Gonçalves, 2018). Furthermore, gamification positively affected satisfaction, creativity, and perceived control with a significant impact on decision making and few negative effects (García-Viola et al., 2019).

However, the success of gamification depends on the domain or context to which it is applied, so Hamari et al. (2014) called for more rigor regarding methodology. The literature research conducted in this paper found an interculturally validated scale for measuring gamified learning experiences called GAMEX (Márquez-Hernández et al., 2019).

Although this is a rather general finding that can be applied to different VR applications and IT projects, it is worth mentioning because taking the needs of nursing students into account is important (Jeon et al., 2020). Specifically, a wide range of scenarios, capabilities, levels of difficulty, instant feedback, and simulations of emergency situations are needs that were specifically mentioned in Jones et al.'s (2019) study, and these requirements or needs may be taken into consideration when implementing VR applications in the field of nursing.

Table 1. Overview of literature extending existing meta-analysis and systematic literature reviews

Authors	Classification	n	Core findings
Aebersold et al. (2012), USA	VR experiment (crisis management)	51	- VR simulations are a cost-efficient form of training - Remote training without location on premise is possible
Castro and Gonçalves (2018), Brazil	Experiment in gamified VR learning environment	15	- Gamification can motivate students and improve their learning. - Gamification positively affects learning processes in the context of nursing education.
Chen et al. (2020), International	Meta-analysis of 12 studies on the effectiveness of VR	821	- VR can contribute to expanding students' knowledge but compared to traditional methods, no differences in learning outcomes could be identified.
Dubovi et al. (2017), Israel	Experiment with non-immersive desktop VR application	129	- Conceptual, procedural knowledge could be improved - Positive correlations were reported between feeling of presence and learning effect. - Gap between theory and practice in tertiary education was reduced.
García-Viola et al. (2019), Spain	Experiment on effects of gamification on decision making of nursing staff.	191	- Gamification positively affects satisfaction, creativity, perceived control, and further aspects. - No or few negative effects were reported. - A significant impact on decision making was found.
Jeon et al. (2020), Korea	Qualitative study (focus groups and interviews)	14	- Needs of nursing students should be considered when developing VR simulations. - A wide range of scenarios, capabilities, levels of difficulty, instant feedback, and simulation of emergency situations was mentioned.
Márquez-Hernández et al. (2019), Spain	Intercultural validation of the GAMEX scale	226	- GAMEX can measure the experiences during learning.
Smith and Hamilton (2015), USA	Experiment with immersive Unity VR application.	20	- Performance is improved by the VR simulation. - The VR simulation enables more time for exercises. - The VR simulation can be used to train capabilities used in clinics (e.g., catheter placement) - Research on VR simulation in a clinical context is insufficient.

The literature is not clear on exactly how VR can be beneficial (Smith & Hamilton, 2015) in the context of nursing education. Therefore, the research question is posed as follows:

RQ: How can VR provide value in the context of nursing education?

Furthermore, four sub-research questions regarding value and gamification from a student as well as an educational institution perspective are posed:

SRQ1: How can VR add value for students?

SRQ2: How can gamification add value for students?

SRQ3: How can VR add value from the perspective of the institution providing this education?

SRQ4: How can gamification add value from the perspective of the institution providing this education?

Regarding the education, the aspects of the educational provider that influence students' decisions in choosing an institution are relevant too. Therefore, the attractiveness of the educational program and the organization providing it in the eyes of customers or students is relevant. There are seven factors influencing this decision: image of the institution, influence of parents or friends and recommendations, quality of the education or service, costs and expenses, physical location, job perspectives, and offering of degrees the institution provides (Munizu & Hamid, 2015; Simões & Soares, 2010). Furthermore, word-of-mouth (WOM) is relevant (Chen, 2016) as this may lead to acquisition of further students, which is quite relevant to business schools and private tertiary education organizations alike. Also relevant is customer satisfaction since it can lead to WOM (Chen, 2016) and thus reduce acquisition costs.

As mentioned in Section 1, one of the reasons a shortage of staff in nursing exists is the high drop-out rate, so customer loyalty (in this case, continuing and finishing the education) and transitioning into the workforce are relevant constructs. Satisfaction correlates with loyalty in general (Bae et al., 2020; Casalo et al., 2008;

Curtis et al., 2011), and this holds true also for the nursing industry (Chen, 2016; Munizu & Hamid, 2015). Furthermore, customer loyalty, customer value, and customer trust are relevant as they tend to be linked with each other (Curtis et al., 2011; Mahaputra, 2017) and with satisfaction (Kim et al., 2009; Mahaputra, 2017).

A further concept that is linked to learning, motivation, and satisfaction is self-efficacy. It can positively affect motivation and the construct itself can be positively affected by achievements, experiences, observations, feedback, and psychological state (van Dinther et al., 2011). Furthermore, self-efficacy is an important indicator of students' success (Bartimote-Aufflick et al., 2016) which holds true for nursing students as well (Zengin et al., 2014) and can positively affect satisfaction (DeWitz & Walsh, 2002). Prior research suggests that VR can positively affect self-efficacy (Nissim & Weissblueth, 2017).

3. METHOD



Figure 1. Screenshot of the prototype

An experiment is conducted to answer the research questions by inviting nursing students in their second and sixth terms to use a VR prototype (see Figure 1) and take a subsequent survey. The experiment was split into three phases. In the first phase, the students learned the controls of the VR application. In the second phase, they used the VR application in a learning mode. Finally, in the third phase, the students took the survey. The operationalization was implemented as follows: Age, gender, place of residence, education (current and previous), years of working experience, and hours of experience in VR were control variables. The constructs were measured by scales used in past research: psychometric skills (Stump et al., 2012), customer satisfaction (Elliott & Shin, 2002), customer loyalty and referral (Chen, 2016), hedonic and utilitarian customer value (Kim & Hall, 2019) and trust (Ghosh et al., 2001). Nineteen students in their second term participated in the experiment. They were randomly assigned to the treatment (VR application with gamification) and control (VR application without gamification) groups. A small incentive for participating was provided as participation in the experiment was optional. Participants filled out a questionnaire before using the VR application (baseline) and another one after the VR experience.

4. RESULTS, DISCUSSION, FURTHER RESEARCH, AND LIMITATIONS

The participants of this study were on average 21.53 years of age. Furthermore, they had an average of 1.79 years of working experience. The majority (79%) were female, were residents in urban regions (53%), and did not have any experience yet with VR (58%). First, a test on normal distribution was conducted (Shapiro-Wilk) and apart from the self-efficacy and referral, all of the variables followed a normal distribution. Therefore, parametric testing could be conducted with these two exceptions. Of the variables, only years of work experience had significantly higher levels in the control group than in the treatment group. All other control variables showed no significant group differences.

Hypotheses H1 to H3 (see Table 2) were tested by t-test and showed p values of .00, .07, and .73, respectively. Hypothesis H1a showed significant differences whereas H2a and H3a did not. Hypothesis H1b

showed significant group differences with a *p* value of .00 whereas H2b and H3b did not with *p* values of .33 and .61, respectively. Hypotheses H4 to H10 were tested by regression analysis. All hypotheses, except H5 (*p* = .45), showed significant *p* values of .00 and hence could be accepted (see Table 2).

Table 2. Overview of hypothesis

Hypotheses	Path	<i>p</i> value	Result
H1a	VR simulation → self-efficacy	.00	Accept
H1b	Gamification moderates (VR simulation → self-efficacy)	.00	Accept
H2a	VR simulation → customer satisfaction	.07	Reject
H2b	Gamification moderates (VR simulation → customer satisfaction)	.33	Reject
H3a	VR- simulation → customer value	.73	Reject
H3b	Gamification moderates (VR simulation → customer value)	.72	Reject
H4	Customer value → customer satisfaction	.00	Accept
H5	Self- efficacy → customer satisfaction	.45	Reject
H6	Customer satisfaction → customer loyalty	.00	Accept
H7	Customer satisfaction → WOM	.00	Accept
H8	Customer loyalty → WOM	.00	Accept
H9	Customer trust → customer value	.00	Accept
H10	Customer trust → customer loyalty	.00	Accept

The moderation effect was only significant for the gamification’s moderating effect on the path VR simulation to self-efficacy. Therefore, gamification fostered VR effects neither on customer satisfaction nor on customer value. The VR simulation had significant effects on self-efficacy but affected neither customer satisfaction nor customer value directly. Furthermore, self-efficacy did not affect customer satisfaction.

However, customer satisfaction had a significant effect on customer loyalty and WOM. In turn, customer loyalty had a positive effect on WOM. Customer trust affected both customer value and customer loyalty. Not only did the VR simulation affect self-efficacy, an important and relevant concept of learning outcomes, but also gamification had positive effects on self-efficacy. This result matches that of past research on VR (e.g., Nissim & Weissblueth (2017); Hsiao (2021)) and traditional simulations (Nishisaki et al., 2007). Also, self-efficacy did not directly affect customer satisfaction; however, it is possible that indirect effects not modelled in this research, such as effects on trust and in turn on satisfaction, may play a role as self-efficacy may trigger emotions or affect cognitive as well as affective aspects of customer trust. The results also showed that customer satisfaction affected customer loyalty and WOM. Customer loyalty in turn affected WOM. Both customer value and customer loyalty were affected by customer trust. From a didactic point of view, the use of VR and gamification is beneficial regarding self-efficacy. With regard to the traditional customer-related aspects such as trust, customer satisfaction, customer value, and customer loyalty, the picture was less clear. Although the hypotheses were accepted and the customer-related constructs as well as beneficial customer behavior such as WOM held true in the context of nursing education, no direct link between VR and gamification and customer-related constructs could be reported. A further analysis and regression with utilitarian and hedonic customer value showed a clearer picture in favor of the hedonic customer value. Furthermore, a simple cross-table comparison suggested that VR positively affected the customer-related constructs as these results were higher in the post questionnaire than in the baseline one.

Therefore, further research may take a closer look at the customer-related constructs that account for direct and indirect effects. Additionally, adding further constructs which are more hedonically related such as the affective dimension of trust may further help shed light on the complex and presumable emotional affective effects of VR and gamification in a nursing education setting. As these results can be considered preliminary, further research may analyze larger or comparable sample sizes with structural equation modelling (SEM) like in the latest research of Hsiao (2021) on self-efficacy in order to test for further direct or indirect effects of VR and gamification on the constructs discussed in this paper.

Primary limitations of this study are the small sample size, the relatively young ages of the participants as they were from the second term in their education, and the gender bias towards female participants. A final aspect which deserves note, though, is that the number of years of working experience was significantly different between the two experimental groups. Nevertheless, since this study focused on the nursing profession, the results are interesting and relevant as the makeup of the profession is relatively young and primarily female. Hence, the study is relevant and applicable to the target group of nursing students.

5. CONCLUDING REMARKS

The results of this research suggest that adding VR simulations to nursing education curricula and training may help improve students' self-efficacy. Furthermore, traditional customer management constructs hold true in this branch, too. In education and elsewhere, customer satisfaction affects customer value. Happy students are more loyal and tend to give more positive WOM, which in turn can reduce the cost of acquiring new students which is important to business schools as well as private tertiary schools. Customer loyalty, too, positively affects WOM. The younger target group in this study tends to seek information online, so positive ratings and WOM are thus relevant and important. To this end, VR can help foster customer satisfaction, and with affective and emotional effects, this technology can enable customer behavior, such as WOM, that is beneficial to educational institutions. Furthermore, trust has been identified as highly relevant to business success in the past and even more so online, so trust positively affects customer value as well as loyalty, both aspects beneficial to the success of educational institutions.

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