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Influence of narrative settings on learning success in virtual reality games – a case study with "*Bridge of Knowledge VR*"

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Gamification has received increasing attention in research and practice. Although narrations as gamification design elements are frequently implemented into gamified systems, specific content- and context-related design elements of narrations are only scarcely addressed. In this study, we varied the content of the narration for a gamified virtual reality learning system by addressing either a self-oriented (finding a treasure) or other-oriented (rescuing a person) motivational orientation. Further, we varied the context of the narration by using a similar or dissimilar setting of the narration compared to a subsequent virtual reality learning setting. The results of a 2 (motivation: self-oriented vs. other-oriented) × 2 (context: similar vs. dissimilar) between-subjects experiment with a control group show that using an other-oriented motivational orientation in contrast to a self-oriented one increases intrinsic motivation and germane cognitive load, although we could not find evidence for improving learning performance for any of the independent variables. These results imply that implementing rescues in narrations of serious games can be beneficial to foster engagement for language learners.

KEYWORDS

gamification, digital game-based learning, virtual reality, narration, vocabulary learning

1 Introduction

Gamification is generally regarded as being beneficial for motivation and learning. However, there is also evidence that this is not always the case (Mekler et al., 2017; Sailer et al., 2017; Sailer and Homner, 2020). One possible explanation for these inconsistent findings lies in the learners' individual preferences for different elements of game-based learning. While some studies indicate that personalized gamification could have a positive effect (Krath and von Korflesch, 2021; Mora et al., 2018), especially narration as a design element is not well studied so far.

The effects of narrations in gamified environments have mainly been investigated in relation to using narrations or not, or with regard to how narrations interact with other variables (Sailer et al., 2017; Vega and Camarero, 2024). A recent meta-analysis shows that while narration does not influence motivational or cognitive outcomes, it positively influences behavioral outcomes (Sailer and Homner, 2020). However, categorization of different types of narrations is still at an early stage, and specific design elements of narrations have only scarcely been addressed in the literature so far (Breien and Wasson, 2021).

In relation to language learning, a recent review of various studies that investigated gamification in general reveals that the effects of specific gamification design elements have not been investigated so far (Dehghanzadeh et al., 2021). Therefore, we do not yet know how specific design elements of narrations influence learning. Previous research has identified different types of narrations used in practice (Pujolà and Argüello, 2019; Kosmas et al., 2023). From a motivational perspective, the content of the narration may play a major role in providing an engaging learning experience.

Another important factor apart from the direct content of a narration is the context in which the narration takes place. This is in line with research on vocabulary learning, which shows that an important aspect for narrations is contextual diversity (Adelman et al., 2006; Wilkinson and Houston-Price, 2013; Johns et al., 2016). Although gamification research has already addressed the effects of context in a more general sense, like, for example, using the same game on different types of gaming devices (Sreejesh et al., 2021), contextual diversity has not been addressed in the area of vocabulary learning so far. Therefore, our study aims to investigate how contextual diversity can influence vocabulary learning when using narration as a gamification design element for a virtual reality learning system.

For our study, we developed a vocabulary learning task for the mobile game *Bridge of Knowledge VR* and combined it with different types of narration in which the content and context were varied. *Bridge of Knowledge VR* is a virtual reality adventure game in which the goal is to cross a rope bridge across a chasm in a tropical rain forest. To successfully cross the bridge, learners need to correctly answer ten multiple-choice questions in a row correctly. The narration was either closely related to the context of the game (describing the bridge and its surroundings) or not related to the context (describing only the forest). As a second variable, the content of the narration either possessed a self-related (finding treasure) or an other-related (rescuing a friend) motivational orientation.

2 Theory

2.1 Cognitive load and motivation

According to cognitive load theory (Sweller et al., 1998; Sweller et al., 1019), learning processes are affected by the cognitive load of the learning task. Cognitive load can be divided into intrinsic cognitive load, germane cognitive load, and extraneous cognitive load. While intrinsic cognitive load refers to the complexity of the learning material itself, extraneous cognitive load refers to investing mental resources on factors that are not part of the learning content. On the other hand, germane cognitive load refers to the mental resources the learner invests into creating schemata when being confronted with the intrinsic cognitive load elicited by the learning material (Sweller, 2010). Therefore, extraneous cognitive load should be minimized, and germane cognitive load should be maximized. While intrinsic cognitive load is influenced by the selection of the learning topic and the learners' expertise and therefore cannot be influenced by the design of learning material, extraneous cognitive load is mainly influenced by the design of the learning material. Likewise, germane cognitive load is influenced by the ability of the learning material to redirect learner's attention (Sweller et al., 1998) and recent research has specified that germane cognitive load can be affected by characteristics of the learner, such as motivation (Sweller, 2010; Debue and van de Leemput, 2014).

Self-determination theory (Deci and Ryan, 1985; Ryan and Deci, 2017) is one of the most prominent theories explaining motivation in relation to gamification (Bai et al., 2020; Zainuddin et al., 2020). Self-determination theory proposes that humans can strive towards meeting goals through extrinsic or intrinsic motivation, or a combination of both types. While extrinsic motivation is caused by separable rewards or avoidance of punishment associated with accomplishing the activity, intrinsic motivation leads to engagement in an activity because the activity itself is rewarding and provides positive feelings (Deci and Ryan, 2000).

Narration in serious games can raise intrinsic motivation through motivators such as curiosity and challenge (Naul and Liu, 2020). Furthermore, narration can also promote flow and perceived learning outcomes (Alexiou et al., 2020). Experimental research concerning narrations in gamification has mainly compared the impact of whether a narration is present or not. Previous research has based narrations of gamified systems for language learning on becoming podcast speakers (Massler et al., 2022), on Greek mythology and conflicts between Greek gods (Kingsley and Grabner-Hagen, 2018), or on the creation of narrations by the learners themselves (Zhou et al., 2017). However, specific design elements of narrations in gamification have scarcely been addressed so far, and especially in language learning studies on the effects of specific aspects of gamification, design elements are still underresearched (Dehghanzadeh et al., 2021). To fill this gap and further investigate narrations in gamification, we draw upon self-determination theory and research on altruism vs. egoism. Studies in the gamification domain have suggested that helping behavior could lead to intrinsic motivation by contributing to the relatedness need (Riar et al., 2024). Related to this, motivation can be differentiated into altruistic and egoistic motivation (Batson and Shaw, 1991). Previous research has already used narrations related to helping behavior for gamification and found that, in combination with avatars and teammates, helping behavior enhanced the relatedness need (Sailer et al., 2017). This more other-oriented helping behavior is in line with a model of gamification user types which proposes a philanthropist user type motivated by altruism and purpose (Tondello et al., 2016).

Another more self-oriented motivational orientation frequently employed in gamification is using treasures as a reward, for example, in the form of badges. Additionally, in the context of museums, treasure hunts can be implemented to foster engagement (Cesário, 2019). Gamified language learning apps also use treasure hunts, although not necessarily integrated into narrations (Almendingen et al., 2022).

Based on all of the above, we propose the following hypothesis:

H1: Other-oriented compared to self-oriented motivation leads to a) higher learning performance, b) higher germane cognitive load, and c) higher intrinsic motivation.

2.2 Contextual diversity

A range of studies have been conducted to explain how first language learners and second language learners acquire vocabulary knowledge. Generally, the number of times that words are encountered seems to be a predictor for vocabulary learning (Broadbent, 1967; Scarborough et al., 1977). However, vocabulary learning is also strongly influenced by contextual diversity (Adelman et al., 2006), which refers to "the number of distinct contexts in which the word occurs" (Jones et al., 2017, p. 242). In line with this finding, the principle of likely need describes the idea that the larger the number of contexts in which a word is used, the higher the probability for this word to be retrieved in the future (Anderson and Milson, 1989; Anderson and Schooler, 1991; Jones et al., 2017). Narrations are an excellent way to provide learners with a context. In the area of narrations, school children learning English as a first language benefit more from being exposed to a story with a definition of the target word than from being only exposed to the context (Wilkinson and Houston-Price, 2013). Additionally, when it comes to learning new vocabulary, an informative context can be helpful, compared to simple retrieval without context (van den Broek et al., 2022). Therefore, having multiple opportunities to learn the meaning of a word appears to be beneficial for learning. Already in 2-year-old children, background color variability facilitates word learning (Twomey et al., 2018). Further studies have shown that contexts that are not purely semantic can facilitate learning. For second language learners, learning increases when narrations containing target words are presented by different speakers compared to being presented by the same speaker (Tapia et al., 2022).

Based on this research on contextual diversity, the question arises how contextual diversity can be operationalized in a gamified virtual reality learning system. One major advantage of virtual reality is the high level of immersion it offers by closing off the users' visual sense using a virtual display directly in front of their eyes (Slater and Wilbur, 1997). Thus, immersive virtual reality allows us to design contextual diversity by using the correspondence between the narrational environment in which the story is introduced and the virtual environment in which learning takes place. Therefore, the setting in the narrational environment can either be similar or dissimilar to the setting of the virtual environment. We decided to implement this form of contextual diversity by dividing the learning environment into two different contexts. In the first context, the narrational environment was presented verbally, when participants read a textual presentation of a narration including an environment either similar or dissimilar to the virtual environment of the second learning phase. The second context represented the learning phase and was presented via the immersive virtual reality. In this context, the participants learned vocabulary on a VR rope bridge in the jungle by choosing the option with matching word meaning from a set of alternatives. Drawing on the previously described contextual diversity effects, we propose that a first context that is dissimilar to the second context increases learning-related variables compared to a first context that is similar to the second context.

H2: A dissimilar compared to a similar context leads to a) higher learning performance, b) higher germane cognitive load, and c) higher intrinsic motivation.

Additionally, we propose that an interaction effect may arise for motivation and context.

H3: There is a mutually enforcing interaction effect of motivation and context.

3 Methods

3.1 Participants and design

We used a 2 (motivation: self-oriented vs. other-oriented) × 2 (context: similar vs. dissimilar) between-subjects design to test our hypotheses. The study was conducted in different courses of the local university for which the English language was necessary over the course of the study program. To achieve a higher ecological validity than in a laboratory experiment, participants were tested in class, using their own smartphones. They were merely provided with a smartphone on which the app had been pre-installed if they indicated during the experiment that their setup was not working.

In total, 84 participants took part in the study, which received a positive vote from the local ethics committee. Three participants had to be excluded because they indicated to have had technical issues with their smartphone or the VR system after they had completed all questionnaires. Out of the remaining 81 participants, 58 reported to be female, 18 male, and five non-binary. Furthermore, participants had a mean age of 21.88 years, (SD = 2.69), ranging from 18 to 29 years.

Before participants used the app *Bridge of Knowledge VR*, they were asked to read a story about their journey through a forest and coming to the bridge setting (see appendix, Supplementary Table A1 to read the whole story and exact word manipulation). The story was written from a first-person perspective, describing the current situation. The story was varied according to two factors: first, the motivational orientation of the story, and second, the context. Additionally, a control group was implemented in which participants learned the vocabulary using a simple digital quiz on the platform QuizAcademy (quizacademy.de). Participants in this group did not receive any story prior to accessing the learning platform.

3.1.1 Motivation

Participants were told the story in the application was either about a treasure hunt (self-oriented condition) or about a vacation (other-oriented condition). In both stories, they were together with a friend. In the self-oriented condition, this friend would then request their help for saving the treasure. In the other-oriented condition, the friend would request help to save them from falling into the water. When the participants then selected the respective levels of *Bridge of Knowledge VR*, they would read the same request in a speech bubble inside the game. After completing the level successfully, participants were shown a newspaper article with a stylized picture of a successfully rescued person or treasure (see Figure 1). This was accompanied by applause and cheering.

3.1.2 Context

In the condition with low similarity, the story which the participants read was situated mostly inside a forest. In the

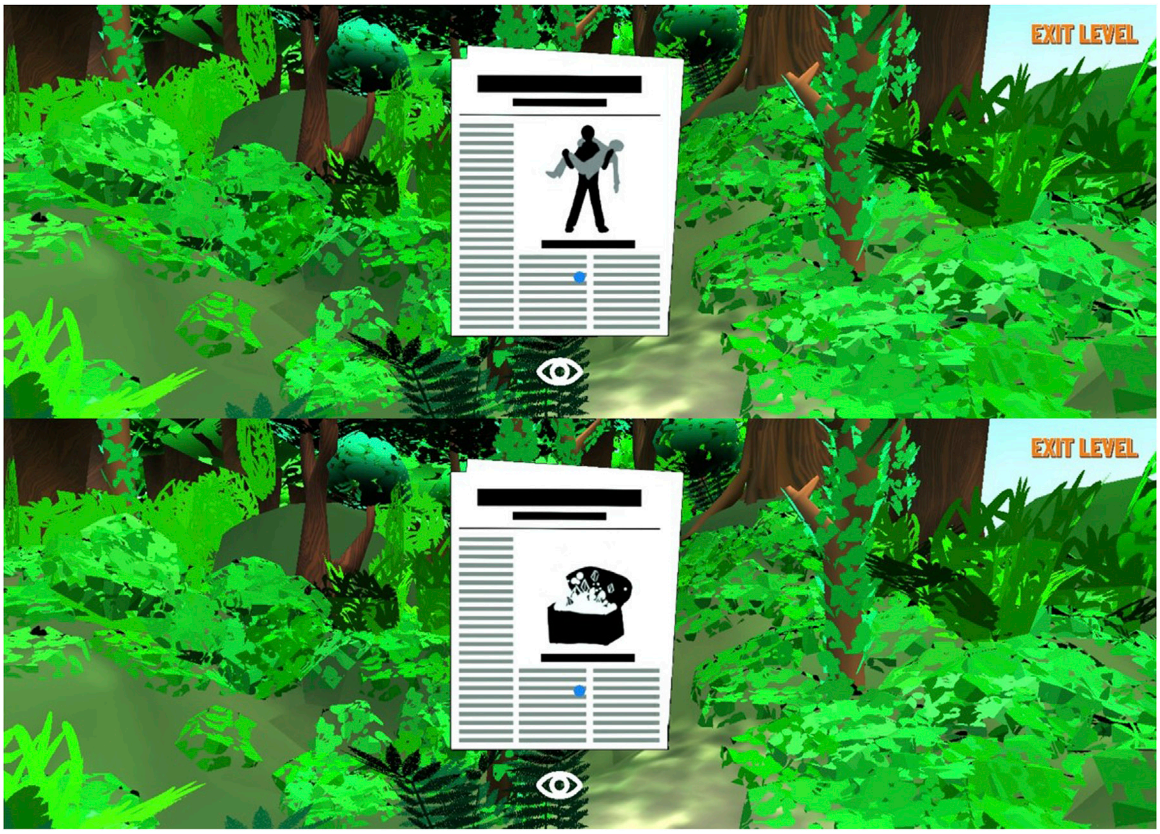

FIGURE 1
After successfully completing the game, a newspaper is shown, either depicting a successfully rescued person (top) or treasure (bottom).

condition with high similarity, the story was situated directly in front of a bridge with a waterfall.

3.2 Materials

The gamified software used for this study is an adapted version of the VR adventure quiz app *Bridge of Knowledge VR* (www.bridge-of-knowledge.de), which was created using Unreal Engine. The application can be played by placing any mobile (Android or iOS) in an accessible VR viewer available for under 5€. This takes the users to a virtual scenery in the jungle. The aim of the game is to cross a rope bridge by answering ten multiple-choice questions in a row correctly. The questions appear on a parchment next to the users, and the alternative answers are projected on the planks of the bridge. There is only one correct answer for each question. Answers are selected by keeping the gaze (represented by a blue dot in the middle of the split screens) on an eye-shaped icon next to the answers. This initiates the loading of a progress bar. When the progress bar is completed, the answer has been logged in. If the answer is correct, the users advance on the bridge, and a new question appears on the parchment. Otherwise, there is an (entertaining) free fall, the learners are presented with the correct answer and can start again. There is also fear-of-heights mode without a cracking noise or fall, in which the bridge spans a calmly flowing river. Within the application, learners can select different levels, which are created by teachers and experts by using a simple template with their own questions, correct answers and distractors.

3.2.1 Learning material

Vocabulary for the learning phase was selected in April 2022 using the following procedure: We started with a google search for "very difficult English words". Our goal was to find real English words that the advanced, but non-native speakers of English in our sample were unlikely to know. This would enable us to measure a learning effect, while still providing a benefit for the participants of our study by learning words that they might potentially encounter during their courses. We decided against using artificial words because 1) we wanted to see if it was feasible to create a fictional narration for the gamification of a set of preselected words, given the relevance when such an approach would be used in practice, and 2) we wanted to avoid deceiving participants, because this might have reduced their willingness to take part in future studies (as language learning studies with artificial words are not common in our subject pool and knowledge of correct English was partly relevant for their future exams). From the results list, we selected 10 target words that could be incorporated into the study and combined them with a description from www.lexico.com and a German translation from www.pons.de. Next, we combined each of the German words with the correct English translation plus four wrong translations with the same word type. The final list can be found in Table 1.

TABLE 1 List of target vocabulary with correct answers and distractors.

Vocabulary	Correct answer	Distractor 1	Distractor 2	Distractor 2
epistolary	written in the form of letters	resembling a riddle	making use of guns	extremely dangerous
to cajole	to persuade sb. through compliments	to trick sb. to do sth	to beg under tears	to threaten in a humorous way
proclivity	a tendency to do or like sth. considered bad	an excessive interest in curiosities	an outstanding artistic talent	a fascination for childish pastimes
arboreal	relating to, or living in trees	describing animals that eat plants	living in large herds	able to blend in with one's surroundings
to clamor	to shout or demand loudly	to hold on to sth. tightly but carefully	to tie two or more things together with a string	to be squeezed in a tight space like a clam
protean	able to change quickly and easily	characteristic of light fog	resembling animal footprints	formed by imagination
antediluvian	very old-fashioned	playing tricks on people	under a false belief	mythical
ulotrichous	having woolly hair	astonishing	fatally wounded	deep black
deliquescent	dividing into many branches	distracted and forgetful	exquisite	committing crimes
inchoate	starting to develop	using lungs to breathe	regarded as unsafe	very ill

3.3 Measures

3.3.1 Learning performance

Learning performance was measured as recall using open answer questions for the ten vocabulary items participants had to learn in the learning system. Answers were coded by two of the authors (0 = not correct, 1 = partially correct, 2 = fully correct), resulting in a Cohen's Kappa = 0.788, indicating a moderate inter-rater reliability (McHugh, 2012). As the answers produced adequate reliability (α = 0.93), we used the means of the two raters as indicator of recall.

3.3.2 Intrinsic motivation

Intrinsic motivation was measured using the interest/enjoyment scale of the Intrinsic Motivation Inventory (IMI, Ryan, 1982, α = 0.93). An example item is "This activity was fun to do". The items were measured on a 7-point Likert scale ranging from (1 = strongly disagree to 7 = strongly agree).

3.3.2 Cognitive load

Cognitive Load was measured using a cognitive load questionnaire differentiating intrinsic (α = 0.74), extraneous (α = 0.81), and germane (α = 0.78) cognitive load (Krieglstein et al., 2023). An example item for intrinsic cognitive load is "The learning contents were complex", an example for extraneous cognitive load is "The design of the learning material was inconvenient", and an example item for germane cognitive load is "I made an effort to understand the learning content". The items were measured on a 7-point Likert scale ranging from (1 = strongly disagree to 7 = strongly agree).

3.4 Procedure

The experiment took place in specific timeframes in the selected seminars of the local university. One week before the experiment, participants were told that they had the option to participate in the study by the lecturer. At the time the experiment took place, the experimenters first gave participants information about the study's procedure and demonstrated the VR application in an example level, explaining how levels could be selected, etc. Since the experiment took place in a group setting in which some participants (i.e., the control group) were not supposed to use the application at all during the experiment, participants were told that they would be instructed at different points in time to use the application, and that they should not be confused when others already used VR when they did not, and *vice versa*. Finally, they were shown a QR code and a download link for the application. Subsequently, all participants downloaded the application.

Afterwards, a link and a QR code were presented with which participants could open a survey on the platform SoSci Survey (soscisurvey.de) with their smartphones. All further instructions and reading texts were presented inside this survey. At the start of the survey, participants could provide informed consent and open a questionnaire regarding general sociodemographic information. Afterwards, they were told to read the respective stories, and the control group was given information about the traditional vocabulary learning app and provided with a link. Random assignment to one of the experimental conditions or to the control group was done automatically by SoSci Survey. After participants in the experimental group had read the stories, they were given the respective codes for the levels which they had to select in *Bridge of Knowledge VR*. To ensure participants saw the correct information (corresponding to their condition) in the virtual environment, participants in the self-oriented and other-oriented condition received different codes. Once participants had completed the level (i.e., reached the other side of the bridge), they were shown the respective newspaper articles with accompanying applause in the virtual environment and returned to the questionnaire in SoSci Survey, in which they completed the measures for cognitive load, intrinsic motivation, and learning performance. Finally, participants were thanked and debriefed. To give all participants the chance to test the VR application, participants in the control group were told that they now could test *Bridge of Knowledge VR* as well.

TABLE 2 Means and standard deviations (in brackets) for dependent variables.

	Control	Dissimilar context		Similar context	
		Self-oriented	Other-oriented	Self-oriented	Other-oriented
Learning Performance	0.86 (0.69)	0.67 (0.42)	0.59 (0.4)	0.72 (0.53)	0.73 (0.66)
Intrinsic Cognitive Load	3.67 (1.35)	4.05 (1.17)	3.65 (1.13)	3.6 (1.26)	3.55 (1.24)
Extraneous Cognitive Load	2.75 (1.01)	3.44 (1.35)	3.14 (1.14)	3.06 (1.34)	2.94 (1.45)
Germane Cognitive Load	4.88 (0.67)	4.65 (1.06)	5.09 (0.67)	4.09 (1.38)	4.72 (1.34)
Intrinsic Motivation	4.22 (1.59)	4.58 (1.38)	5.15 (0.87)	4.87 (1.43)	5.6 (1.19)

Note. Learning performance could range from 0 (no answer correct) to 2 (all answers correct), all other variables were measured from 1 (strongly disagree) to 7 (strongly agree).

4 Results

Data was analyzed in two steps. For each dependent variable, we first compared differences between the control group and all other groups. Second, we checked whether the motivational orientation and context factors elicited significant differences. For the ordinal learning scores, we used nonparametric tests, whereas we used parametric tests for the other dependent variables measured with Likert scales. Assumptions for the respective tests are only reported if they were violated. Because removal of outliers did not change significance values in the data analysis, they were retained. Means and standard deviations for the five different groups can be seen in Table 2.

4.1 Learning performance

To test differences between the control group and all other groups, we conducted a Mann-Whitney-*U*-Test on the ordinal data of the recall scores. The test revealed no significant differences between the control group and all other groups $(U = 425, p = .394, z = -0.27, CI\,[-.55; .20], r = -0.04)$. To test the influence of motivation and context factors on learning performance, we used a Kruskal Wallis test with the four conditions as independent variables. The results revealed no significant differences ($\chi^2 = 0.79, df = 3, p = .852$).

4.2 Cognitive load

For intrinsic cognitive load, a *t*-test revealed no significant differences between the control group and all other groups $(t\,(79) = 0.12, p = .903, d = .0348)$. Likewise, the results of the 2 × 2 ANOVA revealed neither a main effect for motivation $(F\,(1,62) = 0.59, p = .446, \eta_g^2 = .009)$, context $(F\,(1,62) = 0.86, p = .358, \eta_g^2 = .014)$, or an interaction $(F\,(1,62) = 0.36, p = .553, \eta_g^2 = .006)$.

For extraneous cognitive load, no differences between the control group and all other groups emerged in a *t*-test (t (78) = 1.096, p = 0.277, d = 0.314). Likewise, the results of the 2 × 2 ANOVA revealed neither a main effect for motivation $(F\,(1,62) = 0.41, p = .527, \eta_g^2 = .007)$, context $(F\,(1,62) = 0.78, p = .380, \eta_g^2 = .013)$, or an interaction $(F\,(1,62) = 0.07,\ p = .787, \eta_g^2 = .001)$.

For germane cognitive load, an *F*-test revealed that variances between the control group and all other groups were not equal $(F\,(65,14) = 3.12, p = .021)$. A *t*-test for unequal variances was therefore performed, which revealed no significant differences $(t\,(36.92) = -1.07, p = .292, d = -.218)$. A 2 × 2 ANOVA using White adjustment for heteroscedasticity (White, 1980; Long and Ervin, 2000) revealed a marginally significant main effect for motivation $(F\,(1,62) = 3.48, p = .067, \eta_g^2 = .053)$, reflecting more germane cognitive load in the condition with other-oriented motivation than in the condition with self-oriented motivation. On the other hand, the main effect for context $(F\,(1,62) = 2.41, p = .126, \eta_g^2 = .037)$ and the interaction effect $(F\,(1,62) = 0.10, p = .751, \eta_g^2 = .001)$ were not significant.

4.3 Intrinsic motivation

A *t*-test for intrinsic motivation revealed a significant difference between the control group and the experimental groups $(t\,(79) = 2.19, p = .032, d = .625)$, reflecting that individuals in the control group had lower intrinsic motivation $(M = 4.22)$ than individuals in the other groups $(M = 5.05)$.

Looking further into the 2 × 2 ANOVA, a significant effect of motivation emerged $(F\,(1,62) = 4.60, p = .036, \eta_g^2 = .069)$, reflecting higher intrinsic motivation in the condition with other-oriented motivation $(M = 5.37, SE = .215)$ than with self-oriented motivation $(M = 4.72, SE = .215)$. The main effect for context $(F\,(1,62) = 1.45, p = .233, \eta_g^2 = .023)$ and the interaction effect $(F\,(1,62) = 0.07, p = .791, \eta_g^2 = .001)$ were not significant.

5 Discussion

Overall, playing the game *Bridge of Knowledge VR* increased intrinsic motivation, compared to the control group answering the same questions in a simple quiz. Particularly notable is the effect of the other-oriented narrative (rescuing a friend), which led to significantly higher intrinsic motivation than the self-oriented treasure search. Additionally, other-oriented narrative also increased germane cognitive load compared to self-oriented narrative. As far as the learning effect is concerned, there was no difference between the groups. All in all, these results indicate that intrinsic motivation can be improved by using VR-based gamification, and especially narratives with other-oriented motivational focus.

5.1 Implications for theory and practice

Hypothesis 1, that other-oriented compared to self-oriented motivation leads to higher learning-related outcomes, was only partially supported by the experimental data. While we could find no significant effect of the motivational orientation on learning performance, the other-oriented motivation condition led to higher germane cognitive load and motivation than the self-oriented motivation condition. These results suggest that the type of narration selected in gamification can have an important effect on learners' motivation and should therefore be investigated further. This result goes beyond previous research, which only investigated the effect of narrations in general (Sailer et al., 2017; Vega and Camarero, 2024). Moreover, it supports research proposing a relationship between motivation and germane cognitive load (Debue and van de Leemput, 2014). These results imply that although the use of gamified narratives might not change the mere learning outcomes, it might nevertheless be meaningful in practice, because they have the potential to enhance learners' motivation if the content of the narration has an other-oriented motivational orientation.

On the other hand, hypothesis 2, that a dissimilar context compared to a similar context leads to higher learning-related outcomes, is not supported by our data. This contrasts with previous research on contextual diversity (Pagán and Nation, 2019; Tapia et al., 2022). This effect is likely due to the inherent difference between a textual presentation and a virtual environment. Given that the first learning phase was presented as a printed text, participants had to rely solely on their imagination for the context. Therefore, it is likely that the context in the two conditions was too different to reveal any effects. This could also explain why we could not find any differences in the interaction between motivation and context (hypothesis 3). As a consequence, future research could investigate whether it is possible to design narrational contexts in a way that participants perceive an overlap between their imagination and a virtual environment. Another option could be to present the narration via audio while the participants are looking at the virtual environment. However, this was not feasible here due to the limited scope of the current study.

Regarding implications for practice, our results suggest that gamified learning systems should be designed with a narration that is other-oriented (e.g., rescuing another person) to enhance motivation. However, more research is needed to identify what kind of context (e.g., rescuing another person vs. some form of help for others) is particularly beneficial to vocabulary learning in narrations for gamified learning systems. We cannot yet say whether or how contextual diversity (providing a context similar or dissimilar to the learning context) could be useful in narrations for gamified vocabulary learning, but future research might show that. Furthermore, we cannot yet draw conclusions on whether differences in effectiveness of gamified learning systems compared to traditional learning systems exist or not. In view of a possible scarcity of resources regarding technological equipment (e.g., VR-headsets), future research is therefore needed to investigate the efficiency of more resource-intensive as against less resource-intensive vocabulary training applications.

5.2 Strengths and limitations

Our study investigates for the first time how different design elements of narrations in a gamified learning system using virtual reality affect motivational and performance-related learning outcomes. We investigated narrations in the form of written texts, which makes implementation in practice quite feasible. Finally, having studied participants in class, we managed to achieve a higher ecological validity than a laboratory experiment could have.

Like every research, our study has several limitations. First, as our sample size is rather small, it might be that the power of this study was not strong enough to detect effects. However, a larger sample size was not feasible within our context, given that our resources were limited. Second, we only provided a text-based narration. If narrations had combined the texts with pictures or an audio recording played in a virtual environment (either located at the bridge or in the woods before the bridge), larger effects might have been found. Therefore, future research should investigate how contextual diversity could be implemented in a learning scenario with a virtual environment. In this regard, using different forms of virtual environment (e.g., 360° applications on a smartphone instead of using a smartphone with virtual reality viewers) could provide a technology that is more accessible and might be more easily used in practice. Third, we used words that actually exist in the English language, although we ensured that the words were likely to be unknown by the participants. Future studies could investigate if artificially created words lead to different results. Fourth, we did not investigate long-term effects, which would be another fruitful road for future research. Fifth, our story was short with only small variations to minimize confounding factors. A longer narration with more elaborate variations might create stronger effects. Finally, as we measured our variables using subjective questionnaires, future research could use more objective measures for cognitive load and intrinsic motivation (e.g., using eye movements or dual-task analysis; (Korbach et al., 2017).

All in all, our results provide first evidence that using other-oriented motivational orientations as a gamification design element in narrations can increase intrinsic motivation. Therefore, practice could benefit from implementing narrations with other-oriented focus in gamified learning applications.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Ethics Committee, Chemnitz University of Technology. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

KJ: Conceptualization, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Writing–original draft. MS: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Writing–original draft. CS-S: Conceptualization, Funding acquisition, Software, Supervision, Writing–review and editing. GR: Conceptualization, Methodology, Supervision, Writing–review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frvir.2025.1550004/full#supplementary-material

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