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IMMERSING STUDENTS: THE IMPACT OF VIRTUAL REALITY ON STUDENT ENGAGEMENT AND TEAM DYNAMICS IN A BUSINESS SIMULATION

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ABSTRACT

Aim/Purpose	Research has shown that students using virtual reality (VR) have improved engagement, but most work has focused primarily on STEM curricula. This research assesses the implementation of VR within business courses to identify whether student engagement and team dynamics are associated and whether VR differs from in-person interaction.
Background	VR utilization has increased in recent years to improve educational endeavors. Businesses are also adopting immersive technologies, and current business students will likely encounter this VR technology.
Methodology	Students from two universities, with inter-university teams, played an enterprise simulation game using VR headsets, thus pulling together VR technology and business simulation.
Contribution	Statistical analysis of survey responses indicates a positive association between engagement and team dynamics using VR.
Findings	The study's results indicate that VR use in inter-university teams has significantly higher perceived student engagement and team dynamics than in-person non-VR utilization.
Recommendations for Practitioners	This study found that students were more engaged with improved teamwork using VR headsets, indicating a more captivating involvement than students in-person (non-VR). This has broader implications for business and education

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	concerning engagement and collaboration for in-person and remote active learning experiences.
Recommendations for Researchers	VR has the potential to enhance learning environments and create improved experiences for remote learners, making it an imperative research stream. Future research needs to validate that VR is appropriately integrated for improved learning experiences.
Impact on Society	While businesses' adoption of VR is gaining popularity, universities need to investigate VR utilization in their curricula to remain competitive.
Future Research	Future research plans are to collect data from a larger pool of students and include measuring learning objectives when using VR. In addition, plans include investigating the impact of VR utilization differences for students in an in-person class and those in an online class. Specifically, will online students obtain the same or improved VR experience compared to being online without VR?
Keywords	virtual reality, team dynamics, engagement, simulation, gamification

INTRODUCTION

Teamwork continues to be critical for organizations today, with a reported rise in employees engaged in collaborative work over recent years (Dawson & George, 2024). Similarly, virtual reality (VR) is becoming an increasingly common tool in corporate training and education. But does it truly enhance the collaborative environment? This study examines the impact of hands-on team experiences with and without the use of VR. As more universities integrate VR into remote learning, it is crucial to assess whether a virtual environment effectively enhances the learning environment and team interactions. This research delves into building better team engagement learning environments. The experiment detailed in this paper involved students from two universities who participated in a simulation game using VR headsets. Each team consisted of four students – two from each university – collaborating in the game. A prior study on the simulation game without the use of VR showed improved student engagement and team dynamics. The data from that study proved to be a reasonable comparison to the same simulation game, with the only difference being that it was played in a virtual environment.

This pilot study investigates team dynamics (TD) and engagement during the use of VR headsets among inter-university teams participating in a real-time business enterprise system simulation game (ERPsim) by comparing in-person (non-VR) users to those playing the game using VR headsets. ERPsim, a widely used simulation game, provides students with practical experience using an enterprise resource planning (ERP) system (Léger et al., 2007). Previous research has established a connection between engagement, TD, and learning outcomes in ERPsim gameplay (Eder et al., 2019). By employing similar survey methodologies, this pilot study seeks to investigate potential associations and differences in student engagement and TD gameplay between students using VR and in-person (non-VR) teams, thereby filling a lack of research studying VR and student team interaction (Sümer & Vaněček, 2024). This investigation proposes to support the use of VR in higher education in a team environment.

In technology-mediated learning, the primary aim of most interventions is usually to enhance the learning environment, ultimately boosting knowledge acquisition (Agbo et al., 2023; Bower, 2019). VR serves as a catalyst for active engagement by immersing learners in interactive experiences, transforming them from passive observers to active participants in their educational journey. By replicating real-life scenarios, VR furthers emotional investment and enables active involvement among students (Yan, 2023). In media comparison research between VR and other media, educational experiences that follow the Cognitive Theory of Multimedia Learning principles have been shown to motivate and improve the learning environment (Parong, 2021). Recognizing the potential of VR, some universities are embracing it as the future of education, acknowledging its significance in maintaining competitiveness (Malhotra & Fortino, 2024).

This paper begins with a background review of VR in education and ERP education, along with a review of other technologies as they apply to business simulations. It then introduces related work, followed by the research model and hypotheses of the study. Subsequently, the methodology is presented, followed by the survey results. The paper finishes with a discussion, limitations, and a conclusion with a plan for future research.

BACKGROUND

VIRTUAL REALITY UTILIZATION

In recent years, organizations have experienced an increased need for teamwork across departments and continents (Dawson & George, 2024). While several technologies have emerged to support collaborative work, there are few empirical studies of VR in collaborative teamwork settings (Sümer & Vaněček, 2024; Tüzün et al., 2019). However, there are educational studies showing improved engagement using VR (Moro et al., 2017). Di Natale et al. (2020, p. 11) reviewed existing literature on using VR as an instructional tool in science, engineering, and mathematics, resulting in improved learning and motivation. Parmar et al. (2016) demonstrated superior learning and engagement when using a head-mounted display in training simulation for electronic circuitry. A study involving MBA students revealed a greater inclination towards engaging with a VR case study than traditional 40-page case studies (Ellis, 2022). Furthermore, 71.5% of students reported experiencing improved learning outcomes in a newly established Virtual Reality lab at the University of Sydney (Marks & Thomas, 2022). In that study, applications such as humanitarian VR visits to poor rural areas, lab safety, and steel structure virtual visits all reported higher engagement in the subject matter.

VR learning experiences have been shown to improve student engagement persistently (Huang et al., 2021). Over multiple sessions, students became familiar with the new technology, yet they demonstrated improved outcomes. One study in a business school environment used VR to improve communication and public speaking skills (McGovern et al., 2020). Another business school study showed that students using VR were more readily able to recall business processes (Panchenko et al., 2020), and some were better able to digest ethics (Ronaghi, 2024). However, there is a lack of studies exploring the use of VR in team-oriented business application education. Potential employers of business students often look for experience with teamwork (Dawson & George, 2024). One motivation of this research is to investigate potential differences in how students collaborate in a VR team compared to a face-to-face team.

Financial limitations of purchasing VR equipment present a significant challenge, along with training faculty and technical complexity (Tiwari et al., 2023). A recent comprehensive literature review identified a gap in research regarding the potential of VR as a revolutionary technology, highlighting the need for further studies. Studies on gamification and VR indicate that immersion and social presence can be strengthened, knowledge acquisition can be enhanced, and material comprehension can be supported, leading to positive shifts in students' attitudes (Lampropoulos & Kinshuk, 2024). However, the findings on the impact of VR on learning are inconsistent. In higher education, simulations in virtual and augmented reality have primarily been applied as teaching tools, yet they often lack opportunities for student peer interaction (Sümer & Vaněček, 2024). This study addresses this specific research gap by measuring outcomes of a team-based game played in a virtual environment. There are alternative technologies to VR, especially in the area of teamwork and student engagement.

ALTERNATIVE TECHNOLOGIES TO VR

Research on teamwork with technology has highlighted numerous advantages while also revealing certain limitations. Studies examining professional software have reported positive outcomes, particularly in enhancing productivity and collaboration (Georganta et al., 2023). Both synchronous and asynchronous interactions have been well-received, fostering effective communication and flexibility within teams. The use of VR in 3D environments has demonstrated improvements in team coordination, though findings remain limited in scope (Montoya et al., 2011). Similarly, the Internet of Things (IoT) has contributed to greater efficiency in team-based workflows. Collaboration platforms such as Slack have been associated with enhanced communication and task management (Lin et al., 2016), while wiki-based knowledge sharing has improved collective problem-solving. However, not all technological interventions have yielded positive results. The integration of robots in team settings has been linked to negative interpersonal dynamics, and the use of telemedical robots in trauma intensive care units (ICUs) has raised concerns about the quality of human-machine interactions. While technology can significantly enhance teamwork, careful implementation is necessary to address potential drawbacks and ensure its effectiveness in diverse collaborative environments (Georganta et al., 2023).

Technology has played a critical role in enhancing student engagement by providing interactive and dynamic learning experiences. Learning management systems (LMS) have been shown to increase student participation by offering structured access to course materials, assignments, and communication tools (Osman, 2022). Discussion forums and weblogs support engagement by fostering collaborative learning and providing scaffolding for deeper understanding. Audience response systems, such as clickers, have been well-received by the majority of students, as they encourage active participation during lectures. Online quizzes, when used as feedback mechanisms, enhance student engagement by promoting self-assessment and reinforcing learning. Social media platforms further facilitate interaction and collaboration, creating informal learning communities beyond the classroom. The integration of video, audio, and multimedia content supports positive attitudes toward learning while increasing flexibility and independence. Games and gamification strategies, when designed around real-world problem-solving scenarios, have been effective in maintaining student interest and motivation (Buckley & Doyle, 2016). Additionally, VR environments enhance engagement by providing a strong sense of presence and immersing students in experiential learning. Collectively, these technologies contribute to a more interactive and student-centered learning experience (Godsk & Møller, 2025).

While VR has been shown to help in practicing 3D environments and enhanced engagement, it hasn't been tested in a business simulation game. This research applies VR technology to business curriculum and seeks to measure team dynamics and student engagement.

APPLICATION TO BUSINESS CURRICULUM

ERP systems are complex software programs essential for efficiently managing integrated business processes (Monk & Wagner, 2013). SAP SE, a leading developer in this field, boasts a vast global presence and dominates a significant portion of the market share (SAP SE, 2024). Despite the widespread adoption of ERP software by companies worldwide, teaching the subject remains challenging for faculty members, even though students generally possess strong technological skills (Léger, 2006). To address this challenge, ERPsim, a simulation game utilizing live SAP systems, was developed to facilitate learning. Research indicates that engaging in ERPsim significantly enhances students' engagement and understanding of business processes and ERP concepts (Eder et al., 2019; Seethamraju, 2011).

The game is designed for team play, promoting collaborative learning. Recent studies suggest that VR can support collaborative learning (van der Meer et al., 2023), a promising development for distance learning, which has grown substantially since the COVID-19 pandemic (Carlton, 2023). However, implementing VR in education poses challenges, such as teacher training, managing student expectations, setup and instruction logistics, and addressing inflated expectations (Scavarelli et al., 2021). Research also suggests that VR enhances communication through social interaction by enabling deeper immersion and resource sharing, allowing students to exchange knowledge and information (Zheng et al., 2018). Despite this, the findings remain mixed. van der Meer et al. (2023) indicate that research on collaborative learning in VR is limited. Although VR can support collaboration, specific pedagogical approaches are underdeveloped. For instance, Tüzün et al. (2019) found no significant difference between students in VR and those learning face-to-face when working on a group project in a virtual world. While VR holds potential for collaborative learning, the limited research underscores a gap in understanding how students can effectively learn from each other in a virtual classroom setting (Sümer & Vaněček, 2024). This pilot experiment addresses this gap in VR educational research by incorporating VR headsets into the ERPsim game, a team-based game. VR has limited reported usage in business schools or MIS curricula (Marougkas et al., 2024), and previous studies on VR have predominantly focused on scientific and engineering curricula.

Given the growth of VR and its potential utilization in education, it is important to identify how VR can be integrated into educational activities and to measure student engagement and TD outcomes compared to non-VR educational activities. This research addresses these areas by posing the following research questions that underscore the question of collaborative learning with VR:

(1) How does the use of VR in a real-time ERP simulation affect associations between perceived student engagement and TD?
(2) Is there a difference in perceived student engagement between the use of VR and not using VR during educational activities?
(3) Is there a difference in perceived team dynamics between the use of VR and not using VR during educational activities?

To understand how VR might improve student engagement and TD, there needs to be an understanding of previously completed work in the area of ERPsim's effectiveness.

RELATED WORK

Several studies have highlighted the positive impact of ERPsim on improving complex knowledge and enhancing learning outcomes. Recent research efforts (Eder et al., 2019) have explored various factors that influence these outcomes, including learning outcomes, student engagement, and TD, which are crucial factors in assessing learning in business schools. Eder et al. (2019, pp. 130-137) developed and validated a research model and survey instrument to examine these relationships. They drew on validated measures from the literature on student engagement (Csikszentmihalyi et al., 2014; Whitton, 2011) and TD (Anderson, 2005; Bhagwatwar et al., 2017; Wageman, 2001). Through confirmatory factor analysis, they identified several indicators to assess student engagement and TD levels.

Measuring student engagement in gaming environments is complex due to varying definitions of engagement – such as behavioral, motivational, and cognitive aspects – as well as diverse student aptitudes and game types, making it difficult to generalize learning processes (Whitton, 2011; Wolfe, 2016). Limited research exists on engagement with learning games. However, Whitton (2007) identified key factors influencing engagement, including the ability to see game outcome changes and confidence in playing, while technical issues, difficulty, low confidence, and boredom negatively impacted engagement. Flow theory, proposed by Csikszentmihalyi et al. (2014), describes an optimal state of engagement where individuals are fully immersed, provided there is a balance between skill and challenge, clear goals, and real-time feedback (Whitton, 2011). In this state, attention is focused, a sense of control is maintained, and time seems to pass quickly, whereas imbalance leads to either anxiety or boredom. The Eder et al. (2019) study examined student engagement through three constructs aligned with flow theory: action and awareness, control, and time.

In classroom settings utilizing ERPsim, students typically work in teams of three to five to manage virtual companies using SAP ERP software, with team dynamics playing a crucial role in shaping perceptions and performance (Anderson, 2005; Bhagwatwar et al., 2017; Fisher et al., 2012; Johnson et al., 2007). Effective teamwork, characterized by trust, collaboration, and shared mental models, enhances team interdependence and performance (Greenberg et al., 2007; Nelson & Cooprider, 1996). Teams with well-developed shared mental models, where members have a collective understanding of tasks, tend to perform better (Bhagwatwar et al., 2017; Johnson et al., 2007), with success often measured through perceived effectiveness and performance (Fisher et al., 2012). Positive team interdependence, where members rely on each other while competing against other teams, has also been linked to stronger performance (Wageman, 2001). Additionally, implicit coordination, or the ability to respond to teammates' needs without explicit communication, significantly impacts collaboration and learning experiences (Edmondson, 1999).

Studies examining ERPsim specifically found that team cohesion positively influenced students' attitudes toward learning (Kwak et al., 2013), while strong team characteristics, such as trust, shared understanding, and coordination, moderated perceptions of complexity, rigidity, and radicalness in logistical processes, ultimately affecting team performance (Bhagwatwar et al., 2017). Building on these findings, the Eder et al. (2019) research explored how team dynamics – shared mental models, implicit coordination, team effectiveness, and interdependence – relate to student engagement and individual learning outcomes.

Understanding these relationships is necessary for optimizing learning outcomes in business education, particularly as curricula increasingly emphasize active learning and collaborative work (Eder et al., 2019). By investigating these factors, seen in the following section, educators can tailor teaching methods to better align with students' needs and ultimately improve their educational experience.

METHODOLOGY

STUDENT ENGAGEMENT AND TEAM DYNAMICS MEASURES

The student-perceived engagement and TD measures utilized in this study (Tables 1 and 2) follow the research of Eder et al. (2019), which drew on the foundational work of several other studies (Anderson, 2005; Bhagwatwar et al., 2017; Csikszentmihalyi et al., 2014; Johnson et al., 2007; Wageman, 2001; Whitton, 2011). These measures were piloted and validated (Eder et al., 2019). The students involved in this project were asked the following questions and answered with a five-point Likert scale.

Table 1. Engagement measure (Eder et al., 2019)

(1) I cared if our team won or lost.
(2) I knew what I had to do to play the game successfully.
(3) Our team had a fair chance of winning the game.
(4) I could tell what effect my actions had.
(5) The game was not too complex.
(6) Time passed quickly during the game.
(7) I felt excited during the game.
(8) I did not find the game boring.
(9) I enjoyed the game.
(10) It was clear what I could learn.
(11) Playing the game was worthwhile.

Table 2. TD measure (Eder et al., 2019)

(1) It was clear from the beginning what this team had to accomplish.
(2) This team spent time ensuring every member understood the objectives.
(3) Team members understood what was expected of them in their respective roles.
(4) This team had a common understanding of the tasks we had to handle during the game.
(5) Our team can rely on each other to get the job done.
(6) Members of this team can bring up problems and tough issues.
(7) No one in this team would deliberately act in a way that undermines my efforts.
(8) My unique skills and talents are valued and utilized by the members of this team.
(9) My team members provided task-related assistance proactively to other members without being asked.
(10) My team members were reliable
(11) Members of my team effectively adapted their behavior to the actions of other members.
(12) Our team members worked better together than individually.
(13) I feel my team was very successful with their communication and interaction.
(14) I was a productive member of the team.
(15) All team members were involved in decision-making.
(16) I am satisfied with the performance of my team.
(17) I would work with this team again.
(18) This team met or exceeded task requirements.
(19) This team kept improving while performing the assigned tasks.

RESEARCH MODEL AND HYPOTHESES

The research model represented in Figure 1 extends the student engagement and TD research of Eder et al. (2019) by incorporating VR utilization. Similar to their study, a positive association between student engagement and TD is anticipated. Furthermore, it is expected that during a real-time ERP simulation, students using VR headsets will exhibit greater engagement and higher TD levels than those not using VR headsets.

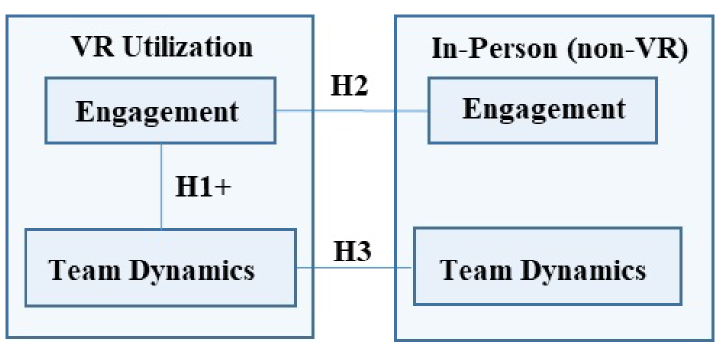

Figure 1. Research model

When student participants perceive their TD as high, their engagement is also expected to be stronger. Students' perceptions of team dynamics were solicited using the questions in Table 2. Previous research has demonstrated that various aspects of team dynamics, including trust and collaborative ability, are linked to both team interdependence and overall team performance (Bhagwatwar et al., 2017; Fisher et al., 2012; Johnson et al., 2007; Kwak et al., 2013). Some studies have specifically investigated how different elements of team dynamics influence individual learning outcomes through ERPsim. For instance, Kwak et al. (2013) examined the connection between team cohesion and participants' attitudes toward learning, revealing that students who felt a strong sense of alignment with their teammates were more likely to have a positive perspective on learning and greater satisfaction with their educational experience. Therefore, levels of TD should be associated with levels of student engagement as indicated in the following proposed hypothesis:

H1: Student TD perceptions positively relate to student engagement perceptions using VR headsets during a real-time ERP simulation.

The data collected in this study involved the utilization of VR headsets during a real-time ERP simulation. In contrast, the data collected by Eder et al. (2019) involved the in-person use of computers without VR during the same real-time ERP simulation. The question remains whether the students were more engaged when using a VR headset. In the broader literature on game engagement, one of the most frequently referenced theories for measuring engagement is the flow theory proposed by Csikszentmihalyi et al. (2014). This theory describes a state in which an individual becomes so immersed in an activity that they lose awareness of everything else (Whitton, 2011). According to flow theory, a student can experience flow while playing a game if their skill level is well-matched to the game's challenges, if the game provides clear objectives, and if it offers feedback throughout the experience. When in flow, a student's attention is highly concentrated; they experience a sense of control, and time seems to pass quickly. This intense focus eliminates distractions, including self-consciousness, allowing for an uninterrupted engagement with the game.

A sense of control reduces anxiety, making the experience more enjoyable. Conversely, when boredom sets in, time appears to drag. However, when a player is fully engaged in flow, their perception of time fades into the background. Flow is closely linked to student engagement in learning games, as it creates a mental state where the game becomes the sole focus. Nevertheless, maintaining this balance is delicate. If the game's challenges exceed a student's skill level, they may feel anxious, whereas if their skills surpass the challenges, they may become bored (Csikszentmihalyi et al., 2014). The comparison of engagement and TD between these two datasets is expected to show differences, with the anticipation that students using VR will report a higher level of perceived engagement and TD, as indicated in the following proposed hypotheses:

H2: Student engagement perceptions will differ between students using VR and students not using VR during a real-time ERP simulation, with engagement being more agreeable for students using VR.

H3: Student TD perceptions will differ between students using VR and students not using VR during a real-time ERP simulation, with TD having a higher level of agreement for students using VR.

Project Implementation and Data Collection

During the 2023-2024 academic year, two separate mid-Atlantic universities made a significant effort to incorporate VR headsets into business class simulations (ERPsim). Both universities had been using ERPsim in their courses in previous years, and it was determined that the students would benefit from using VR based on prior VR research in STEM subjects (Di Natale et al., 2020). VR headsets were obtained through university grants. One university group included upper-division undergraduate students in Business or Information Technology. The second university group consisted of graduate students majoring in Business Analytics and Information Management. Each student was lent a

Meta Quest (formerly Oculus) 2 or 3 headset. Instructions were given on how to configure the headset to the proper specifications. At least one session was dedicated to headset practice and troubleshooting. Figure 2 displays the Meta Quest 3 headset used in the game, while Figure 3 shows what the students see when playing ERPsim via the VR headset.

Figure 2. Meta Quest 3 headset
***Note.* From Meta Quest 3 (2025)**

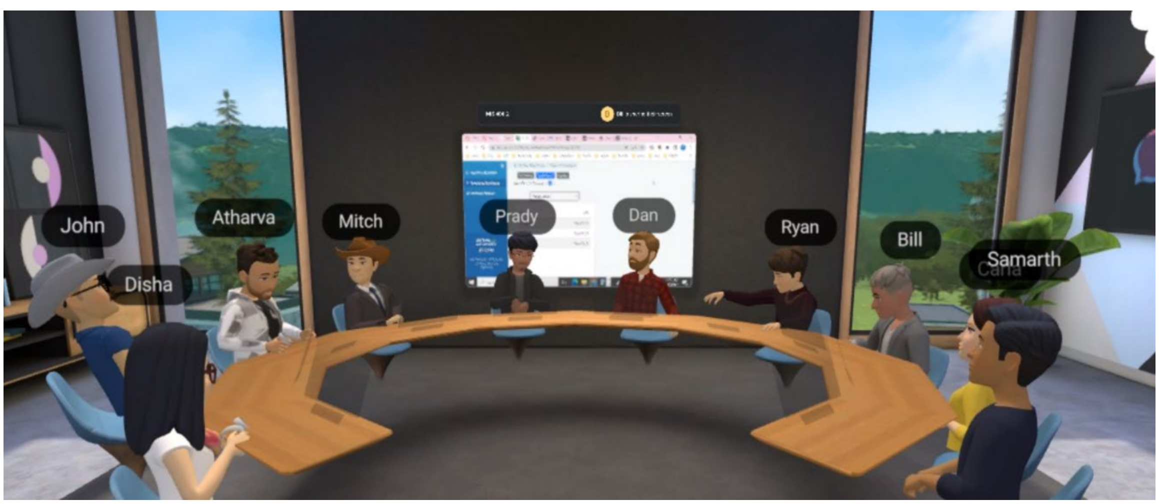

Figure 3. Horizon workroom ERPsim

To capture student perceptions of engagement and TD, a post-ERPsim survey was administered containing the engagement and TD items measured using a five-point Likert scale, in which one indicated "strongly disagree" and five indicated "strongly agree". Open-ended comments were also solicited on the post-ERPsim survey. The survey elicited demographic characteristics related to the two universities to account for possible variations in student perceptions between them.

SURVEY RESULTS AND DATA ANALYSIS

DEMOGRAPHICS

In order to test the first hypothesis, the ERPsim game was implemented across two universities with students utilizing VR headsets, each with their own instructor. One university group comprised upper-division undergraduate students majoring in Business or Information Technology, while the second group consisted of graduate students specializing in Business Analytics and Information Management. Since the data was not normally distributed and both the engagement and TD data were ordinal, Mann-Whitney U test statistics were generated for both engagement and TD measures. There were no significant differences in the 11 items measuring engagement between the two universities, student instructors, or students' education levels, except for item 5 (the game was not complex), which showed a significant difference between the universities, revealing that students at the second institution demonstrated higher engagement agreement ($U=60, p=.014$). Similarly, no significant differences were found in the 19 items assessing student TD perceptions across universities, instructors, or education level.

CONSTRUCT VALIDITY

To test the first hypothesis, we used methods similar to those of the Eder et al. (2019) study to evaluate the internal consistency of the perceived student engagement and TD measures. This involved examining the internal consistency of the items used on each scale (Cerny & Kaiser, 1977).

Student engagement

With reference to the 11 items utilized to assess perceived student engagement, Cronbach's alpha score was 0.945, indicating high internal consistency. Inter-item correlation analysis revealed that removing any of these items would not improve the alpha score. As a result, all 11 engagement items were kept for further analysis.

In the next stage of analysis, the Kaiser-Meyer-Olkin (KMO) test was conducted to assess the extent of shared variance among the items (Kaiser, 1974). The KMO measure for perceived student engagement was 0.878, indicating a "marvelous" level of common variance and suggesting that factor analysis would effectively account for a significant percentage of the variance. Additionally, Bartlett's test of sphericity yielded a p-value less than 0.001, reinforcing factor analysis suitability.

A confirmatory factor analysis with varimax rotation was performed to evaluate the convergent and discriminant validity of the engagement measures (Table 3). Two factors emerged from the 11 engagement-related questions, each having an eigenvalue greater than 1.0. These two factors explain 77.100% of the common variance with minimal cross-loading. The rotated factor loadings indicated the specific grouping of questions to the factors.

Table 3. Factor groupings for engagement

Rotated component matrix[a]		
Engagement measure items	Factor grouping	
	Action and awareness	Operations
(3) Our team had a fair chance of winning.	0.913	
(4) I could tell what effect my actions had.	0.816	
(1) Cared if won or lost.	0.79	
(2) I knew what to do.	0.763	
(7) I felt excited.	0.723	
(10) It was clear what I could learn.	0.695	
(9) I enjoyed the game.	0.678	

Rotated component matrix[a]		
Engagement measure items	Factor grouping	
	Action and awareness	Operations
(6) Time passed quickly		0.895
(5) Game not complex.		0.715
(11) Game worthwhile.		0.682
(8) I was not bored.		0.655
Extraction Method: Principal Component Analysis. Rotation Method: Varimax without Kaiser Normalization.		

a. Rotation converged in 3 iterations.

Team dynamics

We conducted a similar analysis for the 19 items to measure TD. The internal consistency was good ($\alpha = .943$), demonstrating strong internal consistency. Eliminating any question would not reduce Cronbach's Alpha.

The KMO test statistic (.593) for the 19 TD items indicated a "barely acceptable" degree of common variance, suggesting that factor analysis would account for an acceptable amount of variance. Furthermore, Bartlett's test statistic was less than 0.05 ($p<0.001$) significance level, indicating that the responses collected for this study were valid and that a factor analysis is suitable.

Table 4. Factor groupings for TD

Rotated component matrix[a]			
Team dynamics measure items	Factor grouping		
	Perceived team effectiveness/ performance accountability	Mutual trust coordination	Shared mental model
(15) All members made decisions.	0.804		
(10) Members were reliable.	0.788		
(17) Would work with team again.	0.767		
(18) Team met requirements.	0.713		
(14) I was a productive team member.	0.683		
(19) Team got better.	0.621		
(13) Successful communication and interaction.	0.587		
(11) Members adapted to others' actions.		0.824	
(12) Team better together than individually.		0.806	
(6) Members can bring up problems.		0.704	
(8) My skills are valued by the team.		0.701	
(9) Team aided others.		0.694	
(7) Members didn't undermine my efforts.		0.628	
(3) Members understood what was expected.			0.824
(1) Goals were clear.			0.738
(2) Time spent understanding objectives.			0.679
(16) Satisfied with team performance.			0.674

Rotated component matrix[a]			
Team dynamics measure items	Factor grouping		
	Perceived team effectiveness/ performance accountability	Mutual trust coordination	Shared mental model
(4) Team had a common task understanding.			0.572
(5) Team relied on each other.			0.563
Extraction Method: Principal Component Analysis. Rotation Method: Varimax without Kaiser Normalization.			

a. Rotation converged in 13 iterations.

A confirmatory factor analysis using varimax rotation revealed three factors from the 19 TD-related questions, each with an eigenvalue greater than 1.0 (Table 4), explaining 67.890% of the common variance with minimal cross-loading. Each factor is consistent with findings from previous studies (Anderson, 2005; Bhagwatwar et al., 2017; Fisher et al., 2012; Johnson et al., 2007; Wageman, 2001).

HYPOTHESES TESTING

The pilot study survey yielded 38 valid responses, where students used VR headsets during a business simulation (ERPsim). This data was used to test our first hypothesis (H1), comparing perceived student engagement and TD.

Recall that by following the Eder et al. (2019) study, the engagement and TD measures in the pilot data used 5-point Likert scales for item responses. Since the data were not normally distributed, non-parametric tests were employed for comparisons (Nachmias & Nachmias, 1987). The Kendall's tau-b (τ_b) correlation coefficient was employed to examine the strength and direction between perceived student engagement and TD items (H1). As shown in Table 5, the factor groupings of engagement and TD provide full support for H1, indicating a notable positive relationship between engagement and TD.

Table 5. Correlations of combined engagement and TD factors

Team dynamics		Engagement	
		Interest and achievability	Operations
Perceived Team Effectiveness/ Performance/Accountability	Correlation Coefficient	.576**	.482**
	Sig.	*p=0.000*	*p=0.000*
Mutual Trust/Coordination	Correlation Coefficient	.608**	.556**
	Sig.	*p=0.000*	*p=0.000*
Shared Mental Model	Correlation Coefficient	.462**	.452**
	Sig.	*p=0.000*	*p=0.000*

** Correlation is significant at the 0.01 level (2-tailed)

While these findings should be interpreted with caution, they provide evidence that increased student-perceived engagement through the use of VR in a business simulation is positively associated with TD. This conclusion is further supported by the open-ended student comments collected in the survey, which were predominantly positive. Frequently used adjectives included "interesting" and "fun." The following comments provide deeper insight into the themes that motivate this research.

> *"It improves the engagement of team members and makes the team members feel a sense of presence during the game."*

"It made sure we interacted with each other rather than just sitting there and doing nothing."
"It enhances the sense of presence and involvement in a group."
"It increases enjoyment and engagement because it feels more like you're actually in the presence of your teammates rather than talking to them on a screen like in Zoom."

For our second and third hypotheses, we used engagement and TD data from the Eder et al. (2019) study, which included 102 valid responses from students participating in the same business simulation (ERPsim) in-person without VR headsets. Using a Mann-Whitney U test, the Eder et al. (2019) data were compared to our pilot data to examine potential differences between VR and non-VR utilization in student engagement (H2) and TD (H3).

Regarding the differences in engagement between students using VR and those not using VR (H2), responses for all items except 3 and 5 revealed that student engagement beliefs were generally higher among those using VR headsets during the business simulation, as shown by the higher mean ranks of VR. These differences were highly significant (Table 6). Further discussion of this topic is provided in the Discussion section.

Under 1. Introduction, the first paragraph, last sentence: "This teaching initiative aims to provide researchers with insights into whether virtual reality can serve as a valuable enhancement in remote teamwork."

Under 2. Background, 2.1 Virtual Reality Utilization, second paragraph, last sentence: "This study demonstrates how VR can improve engagement and TD."

Table 6. Engagement Mann-Whitney U

Engagement measure items	Dataset	N	Mean rank	Mann-Whitney U[a]	Z-stat.	Sig. (2-tailed)
(1) I cared if our team won or lost.	non-VR	102	63.38	***1211.5	-3.6	*p* < 0.001
	VR	38	89.62			
(2) I knew what to do.	non-VR	101	65.98	*1512.5	-2.132	*p* = 0.033
	VR	38	80.70			
(3) Our team had a fair chance of winning.	non-VR	101	*not significant*	1562.5	-1.914	*p* = 0.056
	VR	38				
(4) I could tell what effect my actions had.	non-VR	101	64.20	**1333	-2.977	*p* = 0.003
	VR	38	85.42			
(5) Game is not complex.	non-VR	101	*not significant*	1612	-1.578	*p* = 0.115
	VR	38				
(6) Time passed quickly.	non-VR	102	66.40	*1519.5	-2.184	*p* = 0.029
	VR	38	81.51			
(7) I felt excited.	non-VR	102	64.96	*1373	-2.568	*p* = 0.010
	VR	37	83.89			
(8) I was not bored.	non-VR	102	65.30	**1407.5	-2.624	*p* = 0.009
	VR	38	84.46			
(9) I enjoyed the game.	non-VR	102	64.37	**1313	-3.087	*p* = 0.002
	VR	38	86.95			
(10) It was clear what I could learn.	non-VR	102	66.28	*1507.5	-2.106	*p* = 0.035
	VR	38	81.83			

Engagement measure items	Dataset	N	Mean rank	Mann-Whitney U[a]	Z-stat.	Sig. (2-tailed)
(11) Playing the game was worthwhile.	non-VR	102	65.84	*1463	-2.351	*p = 0.019*
	VR	38	83.00			

a. **p<0.05, **p<0.01, ***p<0.001*

Concerning the differences in TD between VR and non-VR student responses (H3), students using VR headsets generally reported higher TD levels across all items than those not using VR, except for item 13, during the business simulation. These results were highly significant, supporting H3 (Table 7). Further discussion of these results is found in the next section.

Table 7. Team dynamics Mann-Whitney U

Team dynamics measure items	Dataset	N	Mean rank	Mann-Whitney U[a]	Z-stat.	Sig. (2-tailed)
(1) Goals were clear.	non-VR	101	64.51	**1365	-2.783	*p = 0.005*
	VR	38	84.58			
(2) Time spent understanding objectives.	non-VR	101	64.43	**1356	-2.773	*p = 0.006*
	VR	38	84.82			
(3) Members understood what was expected.	non-VR	101	63.2	***1232.5	-3.47	*p < 0.001*
	VR	38	88.07			
(4) Team had a common task understanding.	non-VR	101	64.82	**1395.5	-2.649	*p = 0.008*
	VR	38	83.78			
(5) Team relied on each other.	non-VR	101	65.87	*1502	-2.124	*p = 0.034*
	VR	38	80.97			
(6) Members can bring up problems.	non-VR	101	65.4	*1454.5	-2.319	*p = 0.020*
	VR	38	82.22			
(7) Members didn't undermine my efforts.	non-VR	101	66.03	*1518	-2.168	*p = 0.030*
	VR	38	80.55			
(8) Team members value and utilize my skills and talents.	non-VR	100	63.13	**1263	-3.234	*p = 0.001*
	VR	38	86.26			
(9) Team aided others without being asked.	non-VR	101	63.83	**1296	-3.136	*p = 0.002*
	VR	38	86.39			
(10) Members were reliable.	non-VR	101	64.87	**1401	-2.741	*p = 0.006*
	VR	38	83.63			
(11) Members adapted to others' actions.	non-VR	100	62.28	***1178	-3.689	*p < 0.001*
	VR	38	88.5			
(12) Team better together than individually.	non-VR	101	64.27	**1340	-2.941	*p = 0.003*
	VR	38	85.24			
(13) Successful communication and interaction.	non-VR	101	*Not Significant*	1793	-0.709	*p = 0.478*
	VR	38				
(14) I was a productive team member.	non-VR	101	64.25	**1338	-2.973	*p = 0.003*
	VR	38	85.29			
(15) All members made decisions.	non-VR	101	61.14	**1320	-3.101	*p = 0.002*
	VR	38	93.55			
(16) Satisfied with team performance.	non-VR	101	64.07	*1411	-2.545	*p = 0.011*
	VR	38	85.76			
(17) Would work with team again.	non-VR	100	64.61	**1357.5	-2.72	*p = 0.007*
	VR	38	82.37			

Team dynamics measure items	Dataset	N	Mean rank	Mann-Whitney U[a]	Z-stat.	Sig. (2-tailed)
(18) Team met requirements.	non-VR	101	64.44	*1477	-2.221	*p = 0.026*
	VR	37	83.31			
(19) Team got better.	non-VR	101	65.62	**1379	-2.699	*p = 0.007*
	VR	38	81.63			

a. *$p<0.05$, **$p<0.01$, ***$p<0.001$

DISCUSSION

A summary of the hypothesis test results (Table 8) indicates that hypotheses H1 and H3 were fully supported. The only exception was H2, which showed higher perceived engagement for students using VR during a business simulation for all but items 3 and 5.

Table 8. Summary of hypothesis test results

Hypothesis	Result
H1: Student-perceived engagement will have a positive association with TD during the use of VR headsets in a business simulation game.	Fully supported
H2: Student engagement perceptions will differ between students using VR and students not using VR during a real-time ERP simulation, with engagement being more agreeable for students using VR	Partially supported
H3: Student TD perceptions will differ between students using VR and students not using VR during a real-time ERP simulation, with TD having a higher level of agreement for students using VR.	Majority supported

Regarding H1, the results suggest that VR positively affects the association between student engagement and TD. The immersive qualities of VR likely contribute to a more engaging experience (Moro et al., 2017). This study found a relationship between student engagement and TD, similar to the theoretical framework from Eder et al. (2019). With the increasing emphasis on active learning and collaborative projects in business school curricula, these findings offer valuable insights for incorporating team-based games into instruction and evaluating learning outcomes. Recognizing the positive connection between student engagement and team dynamics can help educators better understand the factors that contribute to effective teamwork.

Considering H2, the study's results indicate that VR use in inter-university teams has significantly higher perceived student engagement than in-person (non-VR) utilization for most items. The two exceptions are item 3, "Our team had a fair chance of winning the game," and item 5, "The game was not too complex." These exceptions imply that while VR can enhance engagement, it does not necessarily alter students' perceptions of fairness or the complexity of the educational activity. This could be due to the immersive nature of VR, which may make the experience more engaging but does not simplify the ERPsim game. This partial support matches with the "three aspects of flow theory (Csikszentmihalyi et al., 2014): action and awareness; control; and sense of time" (Eder et al., 2019, p. 133).

Concerning H3, VR utilization demonstrated a significantly higher TD compared to in-person (non-VR) utilization, as shown by the higher mean scores for all TD items except for item 13, "Successful communication and interaction". This exception implies that communication and interaction of team members during the simulation did not differ between the use of VR and non-VR use. This can be viewed as a positive outcome of VR use in that the communication and interaction between team members is not any different from non-VR teamwork. Similar to engagement, TD appears to be higher when VR is used. This finding begins to help faculty understand the way that students can effectively learn using VR. The gap in the limited literature on collaborative learning (Sümer & Vaněček, 2024) can be filled by these findings.

The results of this pilot study appear to differ from those of the collaborative study by Tüzün et al. (2019). In that study, students met on a collaborative virtual platform to work on a group programming project. The VR meeting fared no better than a face-to-face meeting. In addition, there were various technical problems with the equipment. This contrasts with the positive results of this pilot study, perhaps due in part to the object of the exercise: playing a team-based game as compared to a group programming project discussion. Perhaps the effect of VR is more positive in a gamification environment.

These findings show that VR can enhance student engagement and TD compared to in-person learning environments. The exceptions noted in the results highlight areas where VR use is no different from non-VR use concerning perceived game complexity and perception of fairness, which is expected since game complexity and fairness are not different. The use of VR in the ERPsim game, as per the theoretical framework and the results of this study, seems to enhance student engagement and TD. These insights support the use of VR in Business and MIS curricula as a strategy to increase active learning and student collaboration.

Overall, these results are very satisfying. A key takeaway from the partial support of H2 and the full support of H3 is that they validate the use of VR over non-VR in student engagement and TD. Also notable is the positive association between student engagement and TD while using VR.

LIMITATIONS

This study was not without limitations. Due to the nature of this pilot study, it was limited to a small number of participants. VR headsets are a costly investment, and the universities were limited in the number of headsets available. Currently, additional headsets are being made available and should enhance future studies with more participants.

Other limitations of this study involve the network capability and setup complexity of VR utilization. In addition, human factor challenges can limit the amount of time a participant can wear a headset. Some students complained that they could only wear the headset for a limited time before needing a break to rest their eyes and avoid headaches. Further studies would be needed to address physical discomfort.

A future study, which is in the planning phase, will gather more demographic data and prior use of ERP systems. The pilot study was limited by the paucity of demographic data collected.

CONCLUSION

While businesses' adoption of VR is gaining popularity (Kuo, 2023), universities need to investigate VR utilization in their curricula to remain competitive (Malhotra & Fortino, 2024). This study first verified the positive significant associations between student engagement and TD using VR headsets during a real-time game simulation, expanding the previous study involving a non-VR in-person simulation (Eder et al., 2019). Then, this study found that students were more engaged and had higher TD with VR headsets, indicating a more captivating involvement than students in-person (non-VR). This has broader implications for business and education concerning engagement and collaboration for in-person and remote active learning experiences.

Future research plans to collect data from a larger pool of students and include measuring learning objectives when using VR. In addition, we plan to investigate the impact of VR utilization differences for students in an in-person class and those in an online class. Specifically, will online students obtain the same or improved VR experience compared to being online without VR? An additional question is students' preference for VR or other learning modes.

Since the COVID pandemic, an increasing number of college classes are being offered remotely, using Zoom or similar applications (Swaak, 2025), and the rates are increasing. One in three college students is now taking at least one online course. Financial pressures and reduced enrollment are compelling universities to offer more flexibility, and this includes offering remote and hybrid courses. Studies have shown (Bettinger et al., 2017; Wong et al., 2023) that it is more difficult to keep students engaged when on Zoom. Utilizing a VR classroom has shown promise in keeping students engaged (Speidel et al., 2023). Virtual classrooms utilizing virtual VR headsets have the potential to closely resemble an actual classroom, allowing faculty to engage students using traditional methods while providing the flexibility of remote learning that students desire.

VR has the potential to enhance learning environments and create improved experiences for remote learners, making it an imperative research stream. Future research needs to validate that VR is appropriately integrated for improved learning experiences.

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