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Transforming business education: the impact of virtual reality on learning outcomes in case studies

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There is a critical gap in educational research in understanding the effectiveness of written, video, and virtual reality (VR) business cases for instructional purposes. The case method is fundamental in business education, with traditional written cases predominating, though video cases are increasingly popular. Recently, VR business cases have been proposed for their potential benefits, yet evidence comparing their effectiveness is limited. This study examines learning outcomes of undergraduate business students using written, video, and VR business case study media. To my knowledge, this is among the first studies to empirically examine the specific trade-offs associated with adopting VR compared to traditional business case-study presentations. In the study, students were randomly assigned to a medium and completed a survey assessing their experiences, recollection, and engagement. Results show that VR enhances presence but increases cognitive load compared to written and video presentations. VR cases improve visual information recall but reduce numerical fact recall and interest in adopting VR as an educational tool. These findings suggest that while VR enhances visual engagement, it introduces higher task demands and is not universally preferred. This dual impact highlights the need for careful integration of VR in business curricula, especially where visual context is crucial. The study's conclusions provide novel insights into the unique advantages and challenges of VR, significantly advancing our understanding of how emerging technologies impact student engagement and learning outcomes.

KEYWORDS

virtual reality, education, case method, immersion, task load, laboratory experiment, learning outcomes, students

1 Introduction

"Help your students remember by giving them something to think about." —Lang (2016: 38)

For decades, the case method has been the cornerstone teaching method in many business schools across the globe (Charan, 1976; Donham, 1922). Historically, business cases are "verbal representations of reality that put the reader in the role of a participant" that "imitates or simulates a real situation" (Ellet, 2007: 13). In the typical case method, students read and prepare a business case which is then discussed in class (Andersen and Schiano, 2014). In the case method, the instructor guides the conversation and documents it on the chalkboard. Through this discussion students learn how to apply concepts to real world examples and how to make and support an argument (DesJardins and Diedrich, 2003). Business cases can be based on real or fictitious companies and can vary greatly based on the content being taught.

Most business cases are still assigned in written format; however, video cases have been growing in popularity (Fang and Chiu, 2024).

Recently, virtual reality (VR) versions of business cases have been developed (Stern et al., 2021). While VR has been used in teaching other subjects—including medicine (Gan et al., 2023; Miltykh et al., 2023), engineering (Li et al., 2023; Rzanova et al., 2024), foreign languages (Schorr et al., 2024), music (Amm et al., 2024), and athletics (Wu et al., 2023)—its application to the business case method is just starting. The introduction of VR into business teaching aligns with its introduction into business research (Hubbard and Aguinis, 2023). In teaching, VR has many potential benefits and drawbacks compared to traditional written and video media (Philippe et al., 2020). However, we lack empirical evidence regarding whether these benefits occur and whether the drawbacks are significant. Thus, I ask the following research question:

Research Question: How does students' learning from case studies differ based on the medium: written, video, or VR?

I investigated both process (Hayes, 2013) and learning outcomes (Wu et al., 2020) as I addressed this research question. Two important process variables that could lead to important differences between the media are presence and task load. Given the immersive nature of VR (Bowman and McMahan, 2007), there could be important differences across these three media. While that is beneficial, however, one key potential drawback to being in VR is that it may be taxing for students. To quantify this concern, I also evaluated the task load of participants in each medium (Hart and Staveland, 1988). These two process variables provide a foundation for understanding why we might see different outcomes between case media. Knowledge recall in cases is an important outcome, as students need to be prepared to discuss the case without continually referring back to it. Given the multimedia nature of the video and the VR cases, we might see differences in the recall of visual information—such as the descriptions of facilities, the characteristics of the CEO, or physical dimensions—compared to numeric information—such as revenue and profit levels. Immersing participants in VR may lead to higher recollection of visual information, while reading a case might lead to students recalling more numeric information. When I combine these process variables and outcome measures, I can position the field to understand better how students learn from business cases in VR compared to written and video presentations.

By addressing this important issue, I begin a new scientific conversation regarding the validity of VR as a method for teaching business cases. To empirically investigate this exciting development, I constructed a business case and presented it to undergraduate business students in one of three randomly assigned presentation modalities: written, video, or VR. After participants completed the case, they were asked a series of questions about their experience, recollection of the case, and demographics in Qualtrics. In the experiment, I measured their presence and task load to explain why they recalled different types of case facts—either the numbers or visuals of the case—and expressed different levels of interest in adopting the method in their curriculum.

1.1 Differences between media: immersion, presence, and task load

While there are many differences between the three modalities considered in this manuscript, three stand out as particularly salient: immersion, presence, and task load.

In the VR context, immersion is defined as "the objective level of sensory fidelity a VR system provides" (Bowman and McMahan, 2007) and presence is the "sense of being in the virtual environment" (Schubert et al., 2001: 266). Presence is based on the users' subjective experience. A sense of presence can be achieved in videos and written text as well—as one would be engrossed in a movie or great book. Even given this possibility, immersion and presence should be greater in VR business cases.

Task load may also vary between the three business case modalities. Task load is defined as the mental and physical effort required to perform a specific task (Hart and Staveland, 1988). Cognitive load has been shown to be higher in VR compared to video presentations on flat screens (Parong and Mayer, 2021). The process of wearing a headset, having both the real and virtual worlds to consider, and the novelty of the experience can all increase task load.

1.2 Knowledge acquisition in VR: learning visual compared to numeric facts

Knowledge recall is a key part of learning. Findings across different fields, however, show different effects of immersion and presence on memory and recall (Smith, 2019). For example, scholars studying eyewitness testimony (Green et al., 2025), firefighter training (Kubr et al., 2024), and the metaverse (Bampouni et al., 2024) showed no effect of immersion (based on medium) or presence (based on scale ratings) on recall, while marketing scholars have shown a decrease in recall based on immersion (Chen and Yao, 2022). Learning scholars, further, have shown higher levels of presence likely result in greater learning (Petersen et al., 2022). Higher task loads have been shown to decrease learning (Parong and Mayer, 2021). Thus, presence and task load likely lead to differences in the extent of students' learning from business cases; while the effect of presence is less certain, higher task load likely leads to less learning.

But while prior studies investigated general knowledge transfer (e.g., Makransky et al., 2019), I considered an important extension: the type of knowledge being recalled. Specifically, I considered visual information gathered from the environment and the case numbers gathered during the experience. Both are important in business cases. For example, knowing the revenue of a company or the layout of a factory can be critical in business education. Thus, Makransky et al.'s (2019: 233) conclusion that participants "actually learned less [in VR] as compared to the low-immersion version" might be based on an underspecified learning outcome.

2 Methods

To address my research question, I ran a between-subjects, randomized-controlled experiment to provide evidence of the effectiveness of the three different case media: written, video, and VR. The randomized design allows me to draw strong causal conclusions (Cook and Campbell, 1979). By using a real business case, the conclusions from the study should be generalizable. I pre-registered this study and all materials, data, and analysis code are provided (https://researchbox.org/3216).

2.1 Procedure

Participants were brought into the behavioral laboratory of a leading American business school and randomly assigned to either the written, video, or VR versions of the case. After reading, watching, or experiencing (via VR) the business case, they were directed to the computers at each station to complete a Qualtrics survey. Once they completed the survey, which contained all the measures in the study, they were given a debrief script that described the study.

2.2 Participants

Business school students are the primary audience for business case studies. Thus, I chose to use a sample of undergraduate business school students. A power analysis using G*Power 3.1 for an ANOVA with a medium effect size (0.25), $\alpha = 0.05$, Power $(1-\beta) = 0.80$ indicated a desired sample size of 159 (Faul et al., 2009). I recruited 154 undergraduate business school student participants (65 female and 89 male) aged 17–22 ($M = 19.09$, $SD = 0.82$) with 22% being non-white (120 White, 5 Black, 18 Asian, 8 Other, 6 Preferred Not to Say, and 23 Hispanic). Six participants were dropped because they failed an attention check (did not answer the question "Through what medium did you absorb the case?" with the correct experimental condition), resulting in a sample of 148 participants (41 written, 45 video, and 62 VR).[1]

2.3 Content of the business case

The business case was written in a manner that allowed for the same text to be used for the each of the three experimental conditions. The written case begins with "You are meeting with Alex Mason to take a tour of his company MobileTech. He wants your help to improve the performance of his company. What follows is what he tells you about MobileTech." Afterwards, the text matches exactly between the written case and the speech in the video and VR conditions. Here is a brief description of the business case:

> MobileTech, led by CEO Alex Mason, produces paper-thin, credit card-sized cell phones catering to customers seeking a minimalist tech experience. Despite their niche appeal, the company faces significant challenges: declining revenues, rising operational costs, outdated manufacturing processes, and waning consumer interest. Manufacturing inefficiencies have increased production times, and the company's outdated machinery exacerbates cost issues. Sales strategies need revitalization as consumer interest declines, but price cuts are hampered by manufacturing constraints. Additionally, innovation is stifled by budget limits and a lack of meaningful feedback from sales. To turn these challenges into opportunities, MobileTech must invest in modernizing production, innovate boldly, and enhance their value proposition and customer engagement strategies.

The case facts are broadly categorized into numbers (e.g., revenue and profitability) and visuals (e.g., the factory layout and design).

2.4 Case media and variants

As previously noted, I randomly assigned participants to either a VR, video, or written version of the case. In the VR case, I used the same techniques established by VR laboratory researchers (Hubbard and Villano, 2024). The VR version of the experiment was created using Unity version 2023.2.8f1. I used a virtual avatar for the CEO (Graf et al., 2024). The avatar of Alex Mason, the CEO in the case, was created using Reallusion's Character Creator 4.[2] The audio of the CEO's voice was recorded specifically for this study by the author. The voice was recorded on a MacBook Pro and processed through Adobe's Enhance Speech tool. The script and audio are provided in ResearchBox (https://researchbox.org/3216). The animation was created using Reallusion's iClone 8[3] including the lip synch with AccuLips.[4] The VR version of the case had five different scenes ranging from offices to factories and stores, which constituted the visual element of the company tour. The scenes—conference rooms, a store, and a factory—were purchased from the Unity Asset Store and were modified to ensure they ran efficiently in the headset. Figure 1 provides screenshots of each of the environments along with the CEO in each. The VR application was run in standalone mode on the Meta Quest 3 headset at 90 Hz.[5] Participants experienced the case in six degrees of freedom. After putting on the headset we let participants acclimate to VR before starting the experience.

The video version of the case was recorded in the Unity engine to identically match the VR version of the case. The video was recorded in Unity at 170 cm facing the default direction of the VR rig. Both the VR and video versions were identical and 4 min and 30 s long.

The written version of the case was based on the transcription of the CEO's speech in the VR application. Participants were not allowed to reread the case. Screenshots of each environment were included in the printed case. These are presented in Figure 1. Each case was printed in color.

2.5 Measures

The measures administered to the participants include two types of two types of variables: process variables to understand how people

1 A *post hoc* power analysis for a one-way ANOVA with fixed effects was conducted using G*Power 3.1. With a total sample size of 148 participants distributed across three groups, an effect size (f) of 0.35, and alpha set at 0.05, the analysis yielded a power (1 – β) of 0.97, indicating a high probability of detecting significant effects.

2 https://www.reallusion.com/character-creator/

3 https://www.reallusion.com/iclone/default.html

4 https://www.reallusion.com/iclone/lipsync-animation.html

5 Profiling in the headset showed that the framerate ran the majority of the time at 90 Hz and was never lower than 72 Hz.

FIGURE 1
Screenshots of the business case used in the written, video, and VR cases.

experienced each case medium and outcome variables to understand how people absorb and engage with the cases. I measured presence using the Igroup Presence Questionnaire (IPQ) (Schubert et al., 2001) on a 5-point scale with an α reliability = 0.87. It includes items such as "I had a sense of being in the case" and "I felt present in the case." I also measured the NASA Task Load Index (TLI) (Hart and Staveland, 1988) with an α reliability = 0.64. Participants rated their mental demands, physical demands, temporal demands, effort and frustration on a 5-point scale ranging from Low to High.

I then administered a declarative knowledge test (Petersen et al., 2022). In the test I asked a series of open-ended questions about the case study such as "Please describe what is happening in the business case. Please provide as much detail as you can." and "What product do they sell?" These questions were then categorized into those that are based on numbers from the case (e.g., the revenue last quarter) and visuals from the case (e.g., the color of the store's ceiling).

I measured four individual differences: gender, age, race, and ethnicity (Do et al., 2024; MacArthur et al., 2024; Van Zelderen et al., 2024).

A printout of the Qualtrics survey which has all scale measures is provided in the online repository.

3 Results

Results of MANOVA analysis showed meaningful differences across the five dependent variables (Wilks' lambda = 0.53, F (10, 282) = 10.27, $p < 0.001$) based on experimental condition. Based on this outcome, I conducted ANOVA analyses to assess individual outcome variables and include regressions predicting those outcomes while also controlling for age, gender, and race. All ANOVAs were statistically significant ($p < 0.01$). The results of the regressions are presented in Table 1. All results are presented with the coefficients representing differences from written case studies—the dominant modality used in business education.

For process variables, I found based on my regressions in Model 1 of Table 1 that watching the video case resulted in lower ($b = -0.34$, $p < 0.05$), while experiencing the VR case resulted in higher ($b = 0.24$, $p < 0.10$), presence than in the written condition. A violin plot of the mean differences is provided in Panel A of Figure 2. Further, the results of Model 2 in Table 1 show that there was greater task load (TLI) ($b = 0.39$, $p < 0.01$) in the VR than in the video conditions, a result shown in Panel B of Figure 2.

For outcome variables, I reported in Model 3 of Table 1 that participants recalled more visuals in both the video ($b = 0.30$, $p < 0.01$) and the VR ($b = 0.34$, $p < 0.01$) versions of the case, compared to the written version. For case numbers, however, I report in Model 4 of Table 1 that those in the VR condition recalled fewer number-based case facts ($b = -2.23$, $p < 0.01$) than those in the written condition. Interest in adoption reported in Model 5 of Table 1 was similarly lower for the VR condition ($b = -0.60$, $p < 0.01$) than in the written condition. The two process variables worked in opposite ways. Task load (TLI) lowered interest in adoption ($b = -0.19$, $p < 0.10$) while presence (IPQ) increased interest in adoption ($b = 0.62$, $p < 0.01$).

I then used Structural Equation Modeling (SEM) to test a mediated path model with my experimental conditions predicting process variables and all predicting the final outcomes (Kline, 2016). The results are graphically presented in Figure 3. The SEM model's fit statistics ($\chi^2_{\text{model vs. saturated}}$ [4] = 2.90 [$p = 0.574$]; CFI = 1.00, SRMR = 0.017 RMSEA = 0.00) demonstrated good fit (based on

TABLE 1 Ordinary Least Squares regression results predicting process and outcome variables.

Variables	Process variables		Outcome variables		
	Model 1 Igroup presence questionnaire	Model 2 Task load index	Model 3 Case visuals recalled	Model 4 Case numbers recalled	Model 5 Interest in adoption
Demographic Controls					
Participant Age	0.02	−0.08	−0.00	0.07	−0.07
	(0.07)	(0.06)	(0.05)	(0.19)	(0.08)
Female Participant	−0.10	0.19†	−0.07	−0.77*	0.14
	(0.12)	(0.10)	(0.09)	(0.33)	(0.13)
Non-White Participant	0.12	0.28*	0.10	−0.62	0.15
	(0.14)	(0.12)	(0.10)	(0.40)	(0.16)
Process Variables					
Task Load Index			−0.10	−0.00	−0.19†
			(0.07)	(0.28)	(0.11)
Igroup Presence Questionnaire			0.05	0.00	0.62**
			(0.06)	(0.23)	(0.09)
Experimental Condition					
Video Condition	−0.34*	0.08	0.30**	−0.43	−0.27
	(0.15)	(0.13)	(0.11)	(0.42)	(0.16)
VR Condition	0.24†	0.39**	0.34**	−2.23**	−0.60**
	(0.14)	(0.12)	(0.11)	(0.41)	(0.16)
Constant	1.22	3.09**	0.89	3.07	4.38**
	(1.35)	(1.12)	(0.99)	(3.80)	(1.48)
Model Parameters					
Observations	148	148	148	148	148
R^2	0.12	0.18	0.09	0.30	0.33

Note: Written case serves as the baseline experimental condition, the reported coefficients are in relation to the baseline; Standard errors in parentheses; two-tailed p-values; **p < 0.01, *p < 0.05, †p < 0.10.

Kline (2016), χ^2 should be statistically nonsignificant; the combination rule for concluding "acceptable fit" is CFI ≥ 0.95 and SRMR ≤ 0.08; and RMSEA should be less than 0.05). The results match the conclusions from the regressions. VR had higher task load and presence, while video had lower presence, than was the case for the written condition. Presence leads to interest in adoption, while task load decreases interest in adoption. The lower presence in the video condition decreased interest in adoption (total indirect effect = −0.23, $p < 0.05$). The total indirect effect of VR on interest in adoption is not statistically significant (total indirect effect = 0.07) because the two mediators have opposite effects (mediation through IPQ = 0.15, $p < 0.10$; mediation through TLI = −0.07, $p = 0.11$).

4 Discussion

This research shows that business students engage with business case studies and recall facts from those cases differently depending on the medium in which the case is presented (see also Andersen and Schiano, 2014). In comparison to written cases—the *de facto* case presentation method in business education—engaging with a case presented in VR had both benefits and drawbacks. On one hand, business students felt more present in the case, but this came at the cost of greater task load. In VR, participants recalled more visual information, but fewer numerical facts. They were also less interested in adopting VR cases in their educational programs.

These results have important implications for business education. While in the past case designers and instructors were essentially limited to the written page, we now have more options available. VR can be particularly useful when the visual information in a case is important. Cases about factory layouts, store designs, or product design might be better suited for VR. For example, a case study that discusses changing the physical layout of the store could be a good candidate for VR, as students can "walk" around the store; they could even effortlessly move displays within the store.

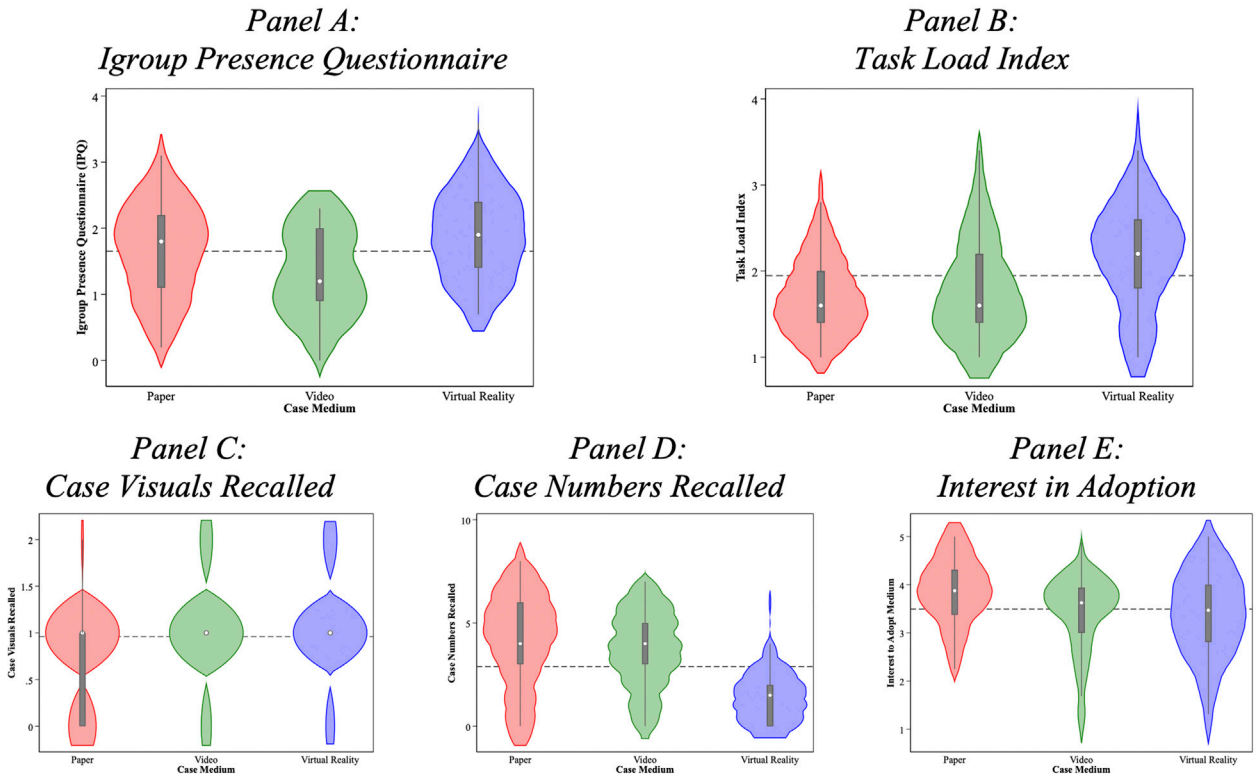

FIGURE 2
Violin plots for process and outcome variables based on case medium. Dashed lines indicate mean values across conditions.

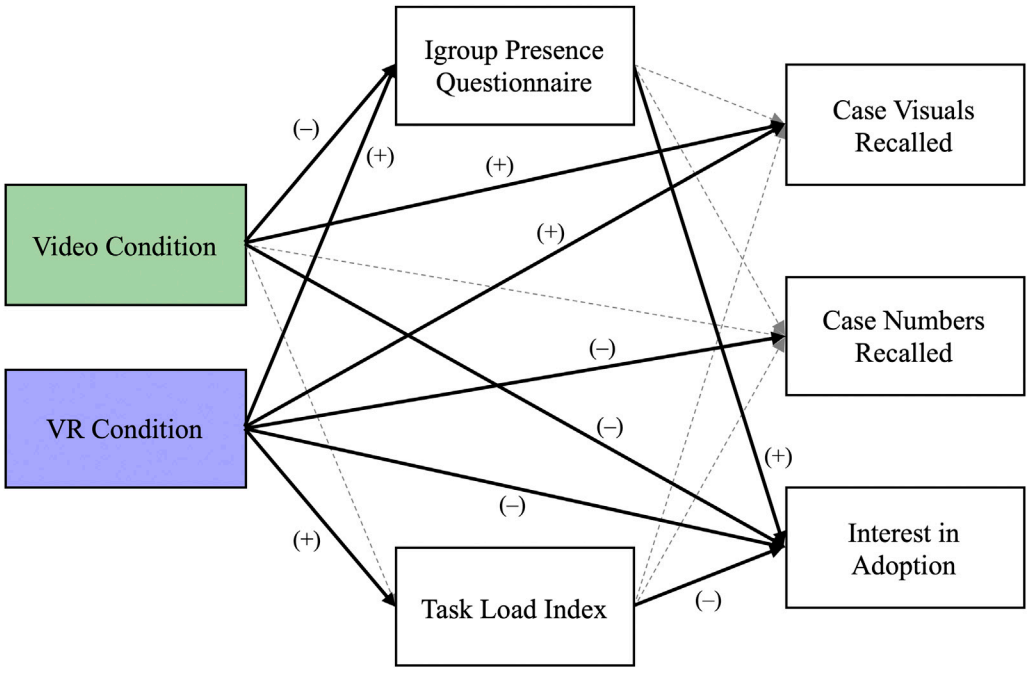

FIGURE 3
Results of structural equation model. Solid lines indicate statistically significant paths ($p < 0.10$). Direction of effect is indicated in the parentheses on each statistically significant line.

Another example of something well-suited for a VR presentation is demonstrating changes in a product design; instead of only seeing pictures of a product in a written case, in VR students could pick up, hold, and inspect the product in higher fidelity. In this study, I specifically asked questions about what participants recalled seeing at a factory, a cell phone store, an office building, or a conference room, as well as what they recalled about the virtual avatar himself. Figure 1 provides screenshots of the visuals on which I tested participants. My findings show how important it is for case designers to have a clear set of goals when they start the project so they can select the most appropriate medium.

VR can lead to greater immersion and presence in the virtual world. This can help give students the opportunity to step into various businesses and business situations without having to leave the classroom. Undergraduate students who have less work experience may especially benefit from cases presented in VR. And immersion in different industries might help students discern which sectors they may be interested in working in.

While the task load students reported in the study was higher in VR than in either written or video case presentations, this is not necessarily a problem. Universities are supposed to be places that prepare students for their future lives, and demanding work conditions are a reality. VR might create "desirable difficulties" which are "desirable" because they trigger encoding processes to support learning (see Bjork and Bjork, 2011; 2020). While we do not want to put students under undue stress, increasing task demands in academic programs may have positive benefits.

It is interesting that students were least interested in adopting VR as a tool in their educational program. While I showed that presence increases interest in adoption, task load reduces that interest. For the VR condition, these effects essentially cancel each other out. Given that the main effect persists, there must be other mediators which were unmeasured in this study. Future researchers can explore potential explanatory variables in greater detail.

While incorporating some of the same features as VR, video provided the study with an important point of comparison. As with VR, video led to higher visuals recalled compared to written case presentations, and it did not exhibit the reduced level of case numbers recalled that I saw with VR cases. Participants in the video case condition, however, reported lower presence compared to written and VR cases. I believe this is due to participants in the written case getting absorbed in the story and those in the VR case being physically immersed in the virtual environments. Those in the video case condition were likely not as engrossed in the story as those in the written condition, and they were also not enveloped in the virtual world. And similar to VR, students were less interested in adopting video cases compared to written cases. My results suggest that this is likely due to lower immersion.

4.1 Future research directions

A limitation of this study is that it was looking at the participants' experience during the case and how much they recall from the case. A key feature of the case method, however, is the case discussion that happens afterwards. I stopped short of this part of the educational experience. Further, this study was focused on the outcome of students' first exposure to the case in different modalities. Students sometimes re-read cases and would likely rewatch the video and replay the VR versions as well. I did not give them that option in this experiment. These limitations present opportunities for future scholars to investigate further the case process based on the VR medium.

The lack of interest in adopting VR for education is an interesting, unexpected outcome. I expected the immersive nature of the VR experience to increase interest in adoption. Understanding this counterintuitive finding presents an interesting avenue for future research. I believe there may be moderators that explain which students may be more interested in adopting VR in their college experiences. One example could be prior familiarity with and knowledgeability about VR. As students become more comfortable and knowledgeable, their likelihood of adopting VR in the future could increase, as Lindner et al. (2019) showed in a study of VR usage among clinical psychologists. A second example could be their perception of the usefulness and ease of use of VR (Wong et al., 2023). Wong et al. (2023) showed that perceiving VR as useful and easy to use increased people's engagement in VR learning. In turn, they showed that this engagement improves learning effectiveness. These findings come from a different context than the business cases I study but can be informative for scholars looking to extend this work. Future studies could investigate familiarity with, knowledge of, and perceptions of the usefulness of VR, which might help scholars and developers develop strategies to help speed VR adoption among skeptics to enhance learning outcomes where appropriate.

Individual differences might also be an important area of future research. In the Wong et al. (2023) study, they investigated the moderating role of openness to experience in VR learning. They showed that openness to experience serves as a moderator to explain learning effectiveness in VR. Wang et al. (2024) showed that agreeableness and neuroticism are both positively related to perceived enjoyment of VR learning. These individual differences—and enjoyment itself—could be useful moderators to consider. Two final individual differences which may be fruitful to study, investigated by Lawson and Mayer (2024), are executive function and working memory capacity. They showed how executive function related to learning outcomes. One could imagine that working memory capacity could play an important role in recalling facts from business cases presented in VR. In all, individual differences might serve as an interesting pathway for future studies.

5 Conclusion

My findings indicate that VR heightens presence yet elevates task load, leading students to recall fewer numeric details and be less inclined to embrace VR presentations of cases. Even so, when the visual aspects of a case are crucial, VR may offer a unique advantage, transporting students into realistic business environments without leaving the classroom. Overall, educators should carefully balance immersion with practical considerations when selecting the medium for case studies.

Data availability statement

The datasets presented in this study can be found in online repositories. The name of the repository and location can be found in the article.

Ethics statement

The studies involving humans were approved by University of Notre Dame's Institutional Resource Board (protocol #24-01-8330). 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

TH: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing–original draft, Writing–review and editing.

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Conflict of interest

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

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