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The effectiveness of teaching virtual reality-based business ethics: is it really suitable for all learning styles?

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Ratna Candra Sari
Department of Accounting Education, Faculty of Economics, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia

Sony Warsono
Department of Accounting, Faculty of Economics and Business, Universitas Gadjah Mada, Yogyakarta, Indonesia

Dwi Ratmono
Department of Accounting, Faculty of Economics and Business, Universitas Diponegoro, Semarang, Indonesia

Zuhrohtun Zuhrohtun
Department of Accounting, Faculty of Economics and Business, Universitas Pembangunan Nasional "Veteran" Yogyakarta, Yogyakarta, Indonesia, and

Hardika Dwi Hermawan
Department of Informatics Engineering Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta, Sukoharjo, Indonesia

Abstract

Purpose – Previous research examined the effectiveness of virtual reality (VR) in various fields including engineering (Alhalabi, 2016), the military (Webster, 2016), robotic surgery (Bric *et al.*, 2016; Francis *et al.*, 2020), firefighters (Çakiroglu and Gökoglu, 2019), negotiation training (Ding *et al.*, 2020), health-care training (Chow *et al.*, 2017) and ethics education (Sholihin *et al.*, 2020). However, empirical research examining learning styles on the effectiveness of using VR is still scarce. VR has different characteristics from other learning media and high immersiveness in a VR environment can create a sense of presence that improves learning outcomes, except for students with certain learning styles who experience cognitive overload when exploring virtual environments (Hsu *et al.*, 2017). Therefore, it is necessary to investigate to what extent learning styles can influence the effectiveness of VR-based learning on business ethics. This is because the effectiveness of business ethics education is indispensable along with the increasing cases of fraud and financial companies (PwC's Global Economic Crime and Fraud, 2020).

Design/methodology/approach – Education must respond to the progress of information technology (IT) development by providing IT-based teaching methods to enhance the learning process. This is because the evolution of technology is changing student learning preferences from verbal to visual or even virtual (Proserpio and Gioia, 2007). VR is an IT-based learning media that creates a virtual environment which

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simulates the real world and provides concrete experiences, so students are able to actively explore their course material. VR technology is able to provide practical experiences without actually leaving home, so it is relevant for responding to the current situation due to the COVID-19 pandemic.

Findings – Compared to traditional learning, VR is a more flexible learning method as it has no limitations of time, distance and space (Yu *et al.*, 2007). The main characteristic of VR is immersion, interaction and imagination (Zhang *et al.*, 2017) that improve cognitive performance in engineering (Alhalabi, 2016), the military (Webster, 2016) and surgical robots (Bric *et al.*, 2016). VR-based learning can improve students' learning abilities compared to traditional teaching (Jena, 2016). VR has already proven effective in teaching business ethics (Sholihin *et al.*, 2020) because VR has the ability to create a virtual world, without any impact from socially reprehensible acts. With VR, students are able to understand scenarios about ethical dilemmas that occur in business practices, observe the potential consequences and make decisions to solve concrete situations where ethical dilemmas require a response. VR allows students to simulate situations virtually and develop their long-term experience. This is crucial because there is the possibility that in the near future the society will live in a mixed world (virtual and physical space).

Practical implications – A virtual environment that is able to evoke a sense of presence refers to the intensity of emotional involvement. Sense of presence can actually improve the learning results, but if the user lacks the ability to explore game tasks it will cause a cognitive overload that has a negative impact on learning outcomes (Hsu *et al.*, 2017; Huang *et al.*, 2020). Learning style preferences cause differences in cognitive load during the learning process using VR (Hsu *et al.*, 2017). In a VR-based learning environment, students are required to explore the virtual environment; therefore, without navigation, students with active experimental learning styles are superior to students with passive or observing learning styles (Chen *et al.*, 2005). Therefore, it is necessary to understand the impact of adopting VR technology to improve student's performance by considering different learning styles.

Social implications – In Indonesia, the shift from offline learning to e-learning has created new academic pressures for some students (Pajarianto *et al.*, 2020). The main challenge for educators is how to improve student's learning outcomes and overcome the problem of using e-learning technology.

Originality/value – In light of the scarcity of research on the effectiveness of VR for teaching business ethics during the COVID-19 pandemic, this study fills the gap by extending the study of Sholihin *et al.* (2020) in that the authors establish the connection between user perception of the use of VR and learning style in relation to the effectiveness of VR.

Keywords Behavior, Cognition, Experiential learning, Gamification, Learning methods

Paper type Research paper

1. Introduction

Education must respond to the progress of information technology (IT) development by providing IT-based teaching methods to enhance the learning process. This is because the evolution of technology is changing student learning preferences from verbal to visual or even virtual (Proserpio and Gioia, 2007). Virtual reality (VR) is an IT-based learning media that creates a virtual environment which simulates the real world and provides concrete experiences, so students are able to actively explore their course material. VR technology is able to provide practical experiences without actually leaving home, so it is relevant for responding to the current situation due to the COVID-19 pandemic. Previous research examined the effectiveness of VR in various fields including engineering (Alhalabi, 2016), the military (Webster, 2016), robotic surgery (Bric *et al.*, 2016; Francis *et al.*, 2020), firefighters (Çakiroglu and Gökoglu, 2019), negotiation training (Ding *et al.*, 2020), health-care training (Chow *et al.*, 2017) and ethics education (Sholihin *et al.*, 2020). However, empirical research examining learning styles on the effectiveness of using VR is still scarce. VR has different characteristics from other learning media and high immersiveness in a VR environment can create a sense of presence that improves learning outcomes, except for students with certain learning styles who experience cognitive overload when exploring virtual environments (Hsu *et al.*, 2017). Therefore, it is necessary to investigate to what extent learning styles can influence the effectiveness of VR-based learning on business ethics. This is because the effectiveness of business ethics education is indispensable along with the increasing cases of fraud and financial companies (PwC's Global Economic Crime and Fraud, 2020).

Compared to traditional learning, VR is a more flexible learning method as it has no limitations of time, distance and space (Yu *et al.*, 2007). The main characteristic of VR is immersion, interaction and imagination (Zhang *et al.*, 2017) that improve cognitive performance in engineering (Alhalabi, 2016), the military (Webster, 2016) and surgical robots (Bric *et al.*, 2016). VR-based learning can improve students' learning abilities compared to traditional teaching (Jena, 2016). VR has already proven effective in teaching business ethics (Sholihin *et al.*, 2020) because VR has the ability to create a virtual world, without any impact from socially reprehensible acts. With VR, students are able to understand scenarios about ethical dilemmas that occur in business practices, observe the potential consequences and make decisions to solve concrete situations where ethical dilemmas require a response. VR allows students to simulate situations virtually and develop their long-term experience. This is crucial because there is the possibility that in the near future our society will live in a mixed world (virtual and physical space).

However, technology's adoption may cause problems, including the effectiveness of technology for learning (Grasha, 1996) because the nature of instruction should accommodate individual differences in learning styles to improve the learning outcomes. Based on Aptitude-by-treatment interaction (ATI) research, improving the learning outcomes required the nature of the instruction that accommodates individual differences in ability, style or preference. Research on individual learning styles in the context of VR is indeed still in its infancy. Lee *et al.* (2010) and Pedram *et al.* (2020) found that in a virtual environment, differences in learning style do not affect learning outcomes, whereas Chen *et al.* (2005) argued that in non-guided VR mode, the accommodator outperforms the assimilator learner.

A virtual environment that is able to evoke a sense of presence refers to the intensity of emotional involvement. Sense of presence can actually improve the learning results, but if the user lacks the ability to explore game tasks it will cause a cognitive overload that has a negative impact on learning outcomes (Hsu *et al.*, 2017; Huang *et al.*, 2020). Learning style preferences cause differences in cognitive load during the learning process using VR (Hsu *et al.*, 2017). In a VR-based learning environment, students are required to explore the virtual environment; therefore, without navigation, students with active experimental learning styles are superior to students with passive or observing learning styles (Chen *et al.*, 2005). Therefore, it is necessary to understand the impact of adopting VR technology to improve student's performance by considering different learning styles.

In Indonesia, the shift from offline learning to e-learning has created new academic pressures for some students (Pajarianto *et al.*, 2020). The main challenge for educators is how to improve student's learning outcomes and overcome the problem of using e-learning technology. In light of the scarcity of research on the effectiveness of VR for teaching business ethics during the COVID-19 pandemic, this study fills the gap by extending the work of Sholihin *et al.* (2020) in that we establish the connection between user perception of the use of VR and learning style in relation to the effectiveness of VR. Therefore, the research question for this study is as follows:

RQ1. Is the effectiveness of VR-based learning media ethics influenced by the interaction between the user's perception of VR and learning styles?

2. Research model and hypotheses

VR technology creates virtual environments capable of breaking the boundaries of traditional educational systems. For example, VR can create a virtual environment for athletic education (Wang and Hu, 2017) and surgical training for surgeons (Francis *et al.*, 2020). VR is an interactive technology that provides visualization and real-time interaction in a virtual world that resembles the real world. VR has three main characteristics that emphasize immersion, interaction and imagination (Zhang *et al.*, 2017). VR provides a highly interactive experience or virtual experience, which is the psychological and emotional state of the user when interacting with a product in a three-dimensional (3D) environment. Virtual experiences create a sense of presence that describes the user's emotional interactions. Sense of presence is a predictor of user perceptions related to satisfaction, quality, motivation, positive attitude or positive performance in VR-based learning environments (Weibel and Wissmath, 2011; Yoon *et al.*, 2015).

VR features are the antecedents of technological quality and technological accessibility (TA) (Salzman *et al.*, 1999; Zhang *et al.*, 2017). The quality of the technology is the extent to which users believe that certain technologies are relevant and useful for accomplishing work and improving their performance. That is, if a user feels that technology is useful to complete the work and improve their performance, they will assume it is a high-quality technology. TA is the extent to which users believe that using a particular technology is comfortable, controllable and easy to use. Therefore, we predict that VR features have an effect on the perception of the technology's quality (TQ) and accessibility:

H1. VR features are determinants of technology accessibility.

H2. VR features are determinants of technology accessibility.

The theory of the interactive media effect implies that media characteristics have an effect on affective, cognitive and behavioral responses (Sundar *et al.*, 2015). Several previous studies have tested the use of VR on undergraduate students and found that VR-based learning can improve the learning outcomes for educational environments (Su, 2018), biology (*Makransky et al.*, 2016), health-care (Chow *et al.*, 2017) and fire safety skills (Çakiroglu and Gökoglu, 2019). Previous research has found empirical evidence that VR features can facilitate learning (Yusoff *et al.*, 2011), experience (Chow *et al.*, 2017; Yusoff *et al.*, 2011) and provide feedback (Chittaro and Zangrando, 2010; Chow *et al.*, 2017). These three components are the antecedents of self-efficacy (SE) (Gist and Mitchell, 1992). Several previous studies have found that VR-based learning can increase SE in various fields as follows: the art of negotiating (Ding *et al.*, 2020), athletics (Wang and Hu, 2017) and surgery (Francis *et al.*, 2020).

However, it is important to note that virtual learning environments will not necessarily facilitate students' performance (Dalgarno *et al.*, 2002). The ATI study examined the effect of students' aptitudes and traits on the learning outcomes of various forms of instruction (Cronbach and Snow, 1969). The main assumption underlying the ATI research is that the nature of instruction is desirable to accommodate individual differences in abilities or learning styles to improve learning outcomes.

A learning style is a process that students use to gather and process information (Cano *et al.*, 1992). A learning style is a general tendency to process information differently (Jonassen and Grabowski, 1993). Kolb (1984) defined a learning style as the preferred way for students to understand and process information and divide it into four types of learning styles, which are as follows: accommodator, assimilator, converger and diverger. Accommodators have a dominant learning ability from real experiences and active experiments. They are classified as actors and touchers. On the contrary, assimilators have a dominant ability in abstract conceptualization and reflective observation. Assimilators are classified as observers and thinkers. Convergers have a dominant ability for abstract understanding and transforming through action and most appropriate learning occurs through abstract conceptualization and active experimentation. Convergers are both thinkers and doers. On the other hand, divergers have dominant abilities through concrete experiences and reflective observation. A diverger is a toucher and an observer.

Some researchers support that learning outcome will improve if the subject matter is presented in a way that is consistent with students' learning styles (Slavin, 2000; Woolfolk, 1998). However the field of learning styles has been repeatedly criticized for confusing and overlapping definitions and terminology, imprecise measurements and lack of independent evaluation (Peterson *et al.*, 2009; Willingham *et al.*, 2015). However, research on learning styles in VR learning needs to be explored. VR has high interaction and immersive characteristics, giving rise to a sense of presence which refers to a sense of spatial immersion in a virtual environment (Weibel and Wissmath, 2011) and the intensity of emotional involvement. A sense of presence can improve learning outcomes if users are not overwhelmed by the virtual environment (Bachen *et al.*, 2016).

In the context of VR, the user explores a virtual environment that involves navigating within it. Navigation is the process of determining the path to be traversed by any object through any environment. However, the process of navigating in a virtual environment is difficult (Stankiewicz *et al.*, 2003; Smith and Marsh, 2004). One of the causes is the problem of disorientation or getting lost (Marsh and Smith, 2001). Some VR users have problems retaining knowledge of location and orientation while moving in a virtual environment (Darken and Sibert, 1993). The ability to retain this knowledge is related to the user's spatial orientation ability which differs between individuals. If the user does not have the ability to explore virtual environments effectively and complete game tasks, it will cause a cognitive load that has a negative impact on learning (Hsu *et al.*, 2017). Chen *et al.* (2016) examined the effects of interactions on VR-based learning with three modes (non-guided, guided and non-VR) and a learning style, on performance. In non-guided VR mode, the accommodator learner outperforms the assimilator learner. Under conditions of lack of guidance or navigation, learners with active experimental learning styles have more ability to explore virtual environments than passive learners, so that cognitive overload in the active type is lower than the passive type.

To improve learning outcomes, it is necessary to accommodate the differences in learning styles or individual preferences. VR has characteristics that allow students to actively explore virtual environments. Students who are active learner types (accommodators and convergers) are able to outperform passive learners (assimilators and divergers) because the use of VR also requires active involvement in exploring virtual environments to solve the learning problems that arise. In addition, passive learners have a tendency to experience higher cognitive overload when exploring virtual environments than active learners. Therefore, we predict that learning style moderates the relationship between TQ and technology's accessibility in relation to learning effectiveness (LE), as measured by SE:

H3. The learning style moderates the relationship between TQ and SE.

H4. The learning style moderates the relationship between technology's accessibility and SE.

3. Methodology

This application was built using the waterfall or the classic life cycle models. The system development life cycle is a process for developing software that emphasizes needs, followed by structured steps to improve the product's quality, based on best practices or well-tested methods (Pressman, 2005; Radack, 2009; Raval and Rathod, 2013). The waterfall development model is shown in Figure 1. This model is systematic. The steps that must be followed to develop the software start with the requirements' definition, the system's and software's design, implementation and testing, integration and system testing and maintenance (Sommerville, 2011).

The requirements' definition stage comprises several aspects including the requirements for the software's functionality, the system's service and constraints. At this stage, it was expected that all the software's requirements would have been met, including the specification requirements which included the specifications for the device to be used. The device used to run this application was an Android-based smartphone with a minimal version of a lollipop supported by a VR box. The second stage was the software's design. This software was modeled with the unified modeling language (UML), a standard language that is widely used in the industrial world to define requirements, undertake an analysis or design and describe architecture in object-oriented programming (Booch, 2005; Viswanathan and Samuel, 2016). UML modeling consists of nine diagrams of models which are grouped into three categories, but in this study, only two types of diagrams were used, namely, use case diagrams and sequence diagrams. Use case diagrams are used to briefly describe who uses the system and what they can do. Sequence diagrams describe the behavior of objects in the use cases by describing the lifetime of objects and the messages sent and received between the objects (Brunel *et al.*, 2016; Siau and Cao, 2001).

After the software model had been successfully created using UML, the next stage was implementation and testing. Software that had been designed using UML modeling was built with the Unity 3D development software, Vuforia SDK, Mono Develop and Java SDK. Meanwhile, for 3D design, virtual environment, user interface and related designs, Adobe Photoshop CS6, Adobe Premiere CS6, Corel Draw X5, Blender 3D, AutoCAD and Format Factory 2.2 applications were used. After the implementation was completed, testing was carried out to determine the performance of the software. The results of the application's functionality and compatibility tests showed that all the application's functions ran well and could be used in a variety of different Android devices. The last stage was maintenance; this

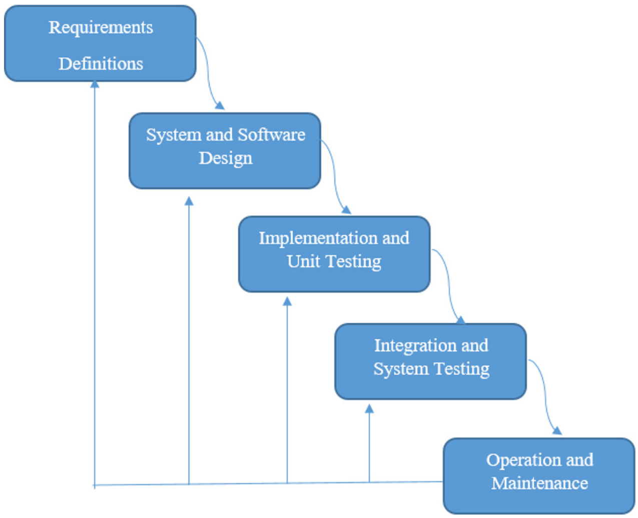


Figure 1.
Waterfall model
(Sommerville, 2011)

was carried out when bugs or errors were found in the application or periodically every quarter.

Hypothesis testing used partial least squares structural equation modeling (PLS-SEM) to analyze the data. This study used WarpPLS as the software for the PLS-SEM. Differing from the covariance-based structural equation model which uses software such as linear structural relationship or analysis of moment structure, PLS-SEM does not assume the normality of the distribution of the samples and can carry out statistical analyzes with relatively smaller-sized samples, which are oriented more toward predictive orientation (Hair *et al.*, 2017). PLS-SEM is primarily intended for causal predictive analyzes in situations of high complexity but with limited theoretical information. Therefore, using PLS-SEM is more suitable for exploratory studies like this research than for rigorous and confirmatory studies.

Measurement of SE was adapted from Fischbach (2015). SE shows confidence in one's ability to control one's motivation, behavior and social environment. While perceived as features of VR, technology's accessibility and quality measures were adopted from Dalgarno *et al.* (2002). The learning style used a modified version of a learning style inventory [adopted from Kolb (1984) and McCarthy (1996)].

VR non-guided mode was implemented for accounting students at the Faculty of Economics, Yogyakarta State University, who were taking online business ethics courses during the COVID-19 pandemic. We offered all the students in the class the opportunity to participate as the respondents in this research. The participants of this study were 123 students. Table 1 below shows the descriptive statistics of the respondents.

The average age of the respondents was 20.53 years, their grade point average was 3.87 and their average work experience was less than 1 year.

4. Result

4.1 Business ethics learning media based on virtual reality

Ethics learning media, based on a VR application, has been successfully developed through a series of software engineering processes, from defining the requirements to its operation and maintenance. This application provides a simulation of a real situation in terms of ethical decision-making. Given a variety of cases or situations in the virtual world, users can experience the dilemma of making a decision when faced with a fairly complex bribery case. This application provides a variety of decision scenarios that focus on auditors' ethical dilemmas.

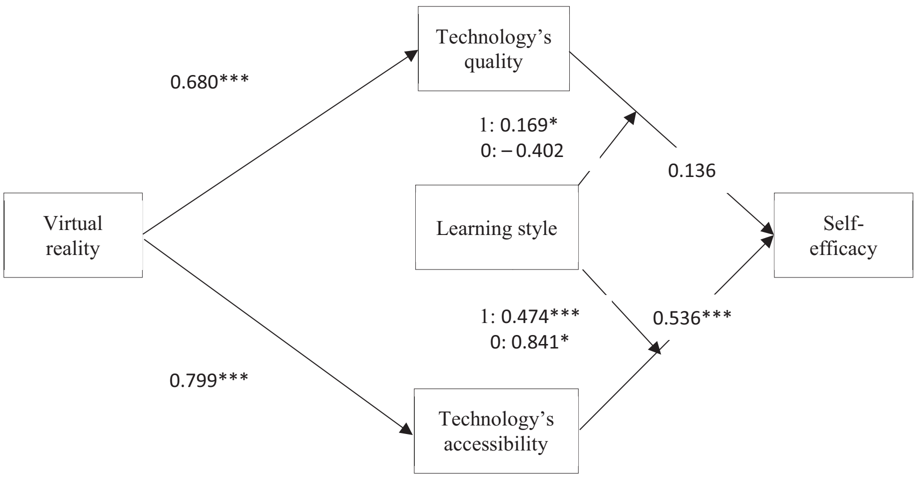
The application was tested in terms of its compatibility and functionality so that the application can run on various types of Android devices, ranging from the Lolipop to Marshmallow versions, with various screen resolutions and all the functions were found to run well. This VR application offers high levels of interactivity and accessibility within its various scenarios. After successfully downloading and installing the application on an Android device, the user just needs to put the Android smartphone on the VR box and activate the Bluetooth remote control.

Variable	N	Minimum	Maximum	Mean	SD
Age	123	20.00	22.00	20.53	0.81
GPA	123	3.00	4.00	3.87	0.34
Work experience	123	0.00	1.00	0.18	0.39

Table 1. Descriptive statistics

A view of the virtual world is displayed according to the use case diagram's design scenario. The application's users act as auditors and have to perform audit simulations. The users see an opening video describing their client's company, which is a construction company (Figure 2). Then, the auditor meets the board of directors to sign the audit engagement paperwork. After accepting the engagement, the auditor performs the audit work. First, the auditor reviews the project and assesses the level of completion of the building (Appendix Figure A1). Second, after reviewing the project, the auditor enters the accounting department and audits the financial statements, including determining the costs charged, based on the level of the building's completion (Appendix Figure A2). During the audit, the auditor experiences pressure from the client to approve the client's earnings manipulation actions. The auditor is faced with an ethical dilemma as follows: the client offers a bribe so that the auditor will agree to the client's profit manipulation actions or the audit gets canceled so that the auditor loses the client (Appendix Figure A3). The user, as the auditor, must make a decision after facing this ethical dilemma.

Figure 2.
Screenshot of the VR condition describing their client's company



Notes: ***$p < 0.01$; *$p < 0.1$; 0 = passive learning style; 1 = active learning style

Figure 3.
Moderating effects of learning style

4.2 Result of hypothesis testing

At this stage, confirmatory factor analysis was used to evaluate the validity and reliability of the constructs. The PLS algorithm was used to assess the reliability and validity of the constructs. Reliability shows the internal consistency of the measurement. Cronbach's alpha should exceed 0.7. In addition, Composite reliability (CR) should exceed 0.7. From Table 2, all the Cronbach's alphas are greater than 0.7. The minimum for CR also exceeds 0.7. Therefore, the items used to represent the constructs were reliable.

Convergent validity shows the degree to which a measure/indicator is positively correlated with an alternative measure/indicator for the same construct. Therefore, items that are indicators of a reflective construct should have a high convergence or divide the variance. Convergent validity was tested using the average variance extracted (AVE), which should be greater than 0.5 for convergent validity to be found (Hair *et al.*, 2017). The AVE value was greater than 0.5 for all of the constructs, indicating good convergent validity. Thus, sufficient reliability and convergent validity were demonstrated, as shown in Table 2.

Discriminant validity shows the degree to which a latent variable or construct is completely different from other constructs, as shown by the results of the empirical research. Sufficient discriminant validity implies that a construct is truly unique and can capture phenomena that are not represented by other constructs in the model. Table 3 shows the discriminant validity's result. The discriminant validity of all the latent constructs was confirmed by comparing the square roots of the AVE to the correlation coefficients of the other variables, as shown in Table 3. The result shows that the square roots of the AVE in the diagonal column are higher than the correlation coefficient between the variables in the

Constructs	Factor loadings	α	CR	AVE
LE	0.976	0.973	0.982	0.948
	0.980			
	0.966			
SE	0.976	0.828	0.887	0.665
	0.693			
	0.768			
	0.800			
TA	0.928	0.836	0.902	0.754
	0.810			
	0.863			
TQ	0.833	0.796	0.867	0.621
	0.666			
	0.812			
	0.831			
VR	0.878	0.915	0.934	0.673
	0.886			
	0.865			
	0.849			
	0.881			
	0.752			
	0.586			

Notes: VR = Virtual reality, LE = Learning effectiveness, SE = Self-efficacy, TA = Technological accessibility, TQ = Technology's quality, α = Cronbach's alpha, CR = *Composite reliability*, AVE = *Average variance extracted*

Table 2. Result of measurement model, reliability and validity

same column. The test results show that the criteria for discriminant validity have been fulfilled. Overall, the results of the measurement model test show that the criteria for reliability, convergent validity and discriminant validity have been met.

Structural modeling consists of testing the relationships between the constructs and the model's predictive capabilities. Validating the structural model can help researchers to consider systematically whether the hypotheses expressed by the structural model are supported by the data (Hair *et al.*, 2017). The results of the PLS-SEM test of the structural model are shown in Figure 3.

VR technology positively affected the TQ ($\beta = 0.680$, $p < 0.01$) and the technology's accessibility ($\beta = 0.799$, $p < 0.01$). This supports *H1* and *H2*.

In this study, we only classified two types of learning styles as follows: the active learning style (accommodators and convergers) and the passive learning style (divergers and assimilators) because there were a few students with divergent and assimilator learning styles. The learning style moderates the relationship between TQ and SE because of the differences in the effect of the TQ on SE in the active and passive learning style group (Table 4). In the active learning style group, the effect of TQ on SE was marginally positively significant while in the passive learning style group the effect was insignificant. The same results were also found for the effect of technology accessibility on SE. In the active learning style group, there was a significant effect of technology's accessibility on SE while in the passive learning group there was no influence. Therefore, *H3* and *H4* were supported.

5. Discussion

An effective learning experience is characterized as an active student experience, providing immediate feedback and a high level of engagement. VR technology has the ability to create an "experience" as in real life. The main characteristic of VR is Immersion which allows the user's presence in the VR environment. Sense of presence encourages users to "engage" and actively interact in a virtual environment.

Construct	LE	SE	TA	TQ	VR
LE	*0.974*				
SE	0.958***	*0.816*			
TA	0.626***	0.616***	*0.868*		
TQ	0.504***	0.452***	0.663***	*0.788*	
VR	0.568***	0.598***	0.799***	0.666***	*0.82*

Notes: The diagonal line (italic) is the square root of the AVE of each construct. ***The correlations among constructs are smaller than the square root of the AVE of each construct

Table 3.
Discriminant validity

Structural path to-	*β and p-value* (LS-passive)	*β and p-value* (LS-active)
TQ → SE	−0.402	0.169*
TA → SE	0.841	0.474***

Notes: Significance of estimation; ***$p < 0.01$; *$p < 0.1$

Table 4.
Model comparison test for multi-group structural model

Sense of presence is a major predictor of user perception (e.g. satisfaction, motivation or positive performance) in VR technology-based learning (Weibel and Wissmath, 2011; Yoon *et al.*, 2015). As predicted by the Technology Acceptance Model and Task-Technology Fit, technology should be easy to use, useful and fit the task so that users can enjoy the interaction and experience of using technology to achieve the expected results. Conversely, if a student is overwhelmed with excessive difficulty when using the technology, it will negatively affect their learning process.

Likewise, in the use of VR, a sense of presence can improve learning outcomes only if users are not overwhelmed by exploring VR-based game tasks (Bachen *et al.*, 2016). Learners construct new knowledge with limited working memory. If the learner does not have the ability to explore learning tasks in VR it will cause an increase in cognitive load, which, in turn, has a negative impact on learning (Hsu *et al.*, 2017).

This study used the non-guided VR mode so that users would most likely run into problems of disorientation or getting lost. Efforts to stay-oriented in a virtual environment take up mental resources which will reduce the number of mental resources available for understanding knowledge. When the internal cognitive load (to understand knowledge) is high and the external cognitive load (to explore the virtual environment) is high, the total cognitive load will exceed mental resources which will ultimately have a negative impact on learning (Cooper, 1998).

According to the result of this study, the use of VR has a positive effect on users' perception of technological quality and TA. The virtual experience is able to bring a sense of presence (Yoon *et al.*, 2015), that is, a sense of immersion to describe the intensity of emotional involvement. The sense of presence that arises is an important predictor of users' perception in a VR-based learning environment (Weibel and Wissmath, 2011; Yoon *et al.*, 2015). The ability of VR to present a sense of presence is an important predictor of the various positive responses of users, including the perception of TQ and technology's accessibility.

However, the exploration of a virtual environment will cause disorientation or getting lost. The ability to retain knowledge related to location and orientation is related to users' spatial orientation which is different for each student. Learners must explore a virtual environment to complete learning tasks so it imposes extraneous cognitive load. If the intrinsic and extraneous cognitive load is high, it will reduce the mental resources available to understand the concept of knowledge which causes the possibility of learning failure.

This study also found empirical evidence that the effect of TQ and technology's accessibility on SE is different in active and passive learning style groups. In active learning styles, perceptions of TQ and technology's accessibility have a positive effect on learning outcomes while in passive learning styles it does not. This study supports Chen *et al.* (2005) in that active experimental learners outperformed reflective observation in non-guided VR-based learning. The absence of navigational aids is beneficial for active experimental learners (accommodators) to actively explore a virtual environment to solve the learning problems that arise. On the other hand, for the reflective observation type of learning (assimilator) it will be difficult to explore a virtual environment, thereby increasing the extraneous cognitive load, which, in turn, will have a negative impact on learning outcomes (Hsu *et al.*, 2017).

The results of this study provide practical implications. The practical implication is that VR is a potential learning technology that can be used in the pandemic era. This is a significant finding because the majority of previous studies focused on online course modules or video streaming as a form of distance learning media. Compared to traditional media, the use of VR makes learning more flexible without the constraints of time, distance and space (Yu *et al.*, 2007). VR is able to present a virtual environment so that it is able to provide practical experiences for students without them leaving their homes. Based on these findings, a well-designed VR has a great deal of potential for use as a distance learning medium, by considering students' learning styles. The learning process that adapts to students' learning styles and preferences is a critical success factor of learning (Thompson, 2013).

6. Conclusion

This study found that the interactivity feature of VR is an antecedent of TQ and technology's accessibility and supports the research by Zhang *et al.* (2017). VR creates a highly interactive experience, giving rise to a sense of presence which refers to the user's emotional interaction. Sense of presence is a predictor of user response including technology quality and technology accessibility. The findings of this study also support the interactive media effect theory that states that the media's interactivity feature will affect the learning outcome (Sundar *et al.*, 2015).

In addition, this study also supports ATI research. For active learners, the technology quality increases SE while for passive learners it does not. Likewise, technology accessibility has a significant positive effect on SE on active learners, but not on passive learners.

The limitation of the research sample is the weakness of this study. Data was collected during the pandemic. Actually, VR is a technology that is adaptive to pandemic conditions, but the problem is that not all students have VR box tools in their homes to operate this media. In addition, this study could not compare the effectiveness of VR for the four learning styles because there were only a few students with the characteristics of assimilators and divergers. Future research can be conducted by examining the differences between guided and non-guided VR modes in relation to learning outcomes due to differences in VR mode which can allegedly lead to discrepancies regarding cognitive load.

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Appendix

Figure A1.
Screenshot of the VR condition when the auditor reviews the project

Figure A2.
Screenshot of the VR condition when the auditor enters the audit room

Figure A3. Screenshot of the VR condition when the client offers a bribe

Corresponding author
Ratna Candra Sari can be contacted at: Ratna_candrasari@uny.ac.id