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Direct and Indirect Effects of Virtual Reality Usage Toward Learning Performance Perception: A Case Study of Thai Undergraduate Students

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Abstract

Virtual reality (VR) has been used in diverse industries as a technological tool to improve communication. Many firms use VR to fulfill their purposes. In the educational field, VR technology has been used to improve educational outcomes, and many schools use VR as a learning tool. Previous studies found positive relationship between VR usage and learning experience. However, the details regarding this relationship are still unknown. The current study aims to find the direct and indirect benefits of familiarity with VR usage and the moderation effect of perception of VR as a learning tool. There were 431 respondents from undergraduates in two universities in Thailand that provided data through online questionnaires, using the multi-stage cluster random sampling method. The moderated mediator regression analysis was used to analyze the mechanism regarding the direct and indirect effects of VR usage. The empirical results show that familiarity with VR usage has both direct and indirect effects on learning performance in a positive way. Moreover, perception of VR usage as a learning tool acts as a moderator that increases the effect of VR usage as well as learning performance. The conclusion and limitations of this study are also discussed.

Keywords

Virtual reality (VR), VR usage, Learning performance, Indirect effect, Moderated mediator.

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Introduction

The concept of Virtual Reality (VR) is widespread nowadays since it is expected to provide a better experience in human communication (Cipresso, Giglioli, Raya & Riva, 2018). Immersive environment from VR technology has been used in various contexts, both in concrete and abstract ways such as VR witness (Nash, 2018) and virtual religion (Tomaselli, 2015). Business firms use both VR and AR (augmented reality) to enhance the online shopping experience for their customers (Porter & Heppelmann, 2017), providing engagement of human senses and improvement of shopping efficiency (Van Kerrebroeck, Brengman & Willems, 2017). In the sport industry, VR usage has also prevailed, although there are higher expectations for quality services and experiences (Ko, Zhang, Cattani & Pastore, 2011). In addition, marketers use VR technology to create brand awareness and engagement through developed technology like stereoscopic 3-D display (Yim, Abdourazakou, Sauer & Park, 2017). VR technology has potential, providing an immersive experience that allows the users to have realistic interaction with the environments and objects (Dede, 2009).

In the educational field, many levels of school incorporate VR technology as their learning tool (Chang, Zhang & Jin, 2016). VR is broadly used to improve the process of studying. For example, Domingo & Bradley (2017) found that using VR can provide a better learning experience. Alfalah (2018) also found that virtual reality leads to a more attractive educational process. A number of schools and new education systems have already used VR as one of their learning tools since VR is gaining attention for having the potential to enrich student's educational experiences (Makransky, Guido, Petersen & Gustav Bog, 2019). VR is not only useful for studying in the classroom, but also in practical training. The benefits of using VR in training include the capability of repeating simulations (de Visser et al., 2011) and studying behavior under situations that are not feasible (Kinateder et al., 2014).

Previous studies found a positive relationship between VR usage and learning results in school as well as using VR as a learning tool as aforementioned. However, those subjects that used VR complementally are solely some specific or practical classes, for instance, VR/AR in design education (Chandrasekera & Yoon, 2018), military, fashion, health care and engineering (McLellan, 2001), VR documentary or non-fiction storytelling (Kool, 2016), science education (Setareh, Bowman, Kalita, Gracey & Lucas, 2005) or even using VR in training with firefighters (Narciso, Melo, Raposo, Cunha & Bessa, 2019).

These examples show the potential of VR/AR technology used to motivate the student to become an active learner (Saidin, Abd Halim & Yahaya, 2015). Additionally, learning outcomes can be improved by several tools. For example, Enterprise Resource Planing (ERP) is used to support management learning performance for individual college students (Costa, Aparicio & Raposo, 2020). Game-based learning used in a Mathematics course indicated significantly stronger improvement from the regular system (Chen & Chang, 2020). Educational technology replacing traditional equipment improves student learning, but students need to develop competencies in usage of technology to thrive in competitive global economies, which would be derived from technology and innovation in education (Schleicher, 2015).

VR has been used to improve learning performance both inside and outside school for quite a while, and it directly affects the experience of learners. In particular, learning performance is measured by numerical measurements such as scores, GPA, or percentage points, which are standards to measure the final result of studying. In contrast, the learning process has not widely gotten much attention. Using VR can change the learning process of users, which could affect learning experiences. Nonetheless, to the best of our knowledge, direct and indirect effects of VR usage to learning performance are not well studied. Thus, in order to deepen our understanding about the mechanism and mediation role of VR usage to learning performance, this research was conducted on a basis of direct effect, indirect effect, and moderator analysis.

Theoretical Background

The occurrence and exponential dispersion of the internet are considered as a big shift of the communicative world from traditional face-to-face to online mode. Computer-mediated communication (CMC) was firstly used in text messaging via computer (Walther, 1992). Educational institutes started expanding their learning system from physical classroom to wider boundaries (Misanchuk, 1994), and CMC supplemented this process by initiating distant and online education.

Social presence theory states that the medium in communication changes the levels of communication experience (Short, Williams & Christie, 1976), and face-to-face has the highest level of presence while CMC has relatively lower. Social presence theory is found to be a very important factor to predict audience satisfaction in CMC (Gunawardena & Zittle, 1997). It is undeniable that these two theories are parts of each other. Social presence

theory focuses on the perception of reality or objects in the message, while CMC focuses on media of communication, providing different degrees of efficiency and effectiveness. For instance, Richardson and Swan (2003) revealed that perception in social presence theory has impacted the overall perceived learning. In contrast, Lowenthal (2009) mentioned that media in communication, such as machine-mediated equipment in online learning, changes the degree of presence and plays a very important role in how people socially interact in online learning environments.

The objective of this research is to comprehend how VR, as a form of media in communication, plays a role in the learning process. CMC and social presence theory are used as the basis to explain how VR usage, which is considered as machine-mediated, and perception of VR, acting as learning tool and as moderator or supporter of social presence, create learning mechanism and affect learning experience. The following parts show mediation, moderation, and regression analysis on the basis of CMC and Social presence theory.

Mediation role of familiarity with VR usage

Although previous studies found that VR is positively related to learning outcomes and experiences, the mechanisms of improving learning are still unknown. Students who own VR headsets are reported to have statistically significant better learning perception and experience compared to those without VR headsets, but other direct and indirect effects of VR usage have to be tested to understand the mechanism (Tirasawasdichai & Pookayaporn, 2019). Familiarity with technological equipment increases learning skills for students in this era. Olszewski and Crompton (2020) mentioned that mobile application usage positively and significantly predicted the exhibition of digital age learning contexts. The young users of technology perceived that media gadgets are multitasking and seldom notice the degradation of productivity (Sun & Zhong, 2020). Simulation of VR provides a more realistic environment for participants so that they can fully experience and engage in the simulated situation. For example, the virtual environment in firefighter training creates involvement and realistic experience for users (Narciso, Melo, Raposo, Cunha & Bessa, 2019). In addition, Pizzi, Scarpi, Pichierri and Vannucci (2019) found that customers in VR-based retail stores perceived better satisfaction experience while shopping. How to design VR content is also crucial as it could help users to better understand and achieve the highest quality of VR usage (McRoberts, 2017).

Moderation role of perception of VR as learning tool

Kim, Lee and Preis (2020) found that technological readiness plays an important role in incentivizing individuals to use technology as a moderator, and technologies also help people accomplish their goals (Parasuraman, 2000). People tend to feel socially empowered through interactivities with other users. Hilken, Keeling, de Ruyter, Mahr and Chylinski, (2019) mentioned that using AR in the marketplace increases the likelihood of incorporating a recommendation into their choice. In addition, the study of Setareh, Bowman, Kalita, Gracey & Lucas (2005) found that the instructor in science felt the class was more interactive with VR usage, and the students also found that this VR technology provided effective outcomes in learning. Interactivity was not only found among users, but was also found between users and virtual objects or environments. For instance, using AR/VR in learning design can achieve tangible interaction with virtual objects, which are useful for the creative design process (Chandrasekera & Yoon, 2018), or using VR in sport consumption enhances telepresence of viewers through interactivity with the game (Kim & Ko, 2019). Sense of presence and immersive experience via VR are the potential of VR technology that connects and involves users with simulated environment. Yim, Abdourazakou, Sauer & Park (2017) studied memory of brand placement, comparing between 3-D and 2-D sport games, and the result illustrated that the dimensional effect of 3-D prevented the disruption in viewers' attention as viewers pay attention to the game or it could be the negative side effect of media. In a virtual learning environment, learners are faced with the content of study directly without competitors, and learners become more patient with completing hard work. Besides, they were fully engaged when undertaking the tasks with high flow experience (Chen & Chang, 2020). The educational experiences were generated from mental status, which can be considered from the increase of motivation, attention concentration, and satisfaction (Belleza, Caggiano, Gonzalez-Bernal, De La Fuente Anuncibay & Sedano Franco, 2017).

Regression analysis

Muller, Judd, and Yzerbyt (2005) provided clarity and a definition of moderated mediation which is used to test moderator and mediator effect along with treatment in this research study. The regression equations are as follows:

First, the moderation effect on dependent variable would be analyzed by the regression equation below: β_1 indicated the influence of learning incentives, β_2 indicated

the influence of perception of VR as a learning tool, and β_3 indicated the interaction term of learning incentives and perception of VR as a learning tool, in other words, the moderation effect of perception of VR as a learning tool on learning incentives to learning performance perception.

$$Lperform_i = \beta_0 + \beta_1 Lincen_i + \beta_2 PercepVR_i + \beta_3 Lincen * PercepVR_i + \varepsilon_i$$

Next, the moderation effect on mediator variable would be analyzed by a different regression equation as shown below. All betas still indicated the same coefficient as the previous equation. Only the dependent variable of this equation, which was mediator variable in overall analysis, was calculated.

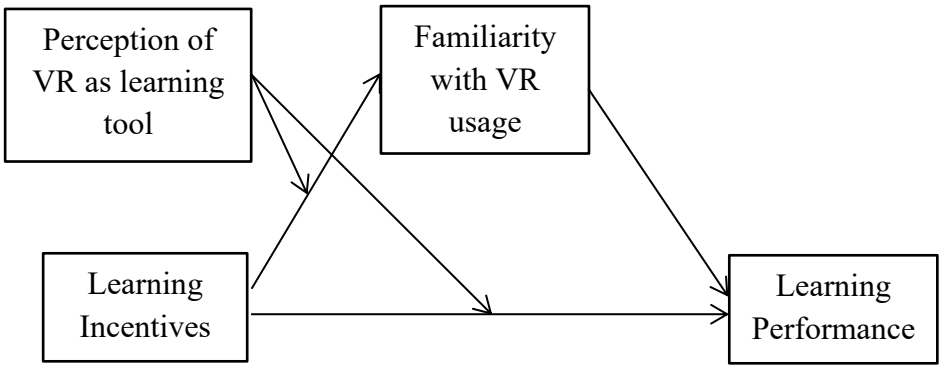
$$FamiliarVR_i = \beta_0 + \beta_1 Lincen_i + \beta_2 PercepVR_i + \beta_3 Lincen * PercepVR_i + \varepsilon_i$$

Finally, the analysis of mediator variable would be analyzed by the following equation. This regression equation indicated moderated mediator, VR usage, or machine-mediated from CMC background, in which β_1 indicated the influence of learning incentives, β_2 indicated the influence of perception of VR as a learning tool, β_3 indicated the moderator effect of perception of VR as a learning tool, β_4 indicated mediator effect, and β_5 indicated moderated mediator effect on dependent variable.

$$Lperform_i = \beta_0 + \beta_1 Lincen_i + \beta_2 PercepVR_i + \beta_3 Lincen * PercepVR_i + \beta_4 FamiliarVR_i + \beta_5 FamiliarVR * PercepVR_i + \varepsilon_i$$

Regression equations bring us to the conceptual framework of this research study, showing learning performance perception as the dependent variable, learning incentives as the independent variable, VR ownership as mediator, and perception of VR as learning tool as moderator.

Figure 1: Conceptual Framework



Data and Samples

The population of this research study was undergraduate students in Thailand. In order to estimate the value of the population, we used the multi-stage cluster sampling method to recruit our samples from more than 100 universities across the country. We selected 2 universities in Thailand in the first stage, which are Sripatum University, located in Bangkok, and Kasetsart University, located in Sakonnakhon, which is in the northeast region of Thailand. Then, we randomly selected one faculty from each university. We got International College and Business Administration from Sripratum University and Kasetsart University respectively, and this was the second stage of our sampling frame. Lastly, we randomly selected the participants from the student name list provided from the faculty as the last stage of sampling.

The total sample size is 431 participants from these universities. On average, the ages of the participants are between 18-23. A small percentage of participants is over 24 because some participants are older or may start school late.

Method and Measurement

This research study used an online questionnaire in Google Forms to collect data from undergraduate students. The questions were designed to measure variables included in the model by 5-level Likert scale questions. The scale ranged from 1 to 5, where 5 means very likely to, 4 means likely to, 3 means neutral, 2 means not likely to, and 1 means not very likely to.

All variables consisted of 5-item questions. Learning Incentives as independent variable measured: demand for good GPA, reviewing content, preparing for next class, attention in class, and class participation. Familiarity with VR usage as mediator measured: knowledge about VR, functions in VR, types of VR, applications of VR, and VR usage understanding. Perception of VR as learning tool as moderator measured: VR improve memory, VR setting phenomenon, VR learning activities, VR content consumption, and VR attractive for learning. Then, Learning Performance Perception as dependent variable measured: class satisfaction, content understanding, teacher's feedback satisfaction, learning adaption, and class participation.

The Cronbach's Alpha showed high value of reliability test in all variables: 0.967 for familiarity of VR usage, 0.957 for perception of VR as learning tool, 0.926 for learning incentives, and 0.925 for learning performance respectively.

Empirical results

In this section, the empirical study is discussed by using those equations from the previous section to test the significance of familiarity with VR usage as mediator and perception of VR as learning tool as moderator. Based on results, we believe that VR can be a powerful communication equipment, which can increase the effectiveness and efficiency of communication. Thus, we have to analyze the collected data from questionnaires to empirical findings.

Table 1

Regression Analysis for Mediator

Predictors	*ß*	*F/t*	*p*	R^2
Overall Model		75.2613	.0000	.346
(Constant)	3.1657***	3.8428	.0001	
Learning Incentives (A)	-.9575***	-4.2544	.0000	
Perception of VR as learning tool (B)	-.0360	-.1587	.8740	
(A)×(B)	.2204***	3.7349	.0002	

Note. N=431. Outcome variable is Familiarity with VR usage. Overall Model uses F. Variables use t. *p<0.05. **p<0.01. ***p<0.001.

Table 1 shows the regression analysis for mediation or mediator variable in this research study, which is familiarity of VR usage. Since we believe that familiarity with this equipment in each person will affect the learning process and social presence, a VR headset could be a medium in communication, affecting the quality and effectiveness of communication. According to the result in table 1 for overall mediator analysis regression model, we can see that the F value is very high and the p-value is significant at 0.001 level (F=75.2613, p-value=0.0000), showing that the mediation analysis is significant. The R-square value in table 1 can explain to the mediator about 34.6% ($R^2 = .346$)

The independent variable, which is learning incentives, is negatively related to the mediator variable, which is familiarity with VR usage, at the 0.001 significant level, showing significance (*ß* = -0.9575, t= -4.2544, p-value= 0.0000). In contrast, the moderator term or the perception of VR as a learning tool is not significant with mediator variable at 0.1 or 0.05 significant level (*ß* = -0.0360, t= -0.1587, p-value= 0.8740). This value depicts that perception of VR as a learning tool is not related to familiarity with VR usage. In other words, we can easily understand that a person may want or look forward to using a VR

headset as a learning tool or it may attract one to be more interested in studying, but that person does not need to be familiar with VR headset use. One very interesting point is the interaction term of moderator and independent variables, which have shown that the direction of learning incentives to familiarity with VR usage is influenced by the moderator variable, which is the perception of VR as a learning tool. The direction of interaction term is positive with 0.001 significant level (β = 0.2204, t= 3.7349, p-value= 0.0002). The interaction term is shown by multiplying the learning incentive and perception of VR as a learning tool or (A)×(B) in table 1. We can interpret this value as follows: the perception of VR as a learning tool improves learning quality, such as when a person's interest in studying is increased, which also affects the familiarity with VR usage, or a person can be more specialized in using a VR headset when they are attracted by the VR headset in their studying.

Results in table 1 conclude that when students perceive VR as a learning tool, they would be more attracted to studying. The interaction term shows the moderator effect, which means that familiarity with VR usage is influenced by perception of VR as a learning tool to be positively related with learning incentives. The interaction between learning incentives and the perception of VR as a learning tool indicates positive effect to the familiarity of VR usage, showing that there is a moderation effect supporting learning incentive with familiarity of VR usage. In other words, when students perceive VR headsets as one of their learning tools and use their headsets in their class, they are more attracted to and more interested in studying.

Table 2

Regression Analysis for Dependent Variable

Predictors	β	*F/t*	*p*	R^2
Overall Model		34.2533	.0000	.2434
(Constant)	.5788	1.2443	.2141	
Learning Incentives (A)	.6545***	5.1309	.0000	
Familiarity with VR usage	.0939***	3.4957	.0005	
Perception of VR as learning tool (B)	.4326***	3.4355	.0006	
(A)×(B)	-.1064**	-3.1959	.0015	

Note. N=431. Outcome variable is Learning performance perception. Overall Model uses F. Variables use t. *p<0.05. **p<0.01. ***p<0.001.

Table 2 shows the regression analysis for the dependent variable, which is learning performance perception, with the mediator variable, which is familiarity with VR usage, and the moderator effect from perception of VR as a learning tool. According to table 2, we can first look at the overall model value to see whether the overall regression model is significant or not. The overall model has high F-value and statistically significant at 0.01 level (F=34.2533, p-value=0.0000), and the r-square in this model could explain the outcome variable, showing learning performance perception about 24.34% ($R^2 = .2434$).

Next, we can see that learning incentives is statistically significant at 0.01 level and also positively related with learning performance perception (β = 0.6545, t= 5.1309, p-value= 0.0000), which is expected. The mediator variable, VR usage, is positively related to the dependent variable, learning performance perception (β = 0.0939, t= 3.4957, p-value= 0.0005) at 0.01 significant level, and the moderation effect is positive to mediator as shown in table 1. Consequently, we can see that there are direct effects of learning incentives on learning performance and indirect effects of learning incentive via familiarity of VR usage on learning performance perception. We realize that there is a mediation effect by comparing the results of table 1 and table 2 at the independent variable change. From table 1, the coefficient value of learning incentives on familiarity of VR usage is negative, but when we include both variables into the same regression model, learning incentive and familiarity with VR usage are positive. This means the familiarity with VR is a mediator as it has positive effect on learning performance. Another variable is perception of VR as a learning tool, which is positively related to learning performance perception at 0.001 significant level (β = 0.4326, t= 3.4355, p-value= 0.0006). This value shows that if a person perceives VR as a learning tool, they could understand their studying better, with better performance than normal.

The interaction term in this regression is the moderator effect of perception of VR as a learning tool. The interaction term is negatively related to learning performance perception at 0.01 significant level (β = -0.1064, t= -3.1959, p-value= 0.0015). According to the results in table 2, the negative result indicates that perception of VR as a learning tool prevents the effect of learning incentives on learning performance. In contrast to previous studies, which found that VR provides and promotes learning improvement to students, the moderator term in this study is supposed to be positive rather than negative. The reason for this inconsistency is likely because the perception of VR as a learning tool affects only the middle level of learning incentives. In other words, students who have high level of learning incentive do not need to be attracted by VR since they already have high

motivation, focusing more on learning than using attractive equipment for their study, which we can see in table 3, the direct and indirect effects of mediator.

Table 3

Direct and Indirect Effect Results

Conditional Direct Effect				
	Effect	*SE*	*Lower CI*	*Upper CI*
3.0000	.3353	.0402	.2562	.4144
4.0000	.2289	.0342	.1617	.2961
4.6000	.1650	.0443	.0779	.2521
Indirect Effect				
3.0000	-.0278	.0110	-.0534	-.0095
4.0000	-.0071	.0067	-.0229	.0034
4.6000	.0053	.0092	-.0135	.0242

Note. Indirect Effect: Learning incentives→ Familiarity with VR usage→ Learning performance perception. Indirect Effect is testing mediator variable. The confidence interval is 95%.

Familiarity with VR usage as mediator along with indirect effect to learning performance and perception of VR as a learning tool as moderator could be considered as social presence and machine-mediated on the basis of CMC and social presence. VR headset as machine-medium of communication, of course, affects the quality of communication, and perception of VR as a learning tool is perceived as presence in communication.

According to table 3, we can see the results of direct and indirect effects of independent variable to dependent variable and another effect via mediator variable. To test the significance and existence of mediator variable, familiarity of VR usage, the first process is using regression analysis to see the significance of each variable. There are pathways from independent variable to mediator variable and another path from mediator variable to dependent variable. Another process to prove the effect of mediator variable is the bootstrapping method (MacKinnon, Lockwood, & Williams, 2004; Preacher & Hayes, 2004), which is used to test direct and indirect effects. In this research study, mediator analysis was tested by the 95% confidence interval of indirect effect with 1000 bootstrap resamples (Preacher & Hayes, 2008). The results of the mediation effect could be found in table 3, and the direct effect of learning incentives to learning performance perception are

found in many levels of moderator, showing that there is strong directional effect from independent variable to dependent variable. Regarding the indirect effect, which is analyzed by mediating the role of mediator variable to dependent variable, it is also confirmed the mediation effect of mediator. However, this finding can be confirmed only in the middle level of perception of VR as a learning tool (*β*= -.0278, CI= -.0534 to -.0095), which is mentioned previously that perception of VR as a learning tool might benefit only those who reported middle level of learning incentives. In addition to that, we can see from table 1 and table 2 that familiarity with VR usage has partial mediation effect to learning performance perception because the variables in both tables are significant, suggesting the partial effect of mediator variable.

We can see that learning incentives as independent variable directly affects learning performance in a positive way as well as indirectly via familiarity with VR usage as mediator. It illustrates that VR usage plays a crucial role in the learning process among respondents. Moreover, familiarity with VR usage is also moderated by perception of VR as a learning tool, especially in those who report middle level of learning incentives, depicted by negative interaction term. Meanwhile, the upper level of mediator may not be affected by moderation effect the same way we see in the middle level. Besides, we can also notice that the size of effect or coefficient value is very small, which is possible since at the upper level, familiarity with VR usage has less influence on learning outcome.

Table 4

Moderated Mediation

Index of Moderated Mediation				
	Index	*BootSE*	*Lower CI*	*Upper CI*
Perception of VR as learning tool	.0207	.0094	.0055	.0416

Note. Testing the moderator effect on mediator variable or whether the mediator is moderated or not. The confidence interval is 95%.

Table 4 shows the index of moderated mediation in order to see an overview picture whether the moderation effects mediator variable or not. As we have mentioned previously that the moderator influences mediator and independent variable differently at different levels, there are some effects in the middle level. Thus, we can see that the moderation has influenced the mediation and independent variable in the overview picture of analysis. The result in table 4 confirms that perception of VR as a learning tool is a moderator that affects

mediator, or the mediator is affected by the moderator variable at the confidential interval that does not include zero value with in the range. As a result, we conclude that there is moderation effect at 95% confidence interval for perception of VR as a learning tool to familiarity with VR usage.

Table 5

Contrast Between Conditional Indirect Effect

Effect1	*Effect2*	*Contrast*	*Lower CI*	*Upper CI*
-.0071	-.0278	.0207	.0055	.0416
.0053	-.0278	.0331	.0088	.0666
.0053	-.0071	.0124	.0033	.0250

Note. Pairwise contrast between conditional indirect effect is effect1-effect2 or the contrast of moderator in direct and indirect effects. The confidence interval is 95%.

Table 5 shows contrast between conditional indirect effect, or the contrast of effect of moderator to mediator, and effect of moderator to independent variable. We can see that perception of VR as a learning tool has affected both learning incentives and familiarity with VR usage. Since the moderator can affect both mediator and independent variable simultaneously, the analysis of contrast could help us understand the difference of moderation effect between conditional direct effect and indirect effect.

According to table 5, we can see that perception of VR as a learning tool, which acts as a moderator, affects two variables differently. In the previous section, the regression analyses of interaction terms show that both mediator and dependent variables are affected by the moderator because the interaction terms are significant. The results in table 5 show the difference of moderation effect in two analyses: one is moderator effect to mediator, and another is moderator effect to dependent variable. Because there is a contrast among effect 1 and effect 2 or a contrast between direct and indirect effects, we can see that there are moderated mediation and direct effect. The confidential interval from the result table confirms that there are moderated mediation and moderated direct effect in this research study.

Conclusions

This research study aims to find the moderation and mediation effect of VR usage toward learning performance perception using survey data from undergraduate students in Thailand. In agreement with our hypothesis, VR headset is a new technology that can be a

powerful tool in education because VR can make students acknowledge learning material better in visualization, which can improve their understanding of content. Also, as a medium of communication, VR can improve the quality and effectiveness of communication as well as increase the social presence of people in communication. Consequently, having familiarity with VR usage can be a good factor to better understand a medium of communication. In other words, this study helps us deepen our understanding of social presence theory and computer-mediated communication (CMC). We find that the familiarity with VR usage can be the mediator effect of learning incentives on learning performance perception, suggesting the indirect effect that makes students perceive their learning performance in progressive experience. This can be because if one gets familiar with a VR headset, they can adapt it with their business, not only in studying but also in any other issues where VR technology will help them understand better. Particularly, in the middle level of learning incentive respondents or those who show relatively lower incentives than others, VR can become a powerful learning tool in attracting general students to pay attention to study.

In summary, we find that VR usage plays an important role in the student learning process. First of all, VR usage as machine-mediated equipment provides a better outcome of communication, and it makes studying in class easier. Secondly, used as a learning tool, VR can bring excitement to the learning process and to studying. VR technology can make students feel fascinated, create motivation in learning, especially in general students with middle level of learning incentive. Next, this research study deepens our knowledge about CMC and social presence theory that VR as media can create effective and efficient communication, including perception of presence via its features. In the era of rapid technological development, VR usage is especially important for distance education. Finally, this research is useful for both education and communication authorities in future research and development.

Discussions and Limitations

Although the interaction terms in table 1 and table 2 have shown the negative sign, which means the perception of VR as a learning tool affects learning performance perception in a negative way or it prevents learning incentives to learning performance, as mentioned previously, students with high incentive are not affected by moderator. The negative sign shows that VR usage supports general students with middle level of learning incentive.

This result is consistent with the study of Oberdörfer and Latoschik (2019) arguing that VR cannot be used to compare the virtual environment of game training directly since during VR usage, it can create discomfort to both body and mind of users (Merchant et al., 2012). Additionally, VR usage can create other psychological problems like dissociation, disorientation, and hallucination (Costello, 1997). The poor instructional design of learning environment of VR is also considered in several cases (Chen, Toh and Ismail, 2005). Even former CMC studies such as Seagren and Watwood (1996) mentioned that with a computer, there is wider information and opportunity to learn, but without interaction, learning is not enhanced.

Nevertheless, other result tables still confirm the positive moderation and mediation effects, illustrating that VR usage supports learning experience and learning process. For example, Dimitropoulos, Manitsaris and Mavridis (2008) found that VR creates a collaborative environment, encouraging students to share and exchange their ideas, which they can gain knowledge from during the learning process. Furthermore, cooperative learning can support learner's adaptability in different situations (Pan et al., 2006). The moderation effect found in this research study is the one that deepens our understanding regarding the medium of communication with application in studying issue. Although the indirect effect does not affect all levels of perception of VR as a learning tool, VR still provides a lot of opportunities in education to support the teaching and learning process (Alshammari, 2019).

The limitations of this research study are in the measurement. First, the data collection of this research study uses a questionnaire, which mostly asks about the feeling of respondents in a 5 level Likert scale. Since each respondent is allowed to choose their own answer, the data is subjective and can be difficult to measure regarding what should be called familiar or not familiar or neutral. Also, the dependent variable is learning performance perception, which we again allow each respondent to choose the answer subjectively. It is possible that each student can have a different degree of performance perception or satisfaction, which can affect the data and analysis.

In further research, the measurement of variable can be more accurate, especially those related to the VR headset part, since we want to deepen our understanding regarding the effect of this technology on learning outcomes. Although many previous studies used experimental research, which could get a better measurement, this research study used questionnaires. Even though the measurement in this study is not as good as experimental

research, we can at least obtain the fundamental concept of how students think about this topic, which can help us design a better study in the future.

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