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A Model for the Acceptance of Immersive Learning Through Virtual Reality Games

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Abstract

In the world of technology and information, schools must adapt and update their learning approach to interest learners by replacing the customary learning methods. For this reason, many schools are interested in learning through gaming. This research studies the factors affecting the technology acceptance model (TAM) through virtual reality game-based learning for high school students in Thailand. The sample group consists of 1,004 students nationwide, with a questionnaire used to collect data and structural equation modeling applied for analysis. The research results show that students are interested in learning through virtual reality games, based on their motivation to learn, behavior imitations, creative practices, and innovation tryouts. Schools successfully and appropriately adapted the teaching approach by applying these factors to improve the learning efficiency of students.

Keywords: Technology Acceptance, Education, Students, Virtual Reality (VR), Makerspace, Game-Based Learning.

Introduction

The implementation of technology in teaching and learning is currently receiving significant attention. One of the concepts for promoting entertainment to improve the learning and interests of the learner is game-based activities. (Taub et al., 2020). The application of technology in teaching and learning, particularly involving digital games, motivates the learner and promotes efficient learning. (Sun et al., 2018) The concept of digital transformation in the educational system comes in the form of new instructional models, such as online coaching, e-learning, or self-directed learning. In particular, the Covid-19 pandemic is having an extensive impact on schools worldwide, and the instructional approach needs to swiftly change. Most teachers agree that gaming in educational innovation can motivate students effectively, enabling them to integrate it into the learning process for goal achievement. Furthermore, it is an entertainment activity that can be used in the classroom. (Grambs, Carr and Fitch, 1970) The constructionism theory by Saymour Papert explains that helping children to construct their experience promotes novel thinking. (Seymour Papert, 1999). The teacher advises the learner to study what they are pleased and interested in to establish efficient and meaningful learning in the appropriate environment where the learners

discuss, share experiences, and develop ideas accordingly.

In the context of Thailand, a gap exists between theory and practice. Significant funding is required to create the necessary makerspace for practice based on the theory. For this reason, the development of tools is required to connect theory and practice. Consequently, gaming can be used as the link between the theory and practice to suit the Thai context to develop the students' experiences in the use of tools and processes to invent new things within the makerspace.

THEORETICAL BACKGROUND

The relevant theories and concepts of learning and intellectual and cognitive development, in this research, are based on Seymour Papert's constructionism, helping the learner to link experiences with knowledge. The theory explains that the highest form of efficient learning relates to liking a subject, taking action, and conducting unlimited self-research and experiments based on understanding and experience of learners at the appropriate age. A makerspace should involve activities classified by age group to promote optimal development potential. (Sun, et.al., 2018)

Constructivism, as proposed by Jean Piaget, is based on how the learner integrates new knowledge and/or experience with existing knowledge and/or experience, considered as the interpretation of new knowledge. As a result, new knowledge is constructed. The process of this theory begins when the learner constructs knowledge from problem-solving and develops it with the appropriate understanding and experience at each stage. The goal at school is to achieve instructional management by supporting the new knowledge constructed by the learner rather than knowledge transfer from the teacher. Meanwhile, the teacher responds to the learner's demands promptly in a comfortable atmosphere, allowing them to try out the knowledge gained and develop their brain. The teacher determines which area of the brain is appropriate for development according to the learner's age group. Moreover, the theory explains that if the learner recognizes the significance of makerspace and can integrate the experience to create new knowledge, this is an opportunity for the makerspace to become a site for developing skills and the thinking process. The accumulated knowledge helps to build confidence in the learner to create more new things. (Taub, et.al., 2020)

Constructivist theory is proposed by Jerome S. Bruner who believes that child intelligence arises from the mental process of self-learning based on lifelong learning. The development at each age level depends on the environment and culture of the learner. Moreover, such development determines the knowledge and instruction method. This theory proposes that child development at each age level relies on the environment and culture experienced by the individual learner. Since the development of the learner shapes their knowledge and the instruction method, the teacher should build motivation at school and set the appropriate learning structure and sequence so that the difficulty matches the age of the learner, and promotes self-reinforcement. In summary, the learner's development at each age level depends on their environment, which in turn, influences learner behavior.

Sociocultural theory, presented by Lev Vygotsky, proposes that the essential intellectual tool for development is society and culture, and an adult acts as a medium for the intellectual development of the child. Additionally, he believes that the child can develop among the organized community and implement the appropriate technology for forming connections. At school, the teacher should give advice and encourage the learner to work and form ideas during the learning process. In short, the perceptions of learners raised in different societies will vary, which is similar to constructivist theory. (Tri, et.al., 2019)

Regarding human needs, it has been suggested that the key factors of human motivation determine the goals to correspond with the individual or group. Motivation urges a person to take action. It may arise from basic needs, drives or desires, incentives, expectancy, or goal-setting, ultimately leading to goal

achievement. Relevant motivation theories in this research include McClelland's motivation theory, which states that every individual is motivated by either the need for achievement or affiliation. Therefore, the school should plan appropriate activities for each type of learner. Some want to obtain the top score while others want to be loved by friends and teachers. In conclusion, the theory explains that each learner has different challenges and motivations, and adaptation is crucial for developing activities in the makerspace based on learner needs (student-centered) to enable them to gain the desired experience and reinforce their behavior to achieve individual goals. (Tufekci, et.al., 2015)

The application of game theory has been the subject of extensive study. However, its implementation in education is different; the key objective of game theory is to allow the learner to learn. Nevertheless, learning cannot be achieved by the use of game theory only, other theories need to be applied simultaneously, such as perception theory, communication theory, educational psychology, and learning psychology. (Tufekci et al., 2015). The theory of meaningful verbal learning by David P. Ausubel can be classified into the same category as cognitivism and represents the connection between concepts and long-term memory. The challenge is to integrate existing knowledge with new knowledge. Game-based learning should have a clear mission and goal to enable the learner to understand and acknowledge the guidelines for connecting it with existing knowledge. The concept of game development for educational benefit involves the use of psychological principles to build or manage learning experiences through gaming. It proposes that humans will earn and change behavior meaningfully during or after playing a game regardless of whether there is an alternative way of playing; they only focus on the results. Game-based learning is applied to instructional management. (Grambs, Carr, and Fitch, 1970) state that gaming is an educational innovation that most teachers agree can effectively motivate students. Teachers can use games to help students achieve their goals and keep the class entertained.

Technology acceptance model from a review of relevant concepts and theories on the acceptance of innovation and technology, the concept of the technology acceptance model (TAM) by Davis (1989) is considered to be the most appropriate for this research. The variation in decisions relates to the intention to use while attitude explains the intention of an individual to use technology. If the user recognizes and perceives usefulness (perceived usefulness) in terms of greater working efficiency and simplicity (ease of use), a positive attitude (attitude toward using) arises which affects the intention of the user toward the technology (behavioral intention) acceptance (actual system use).

Overview of game-based learning. Game-based learning (GBL) is a novel innovation in learning media, using the content creation process and rules of the game to promote learner development and skills by practicing certain techniques, and subsequently applying the discussion method. At this point, the psychological principle is adapted to create or set the learning experience of the learner through gaming based on the belief that humans will change their behavior or have meaningful learning during or after playing the game without thinking about the options or how to play it. They only focus on the results.

RESEARCH MODEL

The researcher created the conceptual framework in this study based on relevant documents, textbooks, and research demonstrating the correlation between perceived usefulness and ease of use when learning the innovation. Four factors are involved as shown in figure 1.

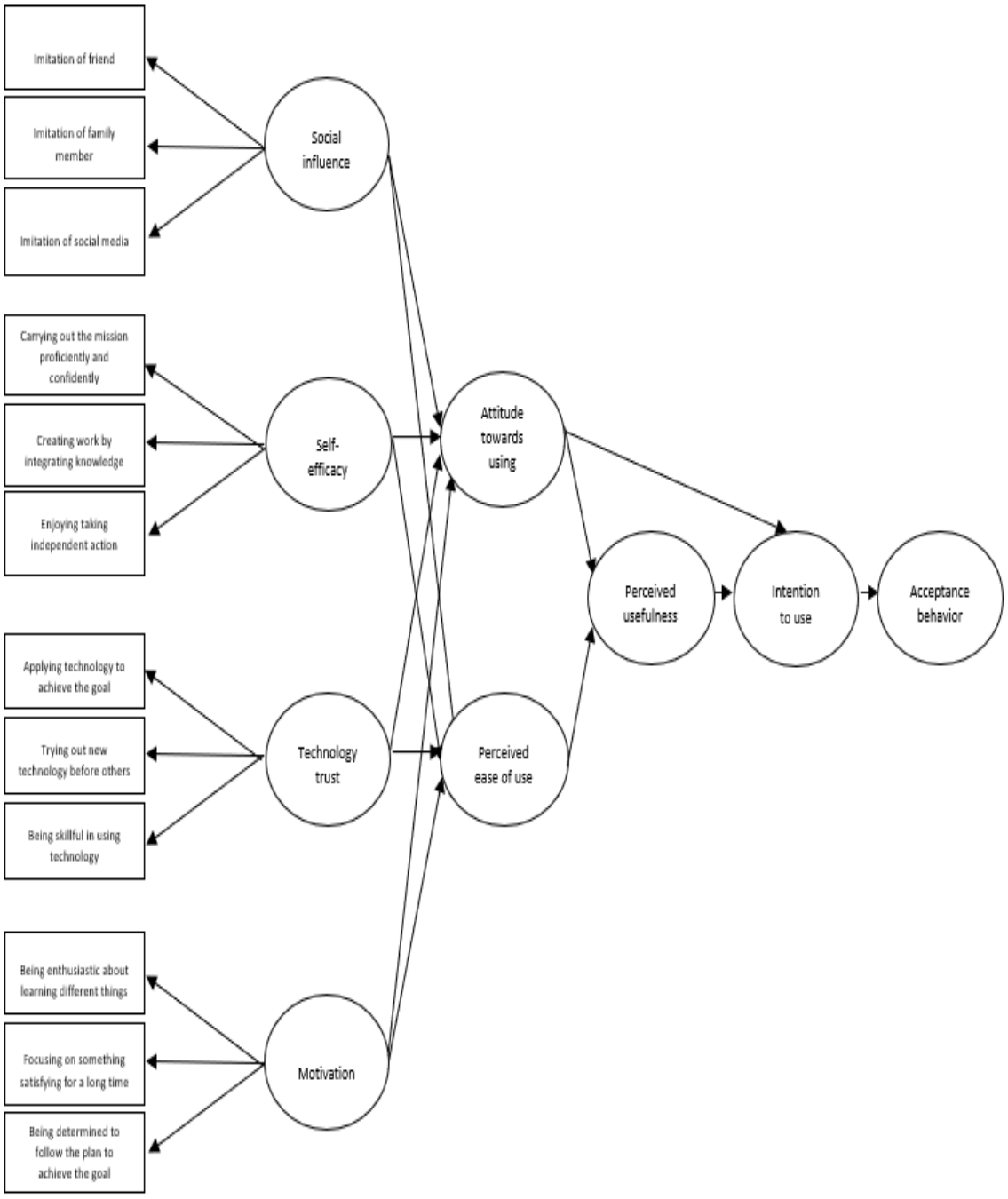


Fig. 1 Conceptual framework

Social influence is exhibited when a person is confident in the information received from another they relate to well in their daily life and decides to follow the information they believe to be useful. It is in line with the constructivist theory (Bruner, 1966) which refers to child development at each age level and depends on the environment of an individual. It is partially influenced by learner behavior. Moreover, the relevant research results indicate compliance with what people have observed in the online society. (Arjo, Yulius and Nasrullah, 2019)

Self-efficacy, A person recognizes their own efficacy because they have the belief and determination to accomplish the desired goal. If

such accomplishment requires efficacy, the person will feel confident in performing such a mission. Self-efficacy relates to constructionism theory but connects the experience to existing knowledge to form new knowledge (Seymour Papert, 1996). Knowledge is not only constructed from teaching but also the action of the learner (Jean Piaget, 1936).

Technology trust, Technology implementation in teaching and learning facilitates the learner in achieving the expected outcome (Hamari, Koivisto, and Sarsa, 2014). A review of the relevant research reveals that a personal interested in technology affects the perceived usefulness of the innovation. If a person has previous experience of using technology, they will be more confident about trying new technology before others, as presented by Rogers (1962) in a study on the diffusion of innovation.

Motivation, it is accepted that educational innovation is a new learning activity for effectively motivating students (Grambs, Carr, and Fitch, 1970). Teachers can apply games to achieve the desired goal and entertain the class. Furthermore, if the game appropriately challenges the skills of the learner, they are likely to enjoy the class rather than focus on how much time has passed, according to the principle of flow proposed by Mihály Csíkszentmihályi, which is consistent with use of games for motivation purposes. The relevant studies reveal that game-based learning increases motivation and intellectual success. Accordingly, perceived usefulness, ease of use, attitude towards using, and behavioral intention to use, are likely to affect the behavior of technology users toward actual system use in the future based on the concept of TAM (Davis, 1998).

RESEARCH METHODOLOGY

Instrument development and validation, the size of the sample group in this study is based on the concept of Hair et al. (1998) who proposed the minimum criterion to determine the sample size for data analysis using the LISREL program as 20 times one parameter. Purposive sampling is applied to select a sample group of high school students where a makerspace has been operating for more than one year in Thailand, and is used by students for subjects which make the most use of the makerspace. Decentralized data collection was used because the makerspace users were from every grade level so all data needed to be accurate for research efficiency. Importantly, student consent was obtained before answering the questionnaire. A seven-point rating scale was used to qualify the content validity of the questionnaire by experts, including two involved in makerspace development, two in game-based learning, two in commercial development, and two in instructional innovation. The index of consistency (IOC) was 0.97, demonstrating the consistency of the questions and objective. The Cronbach alpha coefficient was applied to determine the reliability statistic, which was .873, indicating a good level of validity.

DATA ANALYSIS AND RESULTS

Confirmatory factor analysis and structural equation modeling were applied to the collected data from 1,007 high school students at eight target schools. General information on the sample group included gender, age, educational level, type of educational institute, average grades, hometown, experience in inventing items or creating a workpiece, experience in using makerspace, experience in using game-based learning, and experience in using virtual reality (VR). It was found that 88% of the students who completed the questionnaire had invented an item or created a workpiece, while 67% did not know anything about the makerspace. Moreover, 68% of the respondents had applied game-based learning, while 71% never used VR.

Structural equation modeling, The researcher has determined symbols and abbreviations for the variables to facilitate the analysis and presentation of this study as follows.

Symbol used to represent the variables.

K1	represents	**Social influence**
X1	represents	Imitation of friend
X2	represents	Imitation of family member
X3	represents	Imitation of social media
K2	represents	**Perceived self-efficacy**
X4	represents	Carrying out the mission proficiently and confidently
X5	represents	Creating work by integrating knowledge
X6	represents	Enjoying taking independent action
K3	represents	**Confidence in technology**
X7	represents	Applying technology to achieve the goal
X8	represents	Trying out new technology before others
X9	represents	Being skillful in using technology
K4	represents	**Motivation**
X10	represents	Being enthusiastic about learning different things
X11	represents	Focusing on something satisfying for a long time
X12	represents	Being determined to follow the plan to achieve the goal
E1	represents	**Perceived usefulness**
Y1	represents	Perceived usefulness
E2	represents	**Perceived ease of use**
Y2	represents	Perceived ease of use
E3	represents	**Attitude toward using**
Y3	represents	Attitude towards using
E4	represents	**Intention to use**
Y4	represents	Intention to use
E5	represents	**Acceptance behavior**
Y5	represents	Acceptance behavior

The researcher analyzed the structural model to determine the causal factors of makerspace acceptance. The direct effect (DE), indirect effect (IE), and total effect (TE) are presented in Table 1.

Table. 1 Analysis results for the influence of variables in makerspace acceptance

Results	**E1**			**E2**			**E3**			**E4**			**E5**		
Causal factors	**DE**	**IE**	**TE**	**DE**	**IE**	**TE**	**DE**	**IE**	**TE**	**DE**	**IE**	**TE**	**DE**	**IE**	**TE**
K1	0.00	-	0.00	0.01	-	0.01	-	0.01	0.01	-	0.00	0.00	-	0.00	0.00
	(3.61)	-	(3.61)	(0.93)	-	(0.93)	-	(0.30)	(0.30)	-	(2.85)	(2.85)	-	(1.83)	(1.83)
	0.00	-	0.00	0.01	-	0.01	-	0.02	0.02	-	0.00	0.00	-	0.00	0.00
K2	-0.48	-	-0.48	0.04	-	0.04	-	0.10	0.10	-	-0.39	-0.39	-	-0.30	-0.30

Results	E1			E2			E3			E4			E5		
Causal factors	DE	IE	TE	DE	IE	TE	DE	IE	TE	DE	IE	TE	DE	IE	TE
	(7.75)	-	(7.75)	(2.00)	-	(2.00)	-	(0.66)	(0.66)	-	(6.11)	(6.11)	-	(3.93)	(3.93)
	-0.06	-	-0.06	0.02	-	0.02	-	0.16	0.16	-	-0.06	-0.06	-	-0.06	-0.06
K3	-12.01	-	-12.01	-3.04*	-	-3.04*	-	-0.77	-0.77	-	-9.59	-9.59	-	-7.50	-7.50
	(14.40)	-	(14.40)	(1.48)	-	(1.48)	-	(2.11)	(2.11)	-	(11.29)	(11.29)	-	(7.28)	(7.28)
	-0.85	-	-0.85	-2.00	-	-2.00	-	-0.35	-0.35	-	-0.86	-0.86	-	-0.86	-0.86
K4	13.25	-	13.25	3.64**	-	3.64**	-	1.09	1.09	-	10.66	10.66	-	8.27	8.27
	(13.74)	-	(13.74)	(0.91)	-	(0.91)	-	(2.25)	(2.25)	-	(2.24)	(2.24)	-	(6.92)	(6.92)
	0.98	-	0.98	3.89	-	3.89	-	0.46	0.46	-	0.99	0.99	-	0.99	0.99
E1	-	-	-	-	-	-	-0.15	-	-0.15	0.80**	0.01	0.81**	-	0.63**	0.63**
	-	-	-	-	-	-	(0.22)	-	(0.22)	(0.09)	(0.02)	(0.11)	-	(0.07)	(0.07)
	-	-	-	-	-	-	-0.63	-	-0.63	8.55	0.03	7.26	-	7.26	7.26
E2	-	-	-	-	-	-	0.85**	-	0.85**	-	-0.03	-0.03	-	-0.03	-0.03
	-	-	-	-	-	-	(0.25)	-	(0.25)	-	(0.08)	(0.08)	-	(0.05)	(0.05)
	-	-	-	-	-	-	3.32	-	3.32	-	-0.43	-0.43	-	-0.43	-0.43
E3	-	-	-	-	-	-	-	-	-	-0.04	-	-0.04	-	-0.03	-0.03
	-	-	-	-	-	-	-	-	-	(0.09)	-	(0.09)	-	(0.06)	(0.06)
	-	-	-	-	-	-	-	-	-	-0.47	-	-0.47	-	-0.47	-0.47
E4	-	-	-	-	-	-	-	-	-	-	-	-	0.78**	-	0.78**
	-	-	-	-	-	-	-	-	-	-	-	-	(0.03)	-	(0.03)
	-	-	-	-	-	-	-	-	-	-	-	-	18.52	-	18.52

Table. 1 shows the consistency of the makerspace acceptance model based on the hypothesis and empirical data. The model was found to be consistent with the empirical data, with the Qui-square being 52.97, degrees of freedom (DOF) 55, and probability (p) 0.66230,

all of which were different from zero with no significance. Therefore, it agreed with the hypothesis that the developed factor of the makerspace acceptance model was consistent with the empirical data which correspond with the analysis results. Moreover, the goodness of fit index (GFI) was 0.99, adjusted goodness of fit index (AGFI) at 0.98 was close to 1, and root mean square error of approximation (RMSEA) was 0.0000 which was close to 0. The analysis result of the GFI for the factor of makerspace acceptance is explained in the following section.

The validity of the observed variables ranged from 0.13–0.95. The variable with the highest validity was attitude towards using (Y3), followed by acceptance behavior (Y5), the value for which was 0.83. On the other hand, the lowest validity was imitation of family member (X2). Carrying out the mission proficiently and confidently (X4) and create a workpiece by integrating knowledge (X5) exhibited values of 0.13.

The coefficient of determination (R2) for the structural equation model of the endogenous latent variable and R2 of perceived usefulness were 2.94, representing that they could explain the variance of perceived usefulness (E1) at 294%. The R2 for perceived ease of use was 0.85 or it could explain the variance in perceived ease of use (E2) at 58%. The R2 for attitude toward using was 0.46 or it could explain the variance of attitude toward using (E3) at 46%. The R2 for intention to use was 0.59 or it could explain the variance of intention to use (E4) at 59%. The R2 for acceptance behavior was 0.61 or it could explain the variance of acceptance behavior (E5) at 61%.

The correlation matrix between the latent variables ranges from 0.25–1.11. All pairs of variables showed positive relationships. There were 7 pairs of latent variables with a very strong relationship ($r>0.8$), while 11 pairs had the relation at high level ($r>0.8$). 15 pairs of latent variables had a moderate relationship ($0.4 < r < 0.6$) while 3 pairs had a weak relationship ($r>0.4$). The latent variables with the highest correlation coefficient, 0.90 ($r = 0.90$), were perceived usefulness (E1) and perceived ease of use (E2), followed by compliance with social media (K3) and carrying out the mission proficiently and confidently (K4), with a correlation coefficient of 0.99 ($r = 0.99$). The latent variables showing the lowest correlation coefficient of 0.25 ($r = 0.25$) were imitation of friend (K1) and acceptance behavior (E5).

When considering the effect of perceived usefulness (E1), this variable was found to be directly affected by social influence (K1), perceived self-efficacy (K2), confidence in technology (K3), and motivation (K4). The extent of the direct effects, which exhibited no statistical significance, equated to 0.00, -0.48, -12.01, and 13.25, respectively.

The variable for perceived ease of use (E2) was found to be directly affected by social influence (K1) and perceived self-efficacy (K2). The extent of the direct effects, which exhibited no statistical significance, equated to 0.01 and 0.04, respectively. Meanwhile, perceived usefulness (E1) had direct effects on confidence in technology (K3), and motivation (K4), the extent of which equated to -3.04 and 3.63, respectively, with a statistical significance of 0.01 and 0.05, respectively.

Attitude toward use (E3) was indirectly affected by social influence (K1), perceived self-efficacy (K2), confidence in technology (K3), and motivation (K4). The extent of the indirect effects equated to 0.01, 0.10, -0.77, and 1.09, respectively with no statistical significance.

Intention to use (E4) was indirectly affected by social influence (K1), perceived self-efficacy (K2), confidence in technology (K3), and motivation (K4). The extent of the indirect effect equated to 0.00, -0.39, -9.59, and 10.66, respectively with no statistical significance.

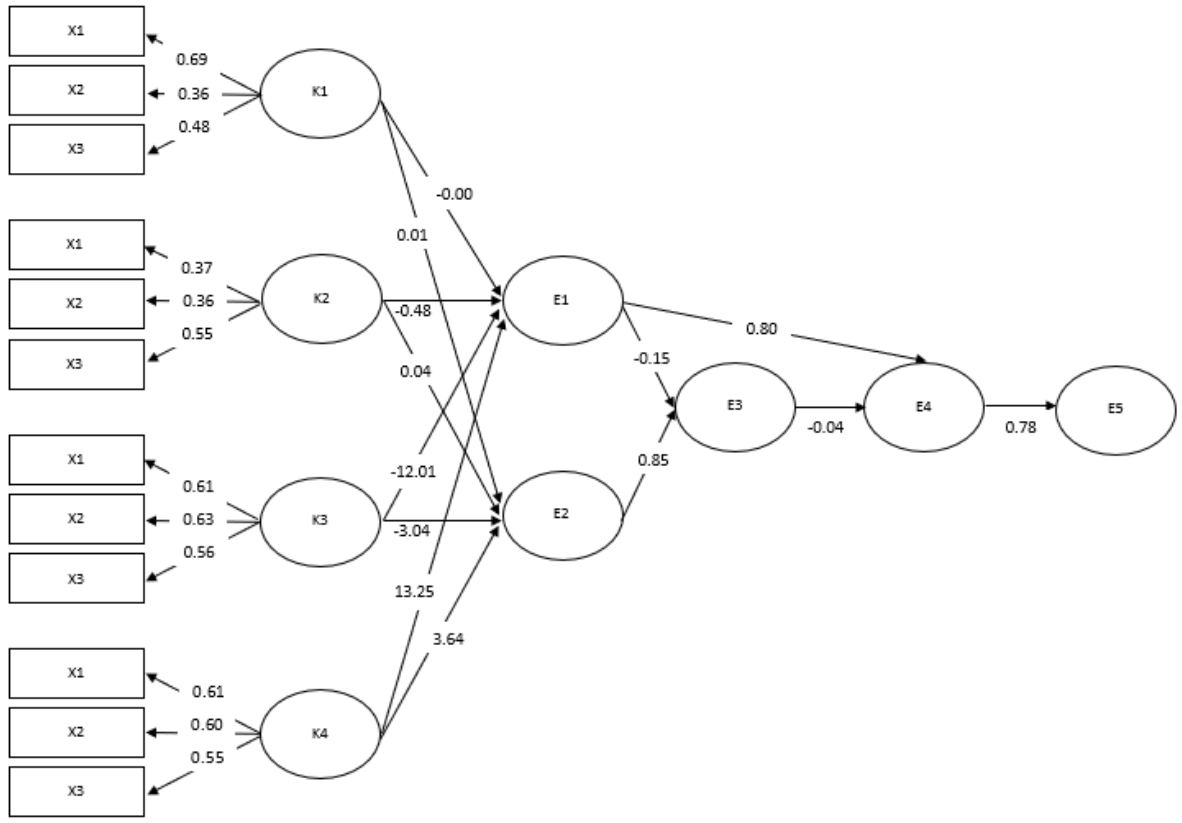
Acceptance behavior (E5) was indirectly affected by social influence (K1), perceived self-efficacy (K2), confidence in technology (K3), and motivation (K4). The extent of the indirect effect equated to 0.00, -0.30, -7.50, and 8.27, respectively with no statistical significance.

Attitude toward using (E3) was directly affected by perceived usefulness (E1), the extent of which equated to -0.15 with no statistical significance. In addition, it had a direct effect on

perceived ease of use (E2), the extent of which equated to 0.85 with a statistical significance of 0.01.

Intention to use (E4) was directly affected by perceived usefulness (E1), the extent of which equated to 0.80 with a statistical significance of 0.01, while the direct effect of attitude towards using (E3), equated to -0.04 with no statistical significance. Additionally, it had the indirect effect of perceived usefulness (E1) via attitude toward using (E3), the extent of which equated to -0.03 with no statistical significance.

Acceptance behavior (E5) was directly affected by intention to use (E4) the extent of which equated to 0.78 with a statistical significance of 0.01. Moreover, perceived usefulness (E1) had an indirect effect via attitude toward using (E3) and intention to use (E4), the extent of which equated to 0.63 with a statistical significance of 0.01. However, acceptance behavior (E5) had an indirect effect on perceived ease of use (E2) via attitude toward using (E3) and intention to use (E4), the extent of which equates to -0.03 with no statistical difference.



Chi-Square= 52.97, df = 58, P-value = 0.66230, RMSEA= 0.000

Fig. 2 Analysis of the Goodness of Fit Index

Analysis results for the factor loading of observed variables Upon completion of data validation prior to analysis of the structural equation model, factor loading of the observed variables was performed to examine the common factors in the relationship between observed variables. The analysis results are shown in Table 2.

Table. 2 Factor loading of observed variables

Variables/Factor	Factor Loading					Factor Score Coefficient
	b	B	SE	t	R^2	
K1						
X1	0.40	0.69	0.03	14.26**	0.47	0.85
X2	0.25	0.36	0.03	8.75**	0.13	0.16

Variables/Factor	Factor Loading					Factor Score Coefficient
	b	B	SE	t	R^2	
X3	0.30	0.48	0.03	11.72**	0.23	0.29
K2						
X4	0.23	0.37	0.02	9.55**	0.13	0.09
X5	0.24	0.36	0.03	8.71**	0.13	0.03
X6	0.33	0.55	0.03	11.75**	0.30	0.18
K3						
X7	0.40	0.61	0.02	18.96**	0.38	0.29
X8	0.40	0.63	0.02	19.54**	0.40	0.33
X9	0.36	0.56	0.02	16.15**	0.32	0.25
K4						
X10	0.37	0.61	0.02	18.27**	0.37	0.32
X11	0.38	0.60	0.02	18.19**	0.36	0.21
X12	0.35	0.55	0.02	15.77**	0.30	0.14
E1						
Y1	0.26	0.68	-	-	0.47	0.22
E2						
Y2	0.31	0.78	-	-	0.60	0.76
E3						
Y3	0.44	0.97	-	-	0.95	2.11
E4						
Y4	0.32	0.75	-	-	0.57	0.92
E5						
Y5	0.46	0.91	-	-	0.83	1.63

** $p < 0.01$

Table 2 presents the analysis results for factor loading of the observed variables (B), illustrating that all variables were positive, ranging from 0.36–0.97 with a statistical significance of 0.01. The variable with the highest loading factor was attitude toward using (Y3) at 0.97, whereas the variable with the lowest loading factor was creating a workpiece by integrating knowledge (X5) at 0.36. Reliability of the coefficient for the observed variables (R2) identified a covariance in the exogenous observed variables ranging from 0.13–0.47 while the covariance in endogenous observed variables ranged from 0.47–0.95. When considering the standardized loading factor (B), the results revealed the following:

(1) For social influence (K1), the variable with the highest loading factor was imitation of friend (X1) at 0.69 and the covariance 47%, followed by the imitation of social media (X3) with a loading factor at 0.48 and a covariance with social influence of 23%, while the imitation of family member (X2) exhibited a loading factor 0.36 and a covariance with social influence of 13%.

(2) For perceived self-efficacy (K2), the variable with the highest loading factor was enjoying taking independent action (X2) for which the loading factor was 0.55 and the covariance with perceived self-efficacy 30%, followed by carrying out the mission proficiently and confidently (X4) for which the loading factor was 0.37 and the covariance with perceived self-efficacy 13%, creating a workpiece by integrating knowledge (X5) for which the loading factor was 0.36 and the covariance with perceived self-efficacy 13%.

(3) For confidence in technology (K3), the variable with the highest loading factor was trying out new innovations before others (X8) for which the loading factor was 0.63 and the covariance with confidence in technology 40%, followed by applying technology to achieve the goal (X7) for which the loading factor was 0.61 and the covariance with confidence in technology 38%, and being skillful in using technology (X9) for which the loading factor

was 0.56 and the covariance with confidence in technology 32%.

(4) For motivation (K4), the variable with the highest loading factor was being enthusiastic to learn different things (X10) for which the loading factor was 0.61 and the covariance with motivation 37%, followed by focusing on something satisfying for a long time (X11) for which the loading factor was 0.60 and the covariance with motivation 36%, and being determined to follow the plan to achieve the goal (X12) for which the loading factor was 0.55 and the covariance with motivation 30%.

(5) For perceived usefulness (E1), there was only one variable, perceived usefulness (Y1) for which the loading factor was 0.61 and the covariance 47%.

(6) For ease of use (E2), there was only one variable, ease of use (Y2) for which the loading factor was 0.61 and the covariance 60%.

(7) For attitude toward using (E3), there was only one variable, attitude toward using (Y3) for which the loading factor was 0.61 and the covariance 95%.

(8) For intention to use (E4), there was only one variable, intention to use (Y4) for which the loading factor was 0.61 and the covariance 57%.

(9) For acceptance behavior (E5), there was only one variable, acceptance behavior (Y5) for which the loading factor was 0.61 and the covariance 83%.

DISCUSSION AND CONCLUSION

This research involves the study of the high school students to acquire guidelines for promoting the competency in creating work which partially uses a virtual reality game-based learning approach. The students completed a questionnaire to enable the researcher to find the causal factors of virtual reality innovation acceptance. The findings of the study reveal that confidence in technology and motivation both had a positive effect on perceived ease of use, which in turn had a positive direct impact on the attitude toward using. Meanwhile, perceived usefulness had a positive direct impact on the intention to use which in turn had a positive direct effect on acceptance behavior. The five highest loading factors were the imitation of friends, enjoying taking independent action, trying new innovations before others, and being enthusiastic about learning different things.

Theoretical and practical implications, the pedagogical implications of adjusting the teaching approach based on the research results, involved the key factors of imitation of friends, enjoying taking independent action, trying new innovations before others, and motivation from being enthusiastic about learning different things. These findings are in line with constructionism theory which involves the promotion of learning by doing for students.

Limitations and Future Scope of Work, the limitations of this research related to the environment and different personalities of Thai and non-Thai students. Consequently, the study did not include the local context which might be a crucial factor of innovation acceptance in Thailand. In addition, some students at the participating schools did not have the opportunity to use the makerspace which resulted in various research results. Furthermore, a study comparing students from the different locations might produce greater variation in the results.

The application of technology in teaching and learning is widespread in Thailand. According to the research results, the highest loading factors were revealed for the need to imitate friends, the enjoyment of doing things independently, enthusiasm for learning different things, and fondness for new innovations. Although the students felt that novel technologies were difficult, they had confidence in technology because motivation facilitated and eased it. They felt they could learn through gaming more easily, regardless of the effort involved. As a result, the students enjoyed game-based learning and recognized its usefulness. Therefore, they had the intention to use game-based learning which led to makerspace acceptance. The research results correspond with the research objective of identifying the reasons for adopting the practice for schools in Thailand.

Declarations The Research Ethics Review Committee for Research Involving Human Subjects: The Second Allied Academic Group in Social Sciences, Humanities and Fine and Applied Arts at Chulalongkorn University, based on Declaration of Helsinki, the Belmont report, CIOMS guidelines and the Principle of the international conference in harmonization – Good clinical practice (ICH-GCP) has approved the execution of the aforementioned research project.

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