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Virtual Reality as a Pedagogical Tool: An Experimental Study of Lower Elementary Grades

교육에서의 가상현실 기술 (VR) 활용: 초등학교 저학년을 대상으로 한 실험적 연구

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Abstract

Virtual Reality as a Pedagogical Tool: An Experimental Study of Lower Elementary Grades

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Artificial intelligence (AI) technology significantly impacted educational institutions, and AI application in education brought new perspectives to develop improved technology-enhanced learning systems. Recently, novel approaches in technology-enabled learning utilizing virtual reality (VR) instead of traditional multimedia materials, digital learning games, and educational software. The use of VR technologies in language education improves creativity, interactivity, collaboration, problem-solving, and active knowledge building. Therefore, this study examined which constructs affect students' continuous use of VR by applying the Technology Acceptance Theory (TAM) theory and explored whether and how VR can improve students' abilities to learn English compared to voice-video-based oral communications. The results have academic and practical implications, as they provide guidance for a rigorous aspect of technology-enhanced learning and demonstrate strong evidence that VR is more effective than traditional education methods. This could assist teachers and academics in the design of VR materials and activities. This study emphasized the advantages and potentials of VR in language education.

Keywords: artificial intelligence, virtual reality, education method, language learning, technology−enhanced learning.

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Chapter 1. Introduction

Artificial Intelligence (AI) technology significantly impacted education institutions (Kowitlawakul et al., 2017; Logan et al., 2021). The application of AI in educational brought new perspectives to improve technology-enhanced learning systems (Hwang et al., 2020; Kabudi et al., 2021; Moreno-Guerrero et al., 2020). Technology-enabled learning systems provide numerous benefits, including a better learning experience, flexibility in time and managing students' learning, and faster student progression (Chou et al., 2018; Kabudi et al., 2021; Moreno-Guerrero et al., 2020; Pliakos et al., 2019).

Novel approaches to technology-enhanced learning systems utilized virtual reality (VR) instead of traditional multimedia materials, digital learning games, and educational software (Reitz et al., 2019). VR, by definition, isolates users from their placed reality by completely immersing them into three-dimensional (3D) simulated reality with head-mounted displays (HMDs), data gloves, tracking devices, and software (Bamodu & Ye, 2013; V. Lin et al., 2021). The software material provided by VR apps can be interactive with the VR components (Ahmet Acar & Bulent Cavas, 2020; V. Lin et al., 2021) or non-interactive, such as users watching a 360-degree video, providing tangible, kinesthetic, haptic, and embodied engagement in the immersive learning environment with real-life scenarios (V. Lin et al., 2021; Tai et al., 2020).

Especially in education, VR facilitates and enhances learners' understanding of abstract concepts in a realistic way (Oyelere et al., 2020). Therefore, it is widely used in health and engineering sciences (Hamilton et al., 2021). However, the use of VR technologies in language education is new, and language instructors have adopted VR as a new form of learning technology to improve users' language learning experiences and effects (V. Lin et al., 2021; Liu, 2008). With the combination of language acquisition philosophies, such as communication, logical input, and output theory (Egbert et al., 2020; V. Lin et al., 2021), VR has been well-received. For instance, English as foreign language (EFL) undergraduate students in Japan described VR as more entertaining and enjoyable than voice-/video-based oral communication learning (York et al., 2021). VR can efficiently improve creativity, interactivity, collaboration, problem-solving, and active knowledge building (Kessler, 2018; V. Lin et al., 2021). Therefore, language learning scenarios can make more use of VR to obtain its educational benefits.

As English is a recognized international language in many countries, it is usually integrated into education and other professional fields, such as business and engineering (Logan et al., 2021). To prepare students to manage continued globalization for future careers, teaching English for specific or professional purposes is one of the principal objectives of current education reforms (Abdel Latif, 2017; C. Chen et al., 2021; Fillmore, 2014).

Since the 1970s, authenticity in language learning has been emphasized, especially for those learning EFL, as they generally have limited contact with authentic input and practical chances for language use beyond the classroom (C. Chen et al., 2021; Gardner & Lambert, 1972). With the development of technology-enhanced learning, it has become feasible to contextualize foreign language learning in real-world settings. Emerging technologies, such as VR, enable students to use numerous modalities of information to learn in language-immersive environments through the construction and simulation of actual situations using "embodied cognition" (C. Chen et al., 2021; Hamilton et al., 2021).

Many studies verify the usefulness of technology-enhanced learning (Allcoat & von Mühlenen, 2018; Fisher, 2005; Khan et al., 2019; Maheshwari, 2021); however, research on user experiences of these technologies based on technology-related theories is scarce (Suh & Prophet, 2018). In addition, online learning applications, such as Zoom and Google Meet, have become widespread during the COVID-19 pandemic, as most education was performed from home, which was a big change in the field of education (Putra et al., 2018; Valentino et al., 2021). Many studies were conducted to understand the effectiveness of online versus offline learning (Wiyono et al., 2021); however, the effectiveness of using VR in language education compared to traditional instruction has been under-investigated (Köse & Güner-Yildiz, 2021). Most research on VR use in education is directed toward students with typical development and Science, Technology, Engineering, and Math (STEM) education (Köse & Güner-Yildiz, 2021; McMahon et al., 2016). Virtual reality (VR) has been used in STEM education to introduce human organs and structures and examine 3D models of the solar system (Köse &

Güner-Yildiz, 2021; Taryadi & Kurniawan, 2018).

The present study explored the influence of using VR on students' abilities to learn English compared voice- and video-based oral communication. In addition, this study investigated what constructs affect students' continuous use of VR utilizing the Technology Acceptance Model (TAM).

Chapter 2. Literature Review

The prolific stream of study on the application of information systems (IS) has several theoretical approaches. The TAM is widely regarded as the most prominent and widely used theory for describing an individual' s acceptance of IS (Adams et al., 1992; Ajzen, 1985; Ajzen & Fishbein, 1980; Chau, 1996; Gefen & Keil, 1998; Y. Lee et al., 2003; Triandis, 1980; Strader & Shaw, 1997). This IS theory demonstrates how users come to use technology and suggests behavioral intention as a factor that leads users to use the technology. In addition, this model is a multidimensional paradigm that demonstrates the results of interactions between cognitive factors in complex learning situations (Panisoara et al., 2020). This study conducted an empirical investigation of VR acceptance and assimilation using TAM3.

2.1. Theoretical Framework: Technology Acceptance Model 3 (TAM3)

Davis (1989) developed the TAM, which asserts that perceived usefulness and ease of use of information technology are the fundamental factors of behavioral intention. Perceived usefulness is defined as “the degree to which a person believes that using a particular system would enhance his or her job performance,” whereas perceived ease of use is defined as “the degree to which a person believes that using a particular system would be free of effort” (Davis, 1989, p. 320).

TAM has continuously developed from its original form, with scholars and practitioners investigating the influence of users’ perceptions and attitudes toward IS on acceptance and resistance (Lucas et al., 1990). Furthermore, the TAM posits that the effect of external variables, such as design characteristics, on behavioral intention is mediated by perceived usefulness and ease of use. TAM2 reveals the external variables of perceived usefulness and ease of use and provides a tangible mechanism for progressing the multi-level model. Venkatesh and Davis (2000) identified social influence, such as subjective norms, and cognitive instruments, such as job relevance, image, quality, and results demonstrability, as external variables of perceived usefulness. Venkatesh (2000) reported anchors, such as computer self-efficacy, perceptions of external control, computer anxiety, and computer playfulness, and adjustments, such as perceived enjoyment and objective usability, as external variables of perceived ease of use.

Venkatesh and Bala (2008) proposed an integrated model of technology acceptance, TAM3 (Figure 1), by combining TAM2 (Venkatesh & Davis, 2000) with the model of variables of perceived ease of use (Venkatesh, 2000). TAM3 represents a comprehensive nomological network of factors that influence individuals’ IT adoption and use. TAM3 proposes three relationships between: 1) perceived ease of use and perceived usefulness, 2) computer anxiety and perceived ease of use, and 3) perceived ease of use and behavioral intention.

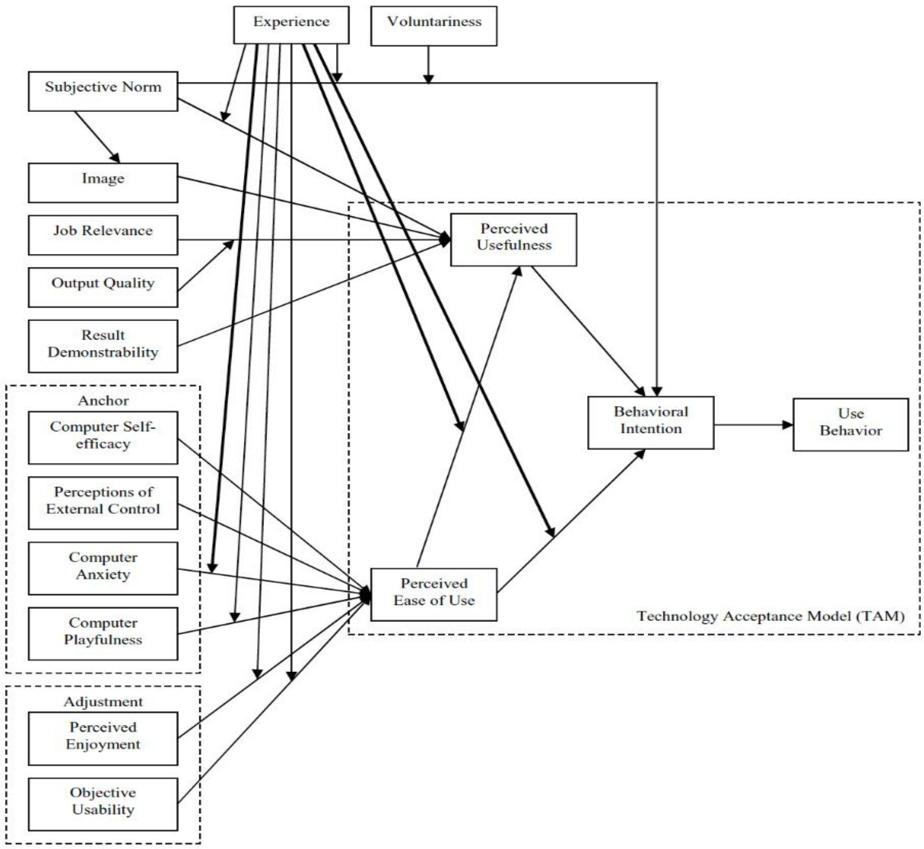

Figure 1. Technology Acceptance Model 3 (TAM3) (Venkatesh & Bala, 2008)

TAM3 is intended to indicate how characteristics of technology acceptance influence users' attitudes toward technology, which is a direct signal of their behavioral intention to use it for a specified goal.

This study focuses on the influence of VR use on students' abilities to learn English; therefore, several constructs related to VR technology, such as image, result demonstrability, computer anxiety, computer playfulness, and perceived enjoyment, were selected for analysis. TAM3 was used to identify the influence of specific VR technology properties on users' attitudes.

2.2. Potential of VR in Education

Previous research has identified some of advantages and potentials of VR in education. First, it is critical to capture students' curiosity and encourage their motivation to learn (Amabile, 1990; Lei et al., 2018). VR outperforms traditional education in terms of establishing learning interests and affects students' internal motivations that lead them to change their behaviors (Lei et al., 2018; M. Lin et al., 2017). Furthermore, VR can help students step out of their comfort zones and challenge their own boundaries, which is a crucial factor of education (Lei et al., 2018; M. Lin et al., 2017).

Second, in the educational context, VR can generate environmental settings that demand significant attention. These environments make it possible to teach concepts in novel and creative ways (Hu et al., 2016) and stimulate students' imagination, which is necessary for creative work (Patera et al., 2008). Furthermore, these simulated settings can raise students' attention and ensure a high-quality educational experience. The first-person perspective, the three-dimensional (3D) panoramic animation, and the speaking voice associated with VR settings can increase students' attention (Wyk, 2011).

Finally, VR allows for experiential learning (Lei et al., 2018). Students learn the knowledge required within a situation and apply what they learned to that situation. VR activities require observation, communication, and self-clarification, which can teach students comprehension skills (M. Lin et al., 2017). Moreover, VR provides a safe space for students to act vicariously (Lei et al., 2018; Wyk, 2011) and a cost-effective approach to optimize all traditional creativity development techniques (Thornhill-Miller & Dupont, 2016).

2.3. Educational VR Applications

VR educational environments exhibit high levels of interactivity and participation, which can improve learning motivation (M. Lin et al., 2017) and collaborative learning (Vedadi et al., 2019). Several studies have developed virtual reality environments (VREs) or educational VR applications for students. VREs can introduce abstract concepts to students, such as the “Round Earth Project,” which helps students learn about the Earth as a sphere (A. Johnson et al., 1999). Some VREs allow students to freely build new virtual objects. For instance, NICE, an immersive multiuser learning environment, permits students to design their own virtual garden, where they can control the weather and period, allowing them to investigate complicated ecological interrelationships (A. Johnson et al., 1998). VREs can be used to rebuild historical sites that no longer exist (Mosaker, 2001), allowing students to visit and experience historical sites previously only accessible through photographs or videos (Lei et al., 2018). Unlike two-dimensional (2D) pictures or videos in which the students only interact as separate observers, VR encourages immersion by allowing exploration in 3D space.

2.4. English Learning through VR Technology

With the growing demands for international communication associated with globalization, students are required to learn a foreign language to become competitive (C. Chen et al., 2021). Many Asian countries, such as Japan and the Republic of Korea, have prioritized learning English in preparation for participation in global contexts (C. Chen et al., 2021; Honna, 2016; Tsui, 2020). However, EFL learners usually find vocabulary acquisition, particularly for a specific field or terminology, challenging (Elahe & Alireza, 2018; Patahuddin et al., 2017). This is a significant disadvantage, as sufficient vocabulary knowledge is strongly associated with English reading, writing, and listening comprehension (C. Chen et al., 2021; M. D. Johnson et al., 2016).

Another problem for EFL learners is the limited circumstances for communicating in English. Authentic input can help create positive learning attitudes, motivation, and outcomes (Hidayati & Diana, 2019; Huda, 2017; Monteiro & Kim, 2020). The effectiveness of educational materials can be increased if they are paired with authentic learning tasks and integrated into specific scenarios and meaningful contexts (Yeh et al., 2020). However, insufficient emphasis has been placed on authenticity in the acquisition of English vocabulary for specific purposes, which could be enhanced by integrating language education resources into realistic scenarios through VR mediation.

Recently, researchers have become interested in the use of VR for language acquisition. As in other disciplines, VR offers immersive environmental settings for language education, allowing students to use virtual avatars in 3D settings to assume a first-person perspective (Lan, 2020; Slater, 2017). Moreover, VR allows for highly interactive learning contexts with visual, aural, and tactile experiences, in which students can communicate in the target language (C. Chen et al., 2021; J. Chen, 2016a, 2016b; Yamazaki, 2018; Yeh et al., 2020). Several empirical investigations demonstrated that VR could help with language education in a variety of ways (J. Chen, 2016a; Hamilton et al., 2021; Parmaxi, 2020). VR-assisted English-education platforms have been used in the classroom to investigate impact on students' cognitive and linguistic improvement, with the results indicating enhanced phonological, morphological, grammatical, and syntax knowledge (J. Chen, 2016a). Lan et al. (2018) used on-site and virtual education with two groups of students to evaluate the effect of 3D avatars on English-listening comprehension |and found that the virtual education group outperformed the physical education group on a listening comprehension test. Alfadil (2020) investigated the impact of a VR game on students' English vocabulary acquisition and revealed that the VR learning group outperformed the regular classroom learning group. Legault et al. (2019) demonstrated that engaging with 3D characters and objects in immersive VR educational settings improved learners' word acquisition accuracy and speed.

VR technology influences the learning of foreign languages; however, the effect of language learning using VR technology compared to traditional teaching methods has not been thoroughly investigated. In addition, relatively few studies have been conducted to understand students' experiences of VR technology based on technology-related theories (A. Suh & Prophet, 2018). Therefore, the present study aimed to address these gaps.

Chapter 3. Materials and Methods

This study posed the following research questions (RQ):

1. What constructs affect students' continuous use of VR?
2. What are the advantages and potentials of VR for English education?

3.1. Participants

This study recruited students who participated in an English class for Spring English Camp using VR. The participants included 120 students in Study 1 and 300 students in Study 2, selected from 476 students based on their English ability determined by a pretest. All participants attended Korean elementary schools and were second or third-grade students whose native language is Korean.
To encourage participation, the $70 entrance fee for the English Camp was waived for participants. An English book worth $30 was given to participants in the second quantitative analysis. Table 1 presents demographic information of the participants in Studies 1 and 2.

Table 1. Demographic information of participants in Studies 1 and 2

Study 1			Study 2		
Grade		N	Items		N
Grade	2nd Grade	60	Grade	2nd Grade	100
	3rd Grade	60		3rd Grade	200
	Total	120		Total	300

3.2. Procedure

All participants provided written informed consent before participant. Subsequently, a questionnaire was distributed to participants to acquire demographic information. Among 300 students, 120 students were randomly assigned to Study 1, which was related to students' continuous use of VR, examined by applying TAM.Study 1 participants entered the VR room, where the teacher provided instructions on VR tools, such as a head-mounted display (HMD) and other equipment, experiment time (20 minutes), and class contents. After experiencing VR, students were given a questionnaire on VR technology acceptance, which was rated on a five-point Likert scale (1 = strongly disagree; 5 = strongly agree). If they had questions, their inquiries were answered. This procedure continued until the participants finished the survey. On average, it took 23 minutes to complete questionnaires.

The first step of Study 2 was the same as Study 1; however, Study 2 included two phases: pretest and main study. In the pretest stage, the students were expected to answer basic English questions (see Appendix 3). As Study 2 aimed to understand the advantages and potentials of VR compared to traditional teaching methods, the level of students in each instructional method was similar. When students indicated that they were ready to start, the main study commenced. Participants were randomly assigned to one of two teaching methods. Students learned English regarding police stations and performed problem-solving tasks, which consisted of three multiple-choice questions using action keywords, vocabulary, and expressions for police stations (Appendix 4). The time they took to answer each problem-solving question was recorded. On average, it took 17 minutes to complete both questionnaires. This experiment was performed between April 18th, 2022 and May 17th, 2022.

3.3. Instrument

This study used a projector-based spatial VR system with three 5,000-lumen projectors, a 360-degree stereoscopic screen, six VIVE pro controllers, six VIVE MAG P90 Guns, and an Intel Core processor (CPU) i7 server. The VIVE Pro headset with two infrared sensors and two handheld controllers to track user motion was used. To perform the catch vocab game, the VIVE Pro headset was used. For the catch criminal game, the VIVE MAG P90 Gun was used. Figure 2 presents the research instruments. For the traditional teaching method, a classroom, whiteboard, activity book, and screen for watching videos are used. Figure 3 shows the participants who are learning English using the traditional teaching method.

Figure 2. Research instruments for virtual reality education

Figure 3. Students using the traditional teaching method

3.4. Design and Measure

3.4.1. Research Model of Study 1

The research model was developed by selecting the key constructs for VR adoption from TAM3. Figure 4 presents the research model. As the research focused on VR usage in language education, eight constructs related to emerging technology, such as

VR, were chosen. Table 2 shows the constructs and provides the definitions.

This study considered the effects of image and result demonstrability on perceived usefulness, the effects of computer anxiety, computer playfulness, and perceived enjoyment on perceived ease of use, the effects of perceived ease of use on perceived usefulness, and the effects of perceived usefulness and perceived ease of use on behavioral intention. Figure 4 shows the research model.

Table 2. Definitions of constructs

Constructs	Definitions	Reference
Image (IMG)	Students who use the VR system have a high profile or more prestige than those who do not.	Venkatesh & Bala, 2008
Result Demonstrability (RES)	Students have no difficulty using the VR system, and the results of using the VR system are apparent to me.	Venkatesh & Bala, 2008
Computer Anxiety (CANX)	Using VR systems makes me nervous, uncomfortable, or uneasy.	Venkatesh & Bala, 2008
Computer Playfulness (CPLAY)	Using a VR system causes me to feel spontaneous, creative, or playful.	Venkatesh & Bala, 2008
Perceived Enjoyment (ENJ)	Using a VR system is pleasant, enjoyable, or fun.	Venkatesh & Bala, 2008

Perceived Usefulness (PU)	As using a VR system enhances my effectiveness and increases my productivity, students think that the VR system is useful in my learning.	Venkatesh & Bala, 2008
Perceived Ease of Use (PEOU)	As interaction with the VR system is clear and understandable, the VR system is easy to use.	Venkatesh & Bala, 2008
Behavioral Intention (BI)	Students who had access to the VR system plan to use it in the future.	Venkatesh & Bala, 2008

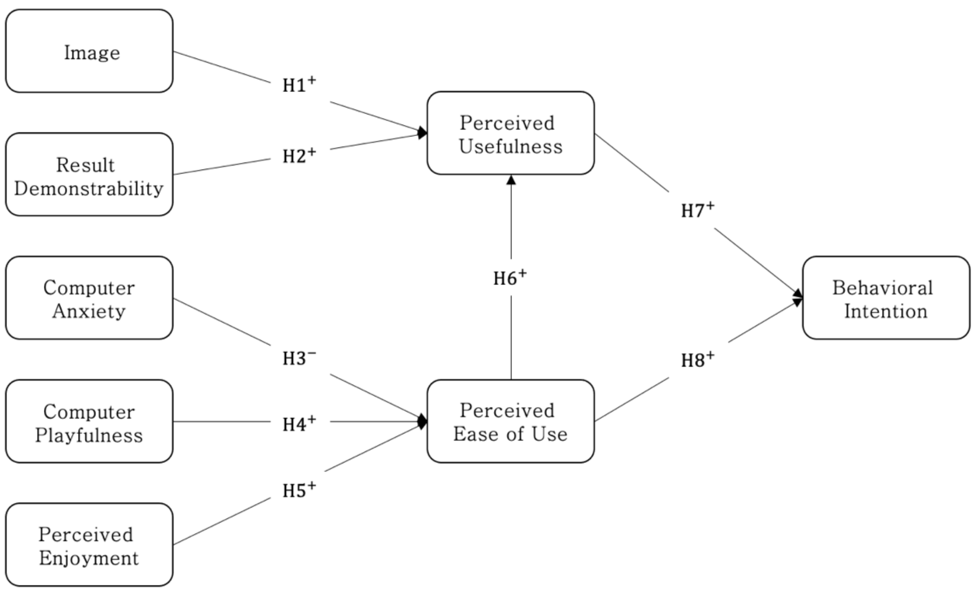

Figure 4. Research model

H1. Image has a positive influence on Perceived Usefulness of VR in English Education.

H2. Result Demonstrability has a positive influence on Perceived Usefulness of VR in English Education.

H3. Computer Anxiety has a negative influence on Perceived

Ease of Use of VR in English Education.

H4. Computer Playfulness has a positive influence on Perceived Ease of use of VR in English Education.

H5. Perceived Enjoyment has a positive influence on Perceived Ease of Use of VR in English Education.

H6. Perceived Ease of Use has a positive influence on Perceived Usefulness of VR in English Education.

H7. Perceived Usefulness has a positive influence on Behavioral Intention of VR in English Education.

H8. Perceived Ease of Use has a positive influence on Behavioral Intention of VR in English Education.

3.4.2. Research Model of Study 2

The research model of Study 2 considered the benefit and potential of VR as a teaching technique. The experiment used a between-subjects design with a teaching method manipulated between groups. Each student learned English based on either traditional teaching or the VR method by random assignment, thus reducing the learning effect. The complete experimental design is summarized in Table 3.

To correctly measure how effectively each teaching method delivered the English police station contents to students and eliminate as many confounding features as possible in evaluating this outcome, prior research selected measures of performance based on problem-solving as dependent variables (Mayer, 1989). These tasks act as a proxy for how well students learn English from the method (J. Suh & Park, 2017).

In this study, problem-solving performance was used as the dependent variable, as performance offers a better indicator of students' deep understanding of English. To measure problem-solving performance, problem-solving accuracy was selected.

Table 3. Summary of study 2 experimental design

	VR	**Traditional Teaching Method**
Participants	150 (2nd Graders: 50, 3rd Graders: 100)	150 (2nd Graders: 50, 3rd Graders: 100)
Duration (4/18/2022- /7/2022)	20 mins	20 mins
Contents	Police Station (Took "police station class" as the 1st section of the day)	Police Station (Took "police station class" as the 1st section of the day)
Teaching-Learning Style	• 360-degree stereoscopic screen • 3D simulated reality with HMD → catching vocab game • VR shooter as a tracking device → catching criminal game	• Offline classroom • Whiteboard • Activity Book • Screen for watching video
Rewards/ Incentives	Free entrance fee and gift (English textbook)	

Chapter 4. Results

Two studies were analyzed in different ways. In the first study, the hypotheses were tested by performing statistical analysis to recognize which construct affected the students' continuous use of VR. In the second study, the results were analyzed in two phases. First, students' scores for the problem-solving measure were calculated. Second, the hypotheses were tested by performing statistical analysis to understand the differences between technology-enhanced learning and traditional teaching method in the scores for problem-solving.

4.1. Study 1

4.1.1. Assessment of the measurement model: reliability and validity

The measurement model was developed to test the relationship between the constructs (image, result demonstrability, computer anxiety, computer playfulness, perceived enjoyment, perceived usefulness, perceived ease of use, and behavioral intention) and their indicators. Before testing the proposed hypotheses, the research model was evaluated to verify each item's reliability, the reliability of the scale, the convergent validity, and the discriminant validity (Bajpai & Bajpai, 2014; Malhotra & Dash, 2013).

The Kaiser-Meyer-Olkin (KMO) and Bartlett's Test were used. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy value was higher than 0.8. The chi-square of Bartlett's Test of Sphericity values was 104.19 (Image), 258.35 (Result Demonstrability), 280.01 (Computer Anxiety), 297.14 (Computer Playfulness), 321.05 (Perceived Enjoyment), 529.88 (Perceived Usefulness), 302.82 (Perceived Ease of Use), and 72.15 (Behavior Intention). Significance value was 0.000, indicating statistical significance at the 0.01 level. Furthermore, the Cronbach's alpha scores of all the constructs were above the threshold of 0.7; therefore, the constructs were reliable (Cronbach, 1951; Hair et al., 2011).

Table 4. Results of factor analysis and reliability analysis of Image (IMG)

Image (IMG)	Component	Communalities	Cronbach's α
Students in my school/institute who use the system have more prestige than those who do not.	0.79	0.63	0.780
Students in my organization who use the system have a high profile.	0.77	0.59	
Having the system is a status symbol in my school/institute.	0.78	0.61	
Total	1.83		
% of Variance	60.98		
Cumulative %	60.98		
KMO and Bartlett's Test			
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.81	
Bartlett's Test of Sphericity	Approx. Chi-Square=104.19		
	df=3		
	Sig.=0.000***		

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

This study analyzed convergent and discriminant validity of each construct (image, result demonstrability, computer anxiety, computer playfulness, perceived enjoyment, perceived usefulness, perceived ease of use, behavioral intention). Convergent validity was established, as the value of average variance extracted (AVE) was higher than 0.5 and composite reliability (CR) was higher than 0.7 (Kline, 2011). The maximum value for the squared of the correlation coefficient of the latent factor was 0.497, and the minimum value of the AVE was 0.520, which was greater than the maximum value for the squared of the correlation coefficient; therefore, discriminant validity was demonstrated.

Table 5. Convergent and discriminant validity of each construct

Items	IMG	RES	CANX	CPLAY	ENJ	PU	PEOU	BI
Image (IMG)	1	0.041	0.025	0.015	0.035	0.000	0.001	0.056
Result Demonstrability (RES)	0.203	1	0.056	0.132	0.094	0.125	0.111	0.102
Computer Anxiety (CANX)	0.157	0.236	1	0.189	0.038	0.148	0.189	0.497
Computer Playfulness (CPLAY)	0.121	0.363	0.435	1	0.114	0.166	0.300	0.348
Perceived Enjoyment (ENJ)	0.186	0.306	0.194	0.337	1	0.102	0.064	0.277
Perceived Usefulness (PU)	0.012	0.354	0.385	0.407	0.320	1	0.346	0.217
Perceived Ease of Use (PEOU)	0.023	0.333	0.435	0.548	0.252	0.588	1	0.246
Behavioral Intention (BI)	0.237	0.319	0.705	0.590	0.526	0.466	0.496	1
Cronbach's α	0.780	0.816	0.838	0.854	0.859	0.875	0.856	0.715
AVE	0.520	0.714	0.670	0.729	0.789	0.701	0.726	0.527
CR	0.763	0.881	0.858	0.889	0.918	0.902	0.888	0.769
$\sqrt{AVE}$	0.883	0.903	0.916	0.924	0.927	0.936	0.925	0.846

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$; Latent Variables Coefficients^2 < AVE.

4.1.2. Hypothesis Test

All constructs of the VR system had varying degrees of association with the TAM; however, not all of them were statistically significant. Likewise, constructs had positive associations with the behavioral intention to use the VR in English learning; however, one hypothesis, H1, showed statistical non-significance. In detail, as examining the effect relationship of Image (IMG) on Perceived Usefulness (PU), (β= -.042, C.R. = -0.77, 0.444, $p < .1$), the hypothesis was rejected because it was not statistically significant even at the 0.1 level. Therefore, Image (IMG) had non-significant associations with Perceived Usefulness (PU). Except for Hypothesis 1, all Hypotheses (H2-H8) were supported. When examining the effect of Result Demonstrability (RES) on Perceived Usefulness (PU), Result Demonstrability (RES) on Perceived Usefulness (PU), Computer Anxiety (CANX) on Perceived Ease of Use (PEOU), Computer Playfulness (CPLAY) on Perceived Ease of Use (PEOU), Perceived Enjoyment (ENJ) on Perceived Ease of Use (PEOU), Perceived Ease of Use (PEOU) on Perceived Usefulness (PU), Perceived Usefulness (PU) on Behavioral Intention (BI), and Perceived Ease of Use (PEOU) on Behavioral Intention (BI), the analysis results were statistically significant at the 0.01 level. Standardized Regression Weights (β) were 0.191 on H2, -0.230 on H3, 0.310 on H4, 0.223 on H5, 0.540 on H6, 0.257 on H7, and 0.513 on H8 individually. Table 6 lists the inferential statistics of the model, and Figure 5 shows the final model with non-statistically significant values represented by dotted lines.

Study 1 explored the implementation of VR as a pedagogical tool by measuring students' acceptance of VR technology.

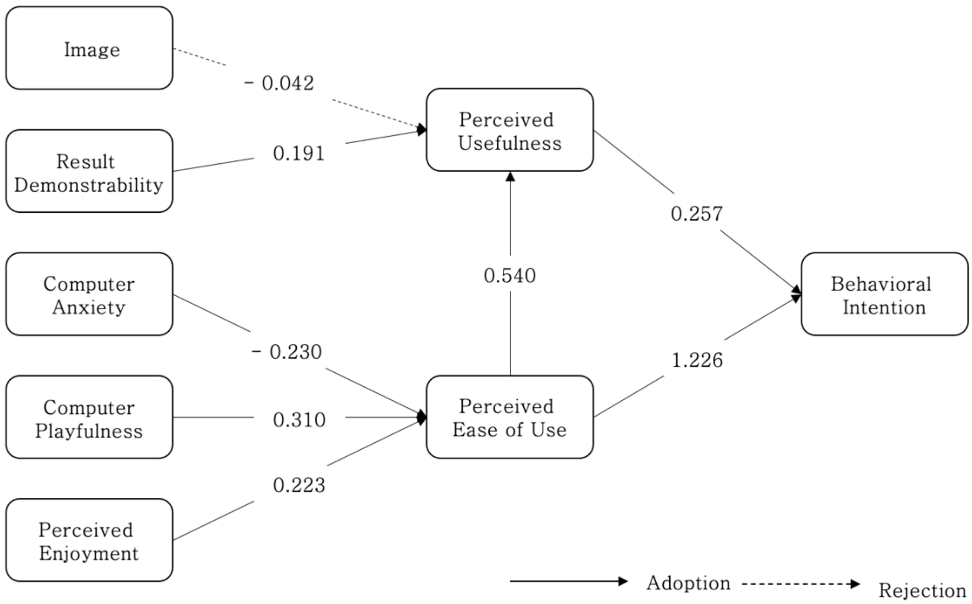

Figure 5. Final research model

Table 6. Hypotheses testing results (SEM)

Path				Unstandardized Regression Weights	Standardized Regression Weights (β)	S.E.	C.R.	P-value
H1	Image (IMG)	→	Perceived Usefulness (PU)	-0.04	-0.042	0.05	-0.77	0.444
H2	Result Demonstrability (RES)	→	Perceived Usefulness (PU)	0.21	0.191	0.06	3.45	0.000***
H3	Computer Anxiety (CANX)	→	Perceived Ease of Use (PEOU)	-0.21	-0.230	0.06	-3.78	0.000***
H4	Computer Playfulness (CPLAY)	→	Perceived Ease of Use (PEOU)	0.31	0.310	0.06	5.63	0.000***
H5	Perceived Enjoyment (ENJ)	→	Perceived Ease of Use (PEOU)	0.26	0.223	0.04	6.14	0.000***
H6	Perceived Ease of Use (PEOU)	→	Perceived Usefulness (PU)	0.54	0.540	0.06	9.67	0.000***
H7	Perceived Usefulness (PU)	→	Behavioral Intention (BI)	0.19	0.257	0.03	7.19	0.000***
H8	Perceived Ease of Use (PEOU)	→	Behavioral Intention (BI)	0.289	0.513	0.09	3.385	0.000***
Chi-square=795.68, df=267, P-value=0.000, Chi-square/df=2.980, RMR=0.041, GFI=0.919, AGFI=0.885, NFI=0.913								

4.2. Study 2

4.2.1. Data Scoring

The Scores were awarded as follows. One mark was given if the answer was correct, whereas zero was given if an answer was incorrect or left blank. Students were encouraged not to answer the question by guessing. None of the students' answer sheets had blank answers.

4.2.2. Hypothesis Test

Study 2 aimed to understand the effect of technology-enabled learning by comparing teaching techniques, VR, and traditional teaching methods based on the problem-solving test score. Therefore, the hypothesis was as follows:

H1. There is a difference in students' ability to learn English between VR and traditional teaching methods, voice-video-based oral communications.

Specifically, this study aimed to recognize the English capacity of the student based on not only the total test score of problem-solving questions but also question types, action keywords, vocabulary, and expressions about the police station. This study undertook the t-test to determine the difference between VR and traditional teaching methods in the police station domain. As shown in Table 7, for comprehension accuracy, the difference between VR (M=86.27) and traditional teaching method(M=78.80) was statistically significant (t = −4.07, p =0.000***, Mean difference = −7.47) at the 0.01 level. Therefore, using VR improved the ability to learn English more than voice-video-based oral communications.

In case of Action Keywords, the difference between VR (M=27.47) and traditional teaching method (M=24.73) on test score was statistically significant (t = −3.08, p =0.000***, Mean difference = −2.72) at the 0.01 level. In case of Vocab, the difference between VR (M=32.73) and traditional teaching method (M=27.47) on test score was statistically significant (t = −3.89, p =0.000***, Mean difference = −3.80) at the 0.01 level. Finally, as a question type Expression, the difference on quiz score between VR (M=26.47) and traditional teaching method (M=25.53) was statistically not significant (t = −1.03, p =0.304, Mean difference = −0.93) at the 0.01 level. In summary, VR on Action Keywords and Vocab had higher scores than the traditional teaching method.

Table 7. Comparison of comprehension accuracy of traditional teaching methods and VR

Teaching Method		N	Mean	Std. Deviation	t	*Sig.*	Mean difference
Action Keywords1	traditional teaching method	150	8.27	3.80	-1.67	0.097*	-0.67
	VR	150	8.93	3.10			
Action Keywords2	traditional teaching method	150	7.33	4.44	-3.26	0.001***	-1.47
	VR	150	8.80	3.26			
Action Keywords3	traditional teaching method	150	9.13	2.82	-2.26	0.025**	-0.60
	VR	150	9.73	1.62			
Vocab1	traditional teaching method	150	9.80	1.40	0.71	0.475	0.13
	VR	150	9.67	1.80			
Vocab2	traditional teaching method	150	8.13	3.91	-2.34	0.020**	-0.93
	VR	150	9.07	2.92			
Vocab3	traditional teaching method	150	5.40	5.00	-3.01	0.003***	-1.67
	VR	150	7.07	4.57			
Vocab4	traditional teaching method	150	5.20	5.01	-2.36	0.019**	-1.33
	VR	150	6.53	4.78			
Expressions1	traditional teaching method	150	8.73	3.34	-0.92	0.358	-0.33
	VR	150	9.07	2.92			
Expressions2	traditional teaching method	150	8.67	3.41	-0.71	0.479	-0.27
	VR	150	8.93	3.10			
Expressions3	traditional teaching	150	8.13	3.91	-0.77	0.444	-0.33

	method						
	VR	150	8.47	3.62			
Action Keywords	traditional teaching method	150	24.73	6.92	−3.80	0.000***	−2.73
	VR	150	27.47	5.46			
Vocab	traditional teaching method	150	28.53	8.47	−3.89	0.000***	−3.80
	VR	150	32.33	8.47			
Expressions	traditional teaching method	150	25.53	7.38	−1.03	0.304	−0.93
	VR	150	26.47	8.28			
Total	traditional teaching method	150	78.80	14.33	−4.07	0.000***	−7.47
	VR	150	86.27	17.28			

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Chapter 5. Discussion

5.1. Implications

These results have academic and practical implications. This study presents guidance for the rigor aspects of technology-enhanced learning. The academic study of educational technology is strengthened by a broad and rigorous engagement with theory; therefore, this study applied the TAM, which is the most influential and commonly employed theory for describing an individual's acceptance of technology (Y.-H. Lee et al., 2013; Salloum et al., 2019), to understand the reasons students use the VR technology in English learning.

Based on TAM, several interesting observations were shown. First, Image had no effect, whereas Result Demonstrability had a positive effect, which indicated that students who used VR in their English learning did not have more prestige or high profile. As electronic devices are familiar to students these days, VR technology itself is not considered special.

Second, Computer Anxiety was found to have a negative effect on Perceived Ease of Use, and Computer Playfulness, and Perceived Enjoyment had positive effects. In addition, Computer Playfulness had the largest effect on Perceived Ease of Use, and Computer Anxiety and Perceived Enjoyment affect the order. This suggested that rather than just a pleasant, enjoyable, and fun factor of using VR in English education, spontaneous and creative causes made it easier to use the VR system in learning. In other words, using the VR system voluntarily and being creative were more critical factors for students than using the VR system for pleasure or fun.

Third, Perceived Ease of Use had a positive effect on Perceived Usefulness. If the VR system was easy to use, it enhanced students' effectiveness and productivity. Therefore, students thought that the VR system was very useful in English learning.

Fourth, Perceived Usefulness and Perceived Ease of Use had a positive effect on Behavioral Intention. Moreover, Perceived Ease of Use had a greater effect on Perceived Usefulness, indicating that learning English was crucial; however, if the VR operation was too complex operate, the lower grades of elementary school may refuse to continue using VR to their English learning.

Another significant implication related to the research scale. The experiment size of previous studies was small compared to the present experiments. Specifically, they used less than 30 participants and three pieces of equipment, such as tracking head-mounted mounted devices (HMD) and electronic gloves as experimental devices. However, our experiment used 300 students as the participants and a 360-degree stereoscopic screen, 3D simulated reality with HMD, and VR shooter as the experimental devices. This solved the problem of investigation size, which has been pointed out as the limitation of technology-enhanced learning research.

Furthermore, this study demonstrated strong evidence that VR had a better educational effect than traditional education methods, which provides guidance for teachers and academics in the design of technology-enhanced learning materials and activities. By engaging students in using VR to solve English questions, this study revealed the significant positive effect of VR-assisted English education on elementary school students. These findings contributed to language education and revealed that incorporating VR systems can increase the motivation and effectiveness of learning. VR provided students with an immersive and practical experience, in which they not only viewed but also experienced the specific situation using the target language, deepening their understanding of English.

5.2. Limitations and Future Research

Future research could be pursued in three directions. First, future studies should compare differences in other problem-solving situations, such as fire stations, marine stations, and hospitals, to gain a deeper understanding of English learning using VR.

Second, this study investigated second and third grades elementary school students; therefore, the results cannot be generalized to upper grades. Including other grades in future experiments would help generalize the argument that VR had a better educational effect than traditional education methods.

Third, this study examined English language education. Although English is regarded as the representative language, testing other languages, such as Chinese, French, and Korean, would provide more accurate results.

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Appendix

Appendix 1

: Survey for study 1 (5−Point Likert Scale)

Item	Statement
Image (IMG) – Venkatesh & Bala, 2008	
IMG 1	Students in my school/institute who use the system have more prestige than those who do not.
IMG 2	Students in my organization who use the system have a high profile.
IMG 3	Having the system is a status symbol in my school/institute.
Result Demonstrability (RES) – Venkatesh & Bala, 2008	
RES 1	I have no difficulty telling others about the results of using the VR system.
RES 2	I believe I could communicate to others the consequence of using the VR system.
RES 3	The results of using the VR system are apparent to me.
Computer Anxiety (CANX) – Venkatesh & Bala, 2008	
CANX 1	Working with the VR system makes me nervous.
CANX 2	VR systems make me feel uncomfortable.
CANX 3	VR systems make me feel uneasy.
Computer Playfulness (CPLAY) – Venkatesh & Bala, 2008	
CPLAY 1	The following questions ask you how you would characterize yourself when you use the VR systems: … spontaneous.
CPLAY 2	… creative.

CPLAY 3	… playful.
Perceived Enjoyment (ENJ) – Venkatesh & Bala, 2008	
ENJ 1	I find using the VR system to be enjoyable.
ENJ 2	The actual process of using the VR system is pleasant.
ENJ 3	I have fun using the VR system.
Perceived Usefulness (PU) – Venkatesh & Bala, 2008	
PU 1	Using the VR system improves my performance in my English learning.
PU 2	Using the VR system in my English learning increases my output.
PU 3	Using the VR system enhances my effectiveness in my English learning.
PU 4	I find the VR system to be useful in my English learning.
Perceived Ease of Use (PEOU) – Venkatesh & Bala, 2008	
PEOU 1	My interaction with the VR system is clear and understandable.
PEOU 2	Interacting with the VR system does not require a lot of mental effort.
PEOU 3	I find that the VR system is easy to use.
Behavioral Intention (BI) – Venkatesh & Bala, 2008	
BI 1	Assuming I had access to the VR system, I intend to use it.
BI 2	Given that I had access to the VR system, I predict that I would use it.
BI 3	I plan to use the VR system in the next 3 months.

Appendix 2

: Results of factor analysis and reliability analysis

1) Image (IMG)

Image (IMG)	Component	Communalities	Cronbach's α
Students in my school/institute who use the system have more prestige than those who do not.	0.79	0.63	0.780
Students in my organization who use the system have a high profile.	0.77	0.59	
Having the system is a status symbol in my school/institute.	0.78	0.61	
Total	1.83		
% of Variance	60.98		
Cumulative %	60.98		
KMO and Bartlett's Test			
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.81	
Bartlett's Test of Sphericity	Approx. Chi-Square=104.19		
	df=3		
	Sig.=0.000***		

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

2) Result Demonstrability (RES)

Result Demonstrability (RES)	Component	Communalities	Cronbach's α
I have no difficulty telling others about the results of using the VR system.	0.84	0.71	0.816
I believe I could communicate to others the consequences of using the VR system.	0.91	0.83	
The results of using the VR system are apparent to me.	0.81	0.65	
Total	2.20		
% of Variance	73.23		
Cumulative %	73.23		
KMO and Bartlett's Test			

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.86
Bartlett's Test of Sphericity	Approx. Chi-Square=258.35
	df=3
	Sig.=0.000***

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

3) Computer Anxiety (CANX)

Computer Anxiety (CANX)	Component	Communalities	Cronbach's α
Working with a VR system makes me nervous.	0.88	0.78	0.838
VR systems make me feel uncomfortable.	0.90	0.81	
VR systems make me feel uneasy.	0.83	0.69	
Total	2.27		
% of Variance	75.71		
Cumulative %	75.71		
KMO and Bartlett's Test			
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.81		
Bartlett's Test of Sphericity	Approx. Chi-Square=280.01		
	df=3		
	Sig.=0.000***		

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

4) Computer Playfulness (CPLAY)

Computer Playfulness (CPLAY)	Component	Communalities	Cronbach's α
The following questions ask you how you would characterize yourself when you use VR systems: ...spontaneous	0.90	0.81	0.854

...creative	0.87	0.75	
...playful	0.88	0.77	
Total	2.32		
% of Variance	77.41		
Cumulative %	77.41		
KMO and Bartlett's Test			
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.83	
Bartlett's Test of Sphericity	Approx. Chi-Square=297.14		
	df=3		
	Sig.=0.000***		

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

5) Perceived Enjoyment (ENJ)

Perceived Enjoyment (ENJ)	Component	Communalities	Cronbach's α
I find using the VR system to be enjoyable.	0.85	0.72	0.859
The actual process of using the VR system is pleasant.	0.91	0.83	
I have fun using the VR system.	0.89	0.79	
Total	2.34		
% of Variance	78.14		
Cumulative %	78.14		
KMO and Bartlett's Test			
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.81	
Bartlett's Test of Sphericity	Approx. Chi-Square=321.05		
	df=3		
	Sig.=0.000***		

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

6) Perceived Usefulness (PU)

Perceived Usefulness (PU)	Component	Communalities	Cronbach's α
Using the VR system improves my performance in my English learning.	0.72	0.53	0.875
Using the VR system in my English learning increases my output.	0.90	0.81	
Using the VR system enhances my effectiveness in my English learning.	0.89	0.79	
I find the VR system to be useful in my English learning	0.90	0.81	
Total	2.93		
% of Variance	73.33		
Cumulative %	73.33		
KMO and Bartlett's Test			
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.87	
Bartlett's Test of Sphericity	Approx. Chi-Square=529.88		
	df=6		
	Sig.=0.000***		

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

7) Perceived Ease of Use (PEOU)

Perceived Ease of Use (PEOU)	Component	Communalities	Cronbach's α
My interaction with the VR system is clear and understandable.	0.89	0.79	0.856
Interacting with the VR system does not require a lot of mental effort.	0.90	0.80	

I find that the VR system is easy to use.	0.86	0.74	
Total	2.33		
% of Variance	77.71		
Cumulative %	77.71		
KMO and Bartlett's Test			
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.83	
Bartlett's Test of Sphericity	Approx. Chi-Square=302.82		
	df=3		
	Sig.=0.000***		

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

8) Behavioral Intention (BI)

Behavioral Intention (BI)	Component	Communalities	Cronbach's α
Assuming I had access to the VR system, I intend to use it.	0.75	0.56	0.715
Given that I had access to the VR system, I predict that I would use it.	0.77	0.59	
I plan to use the VR system in the next 3 months.	0.73	0.54	
Total	1.70		
% of Variance	56.53		
Cumulative %	56.53		
KMO and Bartlett's Test			
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.84	
Bartlett's Test of Sphericity	Approx. Chi-Square=73.15		
	df=3		
	Sig.=0.000***		

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Appendix 3

: Pretest quiz paper

Quiz

1. ____ are ten students in my class.
   A. Their
   B. There
   C. These
   D. Them

2. ____ the time? It's 10 o'clock.
   A. What's
   B. When's
   C. How's
   D. Where's

3. I ____ ten years old.
   A. Is
   B. Be
   C. Am
   D. Have

4. Sam ____ like eating lunch.
   A. Don't
   B. Isn't
   C. Doesn't
   D. Aren't

5. They ____ from Seoul.
   A. Don't
   B. Isn't
   C. Wasn't
   D. Aren't

6. ____ you walk to school or do you take a bus?
   A. Do
   B. Are
   C. Does
   D. Is

7. How ____ is this book?
   A. Many
   B. Cost
   C. Price
   D. Much

8. Here ____ S. Let's tell her all the news.
   A. Coming
   B. Comes
   C. Will come
   D. Is coming

9. She ____ her clothes on the floor.
   A. Always leaves
   B. Is always leaving
   C. Always leaving
   D. Always is leaving

10. He ____ to London last week.
    A. Has gone
    B. Went
    C. Did go
    D. Goes

Appendix 4

: Quiz paper used in study 2

Quiz – Police Station

Action Keywords

1. What is the English expression that means '올라타!' ?
   a) Get on! b) Get him! c) Move! Move!

2. What is the English expression that means '잡아라!'?
   a) Found him! b) Get on! c) Get him!

3. What is the English expression that means '임무 완료!'?
   a) Move Move! b) Mission complete! c) Help me!

Vocabularies

4. What is '경찰관' in English?
   a) Police station b) Police officer c) Jail

5. What is '범죄자' in English?
   a) Criminal b) Jail c) Officer

6. What is '대머리' in English?
   a) Moustache b) Freckle c) Bald

7. What is '무단횡단' in English?
   a) Jaywalking b) handcuffs c) steal money

Expressions

Choose the expression in English in the following speech bubble.

8. 도와드릴까요?
   a) May I help you? b) Who is he? c) What can you see?

9. 도움이 필요해요.
   a) I will help you. b) Safety is important. c) I need some help.

10. 저를 구해주셔서 감사해요.
    a) Thank you for picking up the trash. b) Thank you for riding me. c) Thank you for saving me.

초 록

교육에서의 가상현실 기술 (VR) 활용:
초등학교 저학년을 대상으로 한 실험적 연구

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우리는 지금 4차 산업혁명 시대를 살아가고 있다. 4차 산업혁명은 경제와 산업, 직업 분야뿐 아니라 교육 분야에도 큰 영향을 미치고 있다. 사물인터넷과 빅데이터, 인공지능, 가상현실(VR/AR), 메타버스 등 4차 산업혁명 기술들은 교육 현장 및 교수 학습법에도 빠르게 적용되고 있다. 이에 따라 국내에서도 이러한 기법들이 도입되면서 교육계에 큰 변화와 혁신을 몰고 올 것으로 기대한다.

그러나 이러한 기술의 도입은 아직 매우 한정된 특정 분야에만 적용되고 있을 뿐 기술의 학습 효과를 증명해 주는 관련 기준이 현실적으로 모호한 것도 사실이다. 이를 보다 구체적으로 살펴보면, 과학기술 분야에서 우수인재 확보를 위한 소위 스템(STEM:Science, Technology, Engineering, Math) 과목에만 인공지능 기법을 활용하는 경향이 뚜렷하다. 반면 인문사회 과목에는 아직까지 이러한 기법을 활용하는 시도를 찾기란 쉽지 않다.

뿐만 아니라, 4차 산업혁명 기술을 활용한 교육의 유용성을 확보하기 위한 실질적인 기술 이론의 기반 마련에도 어려움을 겪고 있다. 기술의 사용 유무로 교육의 효과를 비교하는 일부 연구들조차 조사 결과의 신뢰도에 문제점이 드러나고 있다. 일례로 조사 대상자 수가 미미하다거나 조사 방식에 있어서도 두 세대의 기기만으로 이뤄져 그 실제적인 효과를 측정하기가 어렵다.

이에 따라 본 연구는 이 같은 조사의 한계점을 극복하기 위한 실험적 연구를 진행하였다. 스템(STEM) 과목이 아니라 세계에서 가장 많이 또한 보편적으로 사용되고 있는 언어인 영어 교육에 4차 산업혁명의 핵심 기술인 VR을 활용해 초등학교 2,3학년 학생들을 가르쳤을 때 이뤄지는 학습의 효용성을 알아보고자 하였다.

이를 위해 두 가지 실험을 진행하였다. 첫 번째 실험은 120명의 초등학교 저학년 학생을 대상으로 기술 수용 이론 3(TAM3: Technology Acceptance Model 3)을 기반으로 VR 기술 사용 의도를 알아보고자 하였다. 두 번째 실험은 VR기술의 학습 효과를 보다 정확하게 알아내기 위한 목적으로 초등학교 저학년 학생 300명을 두 그룹으로 나눠 동일한 내용의 교육을 같은 시간 동안 다른 방식으로 학습시켰다. 우선 한 집단은 전통적인 기법인 교재, 칠판, 오디오, 비디오 등을 활용해 가르쳤다. 또 다른 한 집단은 VR 기법인 360도 스크린 HMD를 활용해

가르쳤다.

첫 번째 실험 결과는 다음과 같다. 기술 수용 이론 3을 기반으로 우선 Image와 Result Demonstrability가 Perceived Usefulness에 미치는 영향 관계를 살펴보았다. 다음엔 Computer Anxiety, Computer Playfulness, Perceived Enjoyment가 Perceived Ease of Use에 미치는 영향 관계를 따져 보았다. 그런 이후 Perceived Ease of Use가 Perceived Usefulness에 미치는 영향 관계를 살펴보았고 Perceived Usefulness와 Perceived Ease of Use가 Behavioral Intention에 미치는 영향관계를 알아내기 위한 분석을 진행하였다. 조사 결과, 모든 가설은 채택이 되었는데 단 하나 Image(β=-0.042)가 Perceived Usefulness에 긍정적인 영향을 미친다는 것은 기각되었다.

두 번째 실험에서는 학습의 효용을 알기 위해 경찰서를 주제로 영어 수업을 20분 정도 각각 진행한 후 관련된 영어 문제를 풀어 그 학습이 얼마나 효과가 있었는지를 측정하였다. 두 집단의 비교 분석을 통해 각 학년별로 전체 집단을 하나로 합쳐 세 차례에 걸쳐 조사를 했는데 세 번 모두 전통적인 방식과 VR 방식에 따라 시험의 점수 차이가 날 뿐만 아니라 VR 방식이 전통방식 보다 점수가 더 높음을 확인할 수 있었다.

위의 연구가 시사하는 바는 다음과 같다. 첫 번째 실험에서 하나의 가설이 기각된 것을 보면, VR 자체를 활용하여 교육을 받는 것이

학생들에게 굉장한 자랑거리가 되지는 않는다는 것이다. 그 근거는 그들이 어려서부터 새로운 기기들을 접한 얼리어답터 MZ 세대로 기기 사용에 대한 수용성이 다른 세대보다 높기 때문이다. 그러나 아무리 기기 활용이 친근한 세대이어도 VR 사용법 자체가 너무 복잡하거나 어려우면 그들은 계속 VR 기술을 사용하는 것을 거부한다는 사실을 발견하게 되었다. 무엇보다도, 이론을 근거로 교육에서의 VR의 효용을 설명했다는 점은 연구로서 의의가 남다르다고 본다.

두 번째 실험에서는 저학년들에게는 VR을 활용한 영어수업은 학습 효과가 매우 탁월하다는 결론을 도출했다. 따라서 스템 과목뿐만 아니라 영어 더 나아가 언어 교육에 VR을 활용한다면 학습 능률이 한층 올라갈 것으로 관측된다.

이번 연구의 시사점은 제한된 실험 참여자와 한두 대의 VR 기기를 활용하여 실험을 진행한 것이 아니라 300명 이상의 많은 실험 대상자와 최신의 여러 장비로 실험을 진행해 신뢰도 높은 결과를 도출해 냈다는 점이다. 그러나 앞으로 경찰서가 아닌 다른 영어 주제, 다른 과목, 다른 학년 학생들을 상대로 실험을 진행할 경우 더욱 의미 있는 연구가 될 것으로 기대한다. 이번 연구를 통해 Offline과 VR 교육 방식에 극명한 차이점이 있음을 발견했고 VR 방식이 Offline 방식 보다 더 효용성이 높음을 확인할 수 있었다.

주요어 : 인공지능, 가상현실, 교육 방법, 언어학습, 기술 기반 학습
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