The Learning Achievement of Airline Business Students on the Virtual Experience during the Pre-flight Emergency Equipment Check Procedures on the Airbus A320 Series Aircraft

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Abstract

The emergence of disruptive technology in mid-1999 caused the industrial revolution, which leverages the benefits of the industry's products and elaborates new ideas for service sectors to a new level. The recent virtual technology brings opportunities to higher education along with these digital adaptations. However, there is a need for experimental research exploring the educational influence of using immersive virtual reality in aviation safety subjects. This quasi-experimental aimed to 1) address the Airline Business students' learning achievement after using virtual reality technology due to retaining knowledge influenced by virtual experience. 2) study the capability of immersive technology based on the Airbus A320 series aircraft's virtual environment that establishes the Airline Business students' learning development in three areas: cognitive domain, psychomotor domain, and affective domain. Two groups of 30 participants were recruited based on a simple random sampling from a total number of 75 third-year Airline Business students in the experimental and control groups. The parametric statistics were conducted on a hypothesis testing by comparing two measurements from the experimental and control groups. The results revealed that the test scores of the experimental group obtained significantly better academic achievement in terms of the knowledge needed to perform tasks than the control group. Besides, the behavioral learning and emotional intelligence required to complete performance-related tasks were noticed in the experimental group. In addition, the effectiveness index (EI) was computed to affirm that the innovative learning tool can be an integral part of the future physical classroom. It indicated that students effectively learn in the aviation safety context via practicing through virtual reality. The virtual experience positively helps motivate and engage students in an aviation safety study. It also profoundly enhances the Airline Business students' competency, including

knowledge, skills, and attitudes needed to perform their future responsibilities as flight attendants.

Keywords: Virtual experience, Learning achievement, Airline Business students, Airbus A320, Emergency equipment

Introduction

Few people know that the flight attendants' duties begin before boarding passengers as defined by the ICAO: International Civil Aviation Organization (2018) mandates the pre-flight check on emergency and medical equipment under Annex 6 Part I - Operation of Aircraft. Their responsibility starts once they board the aircraft to locate and inspect the emergency and medical equipment on each flight, which differs for each airliner and varies according to the aircraft type. It is required that the flight attendants must be familiar with the location of the equipment as mentioned above before the flight as this equipment are essential tools for the safety of passengers and crew members in non-normal and medical situations. For example, if the flight attendants did not know where the first aid kit was located, it could cause a worsening of the passenger's condition. Another example is the emergency circumstance of a cabin fire. Suppose the flight attendants did not become familiar with the locations of the portable fire extinguisher. In that case, the fire might spread rapidly in the cabin, leading to catastrophic consequences. In congruence with Ji et al. (2019), the flight attendants' safety consciousness is crucial to air travel safety and the safety of passengers in hazardous situations such as during rapid decompression, accidents from the cabin fire, and emergency circumstances such as land evacuation or water evacuation. Yelgin and Ergün (2021) interpreted that the job demand of flight attendants is perceived by the ability to contribute a critical role in the airline's operation, preventing accidents and incidents onboard the aircraft.

The College of Aviation Development and Training (CADT), Dhurakij Pundit University, has designed the pre-flight safety training course based on commercial airlines' procedures. The exercise requires our Airline Business students to be familiar with the flight attendant's pre-flight duties and practices and competent in performing the in-flight safety duties professionally during the flight. In addition, the course aims to support our Airline Business students to develop their skills and knowledge and prepare them to be active citizens in the aviation industry. We at CADT have foreseen the benefits of exercising the pre-flight safety procedures in the virtual environment with a 360-degree vision that offers our students the opportunity to gain experience that previously could not be done in the physical classroom. The virtual reality software programming developed by the College of Creative Design and Entertainment Technology, Dhurakij Pundit University, is believed to improve the students' cognitive function and retain a memory of the emergency and medical equipment locations way better than the lecture-based method and support a positive change of students' skills. Inconsistent with Ngiik et al. (2019), the virtual learning approach inspired positive outcomes that collaborate students' skills during exercise while gaining a unique learning experience in a virtual environment. This study focuses on the potential use of immersive technology to fill the learning gaps and make the virtual classroom an integral part of future physical classroom

management. In a way that virtual technology can help promote Airline Business students' knowledge (K), skills (S), and attitudes (A) coherence with the technology-enhanced learning environment, research by Mills et al. (2019) disclosed that technology would bring a difference in teaching pedagogy in modern education.

Objectives

The objectives of this study were

1. To address the Airline Business students' learning achievement after using virtual reality technology due to retaining knowledge influenced by virtual experience.

2. To study the capability of immersive technology based on the Airbus A320 series aircraft's virtual environment that establishes the Airline Business students' learning development in three areas: cognitive domain, psychomotor domain, and affective domain.

Research questions

1. Can experience-based learning through virtual interaction effectively improve learners' comprehension of the content of airline safety procedures to achieve higher scores on the test results?

2. Can immersive technology enhance the learners' competency to gain knowledge (K), skills (S), and attitudes (A) to execute the flight attendant's safety duties and responsibilities under the ICAO: International Civil Aviation Organization (2018), Annex 6 Part I - Operation of Aircraft?

Theoretical background

In modern education, integrating immersive technology in teaching in a classroom is an essential tool for students' learning achievement. It steers to a fundamental change in how the teacher transfers knowledge and skills to students to make complex topics easier to understand. It also helps stimulate the imagination and makes the subject more engaging on the students' part (Davies et al., 2014). Immersive technology comes in several varieties and can be used in various contexts. Immersive technology in education aims to help generate virtual experience by merging the physical world with digital or simulated reality. It supports the extended human senses of reality (vision, sound, and touch) by creating an artificial world in a 3D environment. The learner can look around in the simulated world through the Head-Mounted Display (HMD), which refers to a VR headset. This motion sensor allows a 360-degree vision of a virtual world while eliminating visual contact with the physical world (Calogiuri et al., 2018). The learner can also interact with the virtual features or items in the digital realm with VR controllers. In addition, in the research study, Cheng and Tsai (2020) indicated that immersive technology helps students with low self-efficacy create the ultimate learning experiences, positively showing students' engagement in lessons more than conventional teaching methods. Moreover, the recent research by Makransky et al. (2020) revealed that an immersive virtual reality (IVR) simulation increases students' interest and self-

efficacy and helps raise the students' perspective to value what they learned from the lesson, improving their attitudes toward career aspirations.

The effectiveness of technology creates a positive learning atmosphere that leads to the students' ability to concentrate and maintain their attentiveness during the learning process. The two methods of learning which are very closely related are sensation and perception. Senses are an input process by which learners receive information from the environment. It explains how the physical world is obtained by human sensory receptors such as vision, hearing, taste and smell, touch, and kinesthetic senses (balance). On the other hand, perception involves selecting and identifying information from the environment. It explains how the human brain selects, organizes, and interprets those sensations—the idea corresponded with Dollard and Miller (1950). They established the learning mechanisms, which emphasized drives and habits. Robert Glaser, an American educator, recognized among scholars in educational psychology and a professor at The University of Pittsburgh Dwell, made a significant contribution to theories of learning and instruction. In his research on Training and Education, Glaser Ed. (1962) focused on testing and technology in education and training adapted to students' behavior through the interaction of knowledge and skills. Through technology aid, the learning process increases the behavioral orientation, maximizes the acquisition and retention rate of the learning knowledge, and enhances the students' motivation, allowing excellent improvement and development of their learning ability.

Furthermore, in the same year, another research by Glaser (1962), the Programmed Instruction — A Behavioral View, referred to the programmed material that can teach things more effectively than textbooks or lecture-based teaching methods. It enhances students' comprehension to guide them to subsequent learning systems connected to the psychology of learning, which relates to how people learn. According to Bloom's taxonomy, the educational literature classified learning objectives in three hierarchical models: cognitive, affective, and psychomotor. It is gripping to note that even though the cognitive domain was initially introduced in 1956 by Benjamin Bloom, the affective domain was not described until 1964 and the psychomotor domain in 1970. The cognitive domain refers to the learners' ability to process information meaningfully, primarily related to the mental (thinking) process and knowledge acquisition. It is used to define how well a competency is mastered. The original six categories under the cognitive domain are knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom et al., 1956). However, Anderson and Krathwohl amended the classic taxonomy in 2001. Anderson et al. (2001) revised the original terminology by changing Bloom's categories from nouns to verbs: remember, understand, apply, analyze, evaluate, and create. The structure of the six categories was also re-ordered to reflect the work's relevance in the 21st century. The affective domain refers to the learners' ability to approach learning, which involves feelings, emotions, values, appreciation, enthusiasm, motivation, and a can-do attitude that leads to the behavioral approach to psychology in education. The affective domain is further classified into 5-sub domains structure that moves from uncomplicated feelings to more complexity, namely receiving, responding, valuing, organizing, and characterization (Krathwohl et al., 1964). As a result, the individuals become more involved, committed, and

internally motivated when it stipulates performance-related tasks. This domain describes learner behaviors that explain how people learn and address resistance or acceptance. The psychomotor domain refers to the learners' ability to use motor skills, which require practice. It is related to physical movements and muscular activities. The speed, precision, procedures, or techniques in executing the task can measure this type of domain. Simpson (1972) explained this domain based on body control to achieve a high level of expertise according to coordination with the physical encoding of information, including involuntary responses or autonomic reflexes. Simpson's taxonomy emphasized the progression of mastery of the skills, which focused on utilizing the motor skills and coordinating them, including seven categories: perception, set, guided response, mechanism, complex overt response, adaption, and origination.

Nonetheless, the efficient way of effective learning occurs when students are challenged while performing their tasks and become masters of their skills through practice in a supportive learning environment. The involvement of students in teaching and learning at the emotional state will shape how well and how much the students learn. It occurs when the students develop positive attitudes and perceptions of themselves, their classmates, and the material they are learning. It refers to an experiential learning theory of experience and education explained by John Dewey, a renowned American philosopher. Dewey (1986) described the idea that learners learn more when they actively do the activity by following the views of the learning process. This technique required the learners to engage with the material to generate knowledge of a particular topic binding into learners' values and ideals. Learning by doing offers a personal experience only possible through personal feelings such as motivation, which helps learners embed knowledge into their memory. Even if the learners make errors, their learning experience will guide a better understanding of what needs to be done next time, as the more mistakes they make, the more they learn.

Methods and measurement

This quasi-experiment research was conducted at the College of Aviation Development and Training, Dhurakij Pundit University in Nonthaburi. The participants were randomly recruited into two groups of 30 students from 75 third-year Airline Business students in the experimental and the control groups. The experimental group attended the virtual aviation safety class using virtual reality headsets and controllers to interact in the virtual simulated interior environment of the Airbus A320 series aircraft. The control group attended the conventional lecture-based class in the physical classroom environment. All students had equal prior knowledge of the airline's safety procedures and practices in an emergency circumstance. A test paper of 20 (true or false) questions, following the learning outcomes, require students to 1) identify the locations of each emergency and medical equipment throughout the A320 cabin, 2) specify the total number of each particular emergency and medical equipment according to the locations, and 3) validate the serviceability of each emergency and medical equipment, was given to both groups of students to examine the students' learning performance after the session. The assessment test was incorporated with the airlines' competency to signify

its relevance criteria of the acquired knowledge (K) that meets the airline industry standards under the CAAT: Civil Aviation Authority of Thailand regulations in compliance with the ICAO: International Civil Aviation Organization. The results from both tests were then compared using the paired-samples t-test. The datasets were analyzed using the statistical software program at a 95% confidence interval to accept the null hypothesis. The hypothesized statements based on the research objectives and questions describing the two variables' relationship were tested by comparing the mean difference between the two measurements, score 1 of the control group and score 2 of the experimental group. It is hypothesized that:

Null hypothesis: H_0 Score 2 = Score 1

Alternative hypothesis: H_1 Score 2 ≠ Score 1

Moreover, the skills (S) and attitudes (A) were observed during the students' learning phase, students' reactions were monitored during the exercise, and attitude surveys were conducted via feedback at the end of the session.

Results and discussion

Results

This study focused on the competency (knowledge, skills, attitudes) of the sixty Airline Business students in their third year, divided into two groups of thirty (mean age =21 years old, ten male and twenty female each group) as shown in Table 1. The achievement results of score 1 (control group) and score 2 (experimental group) revealed in Table 2 give univariate descriptive of the statistics mean, the sample size, the standard deviation, and the standard error for the variable entered. It was noticed that the mean of score 2 (Mean = 14.87, S.D. = 1.358) was higher than score 1 (Mean = 7.67, S.D. = 1.807).

Table 1 shows a descriptive analysis of the demographic data for the sixty participants

Demographic		**Experimental Group**	**Control Group**	**Percentage**
Gender	Male	10	10	33%
	Female	20	20	67%
	Total	**30**	**30**	**100%**

Table 2 shows the paired-sample statistics of the distinctive variables

Paired Samples Statistics					
		Mean	**N**	**Std. Deviation**	**Std. Error Mean**
Pair 1	Score 2	14.87	30	1.358	0.2479
	Score 1	7.67	30	1.807	0.3299

Both scores' results were computed using the statistical software program to evaluate the academic success of the paired differences, as shown in Table 3. The findings revealed a significant average difference between score 2 and score 1 ($Mean = 7.20$, $S.D. = 0.887$). Explaining the score 2 was 7.20 points higher than the score 1 (lower 6.869, upper 7.531), ($t_{0.05} = 44.48$, $p = 0.000$, $p < 0.05$). Consequently, the null hypothesis was rejected at the 95% confidence interval. It was interesting to note that immersive technology positively impacted the students' ability to retain knowledge due to increased scores.

Furthermore, the paired samples correlation was tested, as shown in Table 4. The bivariate Pearson correlation coefficient implies that score 2 and score 1 are significantly and positively correlated ($r = .811$, $p < 0.001$), where a correlation coefficient that is equal to one ($r = 1$) indicates perfect linear relationships between the two variables. Figure 1 and figure 2 present the histogram of both scores' standard normal distribution curve.

Table 3 shows the hypothesis test results of the related variables

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Score 2 – Score 1	7.20	0.887	0.162	6.869	7.531	44.480	29	0.000**

**Correlation significant at the 0.05 level

Table 4 shows the correlations coefficient that reflects a linear correlation of the variables

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	Posttest & Pretest	30	0.811	0.000

Pearson Correlation Coefficient test, showing the significance ($p < 0.001$)

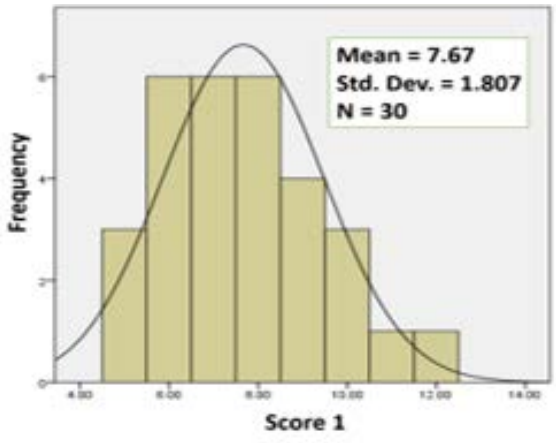

Figure 1 Shows a histogram of score 1 that presents a normal distribution of the control group

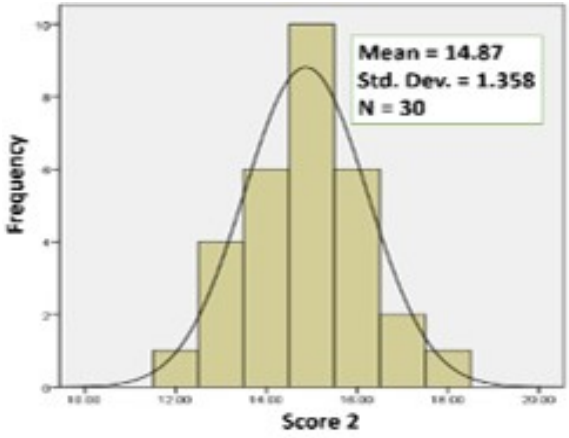

Figure 2 Shows a histogram of score 2 that presents a normal distribution of the experimental group

In addition, the effectiveness index (EI) was computed as a comparative measure to address how much the efficacy of the innovative teaching tool enhanced the students' learning development. According to Goodman et al. (1980), the numerator of the effectiveness index is computed by dividing the amount of change that occurs between P2 (sum score 2 of the experimental group) and P1 (sum score 1 of the control group) by the maximum increase possible score. The formula of the effectiveness index (EI) is:

$$\mathrm{EI} = \frac{\mathrm{P2} - \mathrm{P1}}{(\mathrm{N} \times \text{full score}) - \mathrm{P1}}$$

$$\mathrm{EI} = \frac{446 - 230}{(30 \times 20) - 230}$$

$$\mathrm{EI} = 0.583$$

The result denoted that the effectiveness index (EI) was significant at 53.83% or almost 54% efficiency, which was higher than 0.50 based on a 1.00 scale, where closer to 1.00 implied the higher efficacy of the learning tool.

Tables 5-7 show the summarized matric of learning improvement associated with the measurable verbs in the taxonomy of educational objectives in three learning areas: cognitive domain, psychomotor domain, and affective domain.

Table 5 Assessing the success of learning accomplishment in the cognitive domain

Cognitive Domain, Anderson et al. (2001) adapted from Bloom et al. (1956), refers to the knowledge (K) needed to perform tasks, which relies heavily on students' engagement, understanding, and memory.

Action/Task required to fill the gaps (Subdomains)	**The criterion of analysis questions for the learning objectives**	**Findings on the improvement of score 2** (Yes/No)	**The result findings were assessed from the students' knowledge test after obtaining a virtual experience**
Remember	Can students be able to recall the information learned?	Yes	- Students knew the standard terms of emergency equipment and medical equipment. - Students knew basic concepts of the airline Pre-flight safety procedure check.
Understand	Can students understand and be able to comprehend the knowledge gained?	Yes	- Students understood the method of serviceability check on each onboard equipment. - Students could anticipate the onboard emergency accident and incidents to enhance safety.
Apply	Can students utilize the knowledge learned and relate to a new situation?	Yes	- Students could apply safety principles to manage risk in various onboard situations in the virtual environment of the aircraft cabin. - Students could demonstrate the correct procedure of safety management measures in the virtual environment of the aircraft cabin.
Analyze	Can students provide a reason to categorize the concepts?	Yes	- Students recognized the misconception between safety and security checks. - Students can provide a reason to prioritize important and urgent tasks.
Evaluate	Can students construct the knowledge to establish new meaning?	Yes	- Students could integrate aviation safety principles with the onboard risk assessment.
Create	This sub-domain does not apply to this practice.	n/a	n/a

Table 6 Assessing the success of the behavioral accomplishment in the psychomotor domain

Psychomotor Domain, Simpson (1972), refers to the skills (S), the behavioral learning connected to practice required to complete performance-related tasks.			
Action/Task required to fill the gaps (Subdomains)	**The criterion of analysis questions for the learning objectives**	**Findings on the improvement of score 2** (Yes/No)	**The result findings were derived from observing students' behavior during their conduct of virtual interaction in the virtual environment**
Perception	Can students apply sensory stimulation to relate the action through their senses?	Yes	- Students' motor skills functioned and reacted to sensory stimulation like vision, hearing, touch, and balance. - Students appreciate the behaviors needed to act in the virtual environment.
Set	Are students ready to respond to the phenomena by demonstrating the action needed to perform the pre-flight check duty in the simulated situation?	Yes	- Students progressively built the integrated knowledge and skills required for job performance in the virtual environment. - Students were embedded with competency elements (knowledge and skills) to perform the action needed in simulated emergency phenomena.
Guide Response	Can students simulate the action from the physical world with repeated effort and trial and error in the virtual environment during the practice?	Yes	- Students could perform a calibration motion in which they moved each joint through its full range of motion like the head, hands, and feet. - Students positioned themselves in a suitable part of the virtual environment before beginning the experiment. They used system markers to provide necessary information for critical body segments that allow them to move freely in the safe zone of the physical world.
Mechanism	Can the movement be performed with some level of confidence?	Yes	- Students were at the intermediate stage of becoming familiar with the virtual environment.
Complex Overt Response	Can students coordinate movement patterns to perform more complex actions?	Yes	- Students could integrate and control body movements quickly and accurately with minimum effort in the virtual environment to achieve goals.
Adaptation	This sub-domain does not apply to this practice.	n/a	n/a
Origination	This sub-domain does not apply to this practice.	n/a	n/a

Table 7 Assessing the success of emotional accomplishment in the affective domain

Affective Domain, Krathwohl et al. (1964), refers to the attitudes (A), moral reasoning, and emotional intelligence under variable conditions to perform tasks.			
Action/Task required to fill the gaps (Subdomains)	**The criterion of analysis questions for the learning objectives**	**Findings on the improvement of score 2** (Yes/No)	**The result findings were obtained from:** • **Monitoring of students' reactions during the exercise** • **Attitudinal surveys at the end of the session**
Receiving	Are students attentive to learning through all their senses with willingness?	Yes	- Students were alert and energetic to be exposed to the scenario in the simulated virtual aircraft. - Students were more motivated, as indicated by the increased level of engagement.
Responding	Do students express interest and pay full participation?	Yes	- Students actively followed the virtual instructions and promptly responded to virtual interaction in the virtual environment.
Valuing	Do students associate their knowledge with the activities and the phenomena in the simulated environment of the virtual aircraft cabin?	Yes	- Students related knowledge learned with virtual reality content for each tutorial activity. - Students value the worth of virtual experience and are motivated to continue learning in the virtual environment of the A320 aircraft cabin.
Organizing	Do students synthesize values?	Yes	- Students debated their ideas with one another and sought out additional information regarding the airlines' pre-flight safety procedures to support their beliefs.
Characterizing	Are students willing to spend more time in the virtual environment than in the physical classroom?	Yes	- Students consistently showed interest in learning and began to develop positive behavioral changes in their attitudes toward the context of safety procedures in aviation, which made the subject enjoyable.

Overall, results indicated that Airline Business students construct better knowledge using virtual technology that maintains their rather than passively obtaining the information through lectures in a physical classroom environment.

Discussion

A recent study (Bogan et al., 2019) mentioned that immersive technology promises an extensive return in many industries such as manufacturing, design, and education. Therefore, it is no surprise that immersive technology is the most active topic addressed among scholars in this digital era as a learning tool to enhance students' learning development. The human brain can learn from birth until age; nonetheless, to be good at learning, the human brain needs to be motivated to engage in learning activities and, for this reason, gradually develop intellectual abilities and skills through practice, measured by speed and technique

implementation. Following the learning achievement scores in this research study, the findings are consistent with similar studies, which found that immersive virtual reality has positively impacted learning achievements (Parong and Mayer, 2018; Shi, Wang, and Ding, 2019). The results also disclosed by Prinz et al. (2018) that immersive technology exhibited better cognitive function, motivation, and learning memory in the short-term and long-term performance when the learners can interact with the digital content through the immersive experience. The experiment proved that active learning was highly effective than passive learning. Al-Badrawy (2017) described the same phenomenon in his Engineering classroom experiment. Most Engineering students in the class found that classroom activity was more engaging as some immediately embraced it, while many participated without being convinced. Only a few students found the actions were disrupted. In another research study by Li et al. (2017), a training game was used as a medium for new workers during their initial training compared to the other control group that used the printed reading manual. The results disclosed a high attentiveness among new workers who spent time studying in the training game. They were more engaged and motivated. In addition, the testing results were more effective than the other group in knowledge learning. Consistent with the research paper regarding the average retention rate that adopted the learning pyramid diagram of the National Training Laboratories Bethel, Maine, in the USA. The model indicates that teaching and learning methods are more effective than others as the more active learning modality conducted, the better the knowledge retention in the long-term memory (Lalley and Miller, 2007). The pyramid explains that learners remember only 10% of things they read and 20% of watching and hearing. The higher percentage increase to 30% of what the learners demonstrate and 50% of what they have in a conversation. Practicing-by-doing is better at a 75% retention rate and the highest of 90% as if the learner can teach others. It can be explained that the human brain best gains more information from the environment, the body's movement (including kinesthetic experiences), and all the senses (including sight, hearing, and touch). Besides, the study by (Bot et al., 2005) defined the challenges of the active learning method by applying the learning-by-doing technique, the concept by the philosophy of education John Dewey, an American philosopher, psychologist, and educator. The three components of learning domains: cognitive, affective, and psychomotor, were influential in the classroom that offered real-life simulation-based learning is consistent with Miettinen (2000), which reflected Dewey's theory of thought and action that knowledge is constructed and based on experiences. Knowledge is what students learn from their experiences. Education and experience are a foundation of literature when discussing experiential learning. It also includes interaction between learners and the environment within a social environment.

In addition, the concept of learning domains strongly links the four steps of Bandura's Social Learning Theory: attention, retention, reproduction, and motivation. Bandura (1999) described that the new behavior would happen when 1) the learners value the activities observed by one another and 2) by applying what they have learned, they desire to change their behavior. It is consistent with Abele and Spunk (2009) and Raven and Stephenson (2001) in their studies based on Bandura's self-efficacy theory. They suggested that the learners' belief in their capacity to execute performance essential to construct specific behavior patterns

reflected their confidence and satisfaction. It also helped encourage the learners to devote themselves to the best of their knowledge, enrich their ability, and increase competency levels to achieve excellent performance that meets the expectation of the outcomes. Besides, the research results are in line with Bein, Reggev, and Maril (2014) and Stern (2015) explained that when the learning phase is readily understandable and can be connected to experiences (meaning), there is a dramatically improved retention rate of long-term memory. The findings also indicated that immersive technology helped accomplish a sense of reality that motivated students to participate in airline safety procedures previously dulled due to losing engagement during the conventional lecture class. The value of the virtual experience has increasingly and popularly been discussed when technological advancements offer opportunities to enhance learning and teaching environments (Al-Amri et al., 2020). The technology has become a passage to connect the future use of immersive learning and the potential revolution of education in the 21st century. Overall, the results of this quasi-experimental study explain that the benefits of adopting immersive technology as a learning tool for Airline Business students during the pre-flight safety procedures practicing are 1) help deepen the connection to the complex concepts of airline emergency equipment and medical equipment inspection, 2) providing learning opportunities that would otherwise be impossible for students in the real world, 3) building background knowledge through an immersive experience, 4) eliminating distractions, and 5) building students' confidence and self-efficacy. It also allows broadening of Airline Business students' learning capabilities, who will soon become a future workforce of the airline industry, and marked changes in their competencies that meet future demands.

Conclusions

The safety of the onboard passengers and crew members is the number one priority of every airliner. The flight attendants must check and inspect the emergency and medical equipment before the flight take-off to ensure a high level of safety, as in Annex 6 - Operation of Aircraft - Part I related to cabin safety. Nonetheless, Airline Business students' learning outcomes on the topic were unsuccessful and were found unapproachable with the conventional teaching method in a physical classroom. Therefore, the teacher must develop new pedagogy to adequately respond to the future education era (Barrios, 2021). The classroom concept is where teaching and students' interaction meet the learning process. The researchers have foreseen the benefits of immersive technology to establish a virtual environment, where students can virtually interact with the digital content (experience-based learning) compared with the conventional passive learning method (lecture-based learning).

Regarding the findings, virtual reality can effectively improve intrinsic students' learning competency and support their increased level of academic outcomes. The study was proved by successfully drawing the students' attention, developing their understanding, and prolonging their knowledge retention, which was embedded in their experience.

Recommendations for applying the research results

The ideas for applying the research reflect the following

1) supports teaching and students' development via learning style to utilize the best classroom activities.

2) challenges and motivates students to engage with the learning through virtual experience.

3) assists in developing Airline Business students' core competencies in compliance with learning objectives to prepare them to be active citizens in the aviation industry.

Recommendation for future research

Based on five students' comments, motion sickness symptoms such as nausea and dizziness were reported after the session. Hence, a further study should be conducted on virtual reality sickness and health-related issues while exposed to a virtual environment.

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References

Abele, A. E., & Spurk, D. (2009). The longitudinal impact of self-efficacy and career goals on objective and subjective career success. *Journal of Vocational Behavior, 74*(1), 53–62.

Abo El-Nasr, A.-B. (2017). Role of Engineering Design in Enhancing ABET Outcomes of Engineering Programs at Taif University. *International Journal of Applied Science and Technology, 6*, 9-15.

Al-Amri, A. Y., Osman, M., & Al-Musawi, A. S. (2020). The effectiveness of a 3D-virtual reality learning environment (3D- VRLE) on the omani eighth grade students' achievement and motivation towards physics learning. *International Journal of Emerging Technologies in Learning, 15*(5), 4-16.

Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. New York: Longman.

Annex 6. (2018). Operation of Aircraft Part I, Eleventh Edition. Retrieved from https://ffac.ch/wp-content/uploads/2020/09/ICAO-Annex-6-Operation-of-Aircraft-Part-I-International-commercial-air-transport.pdf.

Bandura, A. (1999). *A social cognitive theory of personality* (pp. 154-196). In Pervin, L., & John, O. (Eds.). Handbook of personality (2nd eds.). New York: Guilford Publications.

Barrios, T. (2021). Teaching competencies for the 21st century. *Academia Letters*, 3183.

Bein, O., Reggev, N., & Maril, A. (2014). Prior knowledge influences on hippocampus and

medial prefrontal cortex interactions in subsequent memory. *Neuropsychologia, 64*, 320-330.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. A. (1956). Taxonomy of educational objectives: The classification of educational goals. Handbook 1: Cognitive Domain. New York: David McKay.

Bogan, M., Bybee, S., & Bahlis, J. (2019). *Increasing XR Technology's Return on Investment through Media Analysis* (pp. 1-14). In Proceedings of the Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC) 2019. Florida, USA: The Interservice/Industry Training.

Bot, L., Gossiaux, P.-B., Rauch, C.-P., & Tabiou, S. (2005). 'Learning by doing': A teaching method for active learning in scientific graduate education. *European Journal of Engineering Education*, *30*(1), 105-119.

Calogiuri, G., Litleskare, S., Fagerheim, K., Rydgren, T., Brambilla, E., & Thurston, M. (2018). Experiencing Nature through Immersive Virtual Environments: Environmental Perceptions, Physical Engagement, and Affective Responses during a Simulated Nature Walk. *Frontiers in Psychology*, *8*, 2321.

Cheng, K.-H., & Tsai, C.-C. (2020). Students' motivational beliefs and strategies, perceived immersion and attitudes towards science learning with immersive virtual reality: A partial least squares analysis. *British Journal of Educational Technology*, *51*, 2956.

Technology integration in schools. (2014). *handbook of research on educational communications and technology, fourth edition*. Retrieved from https://ssrn.com/abstract=2719053

Dewey, J. (1986). Experience and Education. *The Educational Forum*, *50*(3), 241-252.

Dollard, J., & Miller, N. E. (1950). Personality and psychotherapy: An analysis in terms of learning, thinking, and culture. New York: McGraw-Hill.

Glaser, R. (1962). *Training research and education*. *Journal of Research in Science Teaching*, *4*(2), 124-124.

Glaser, R. (1962). Programed instruction—A behavioral view. *American Behavioral Scientist*, *6*(3), 46-51.

Goodman, R. I., Fletcher, K. A., & Schneider, E. W. (1980). The effectiveness index as a comparative measure in media product evaluations. *Educational Technology, 20*(9), 30-34.

Ji, M., Liu, B., Li, H., Yang, S., & Li, Y. (2019). The effects of safety attitude and safety climate on flight attendants' proactive personality with regard to safety behaviors. *Journal of Air Transport Management*, *78*, 80-86.

Krathwohl, D. R., Bloom, B. S., & Masia, B. B. (1964). *Taxonomy of educational objectives: The classification of educational goals, Handbook II: Affective domain*. New York: David Mckay Company.

Lalley, J. P., & Miller, R. H. (2007). The learning pyramid: Does it point teachers in the right direction? *Education, 3-13*(128), 64-79.

Li, K., Hall, M., Bermell-Garcia, P., Alcock, J., Tiwari, A., & González-Franco, M. (2017). Measuring the learning effectiveness of serious gaming for training of complex

manufacturing tasks. *Simulation & Gaming, 48*(6), 770-790.

Makransky, G., Petersen, G. B., & Klingenberg, S. (2020). Can an immersive virtual reality simulation increase students' interest and career aspirations in science? *British Journal of Educational Technology, 51*(6), 2079-2097.

Miettinen, R. (2000). The concept of experiential learning and John Dewey's theory of reflective thought and action. *International Journal of Lifelong Education, 19*(1), 54-72.

Mills, K., Jass Ketelhut, D., & Gong, X. (2019). Change of Teacher Beliefs, But Not Practices, Following Integration of Immersive Virtual Environment in the Classroom. Journal of Educational Computing Research, 57(7), 1786-1811.

Ngiik Hoon, L., & Shaharuddin, S. (2019). Learning Effectiveness of 3D Hologram Animation on Primary School Learners. *Journal of Visual Art and Design*, *11*, 93-104.

Parong, J., & Mayer, R. E. (2018). Learning science in immersive virtual reality. *Journal of Educational Psychology, 110*(6), 785-797.

Prinz, N., Schleyer, C., & Kurth, M. (2018). *Analysis and Verification of the Effectiveness and Efficiency of Virtual Reality Training* (pp. 1-6). In Proceedings of the 2018 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC). Stuttgart, Germany: Institute of Electrical and Electronics Engineers.

Raven, J., & Stephenson, J. (2021). *Competence in the Learning Society*. NewYork: Peter Lang Verlag.

Shi, A., Wang, Y., & Ding, N. (2022). The effect of game–based immersive virtual reality learning environment on learning outcomes: Designing an intrinsic integrated educational game for pre–class learning. *Interactive Learning Environments*, *30*(4), 721-734.

Simpson, E. J. (1972). *The classification of educational objectives in the psychomotor domain*. Washington DC: Gryphon House.

Stern, E. (2015). *Intelligence, prior knowledge, and learning* (pp. 323-328). In Wright, J. (Ed.). International encyclopedia of the social & behavioral sciences (2nd eds.). Waltham, MA: Elsevier.

Yelgin, Ç., & Ergün, N. (2021). Job demands perceived by cabin crew in airline companies: A case in Turkey. *Theoretical Issues in Ergonomics Science, 22*(2), 200-218.

Appendix A

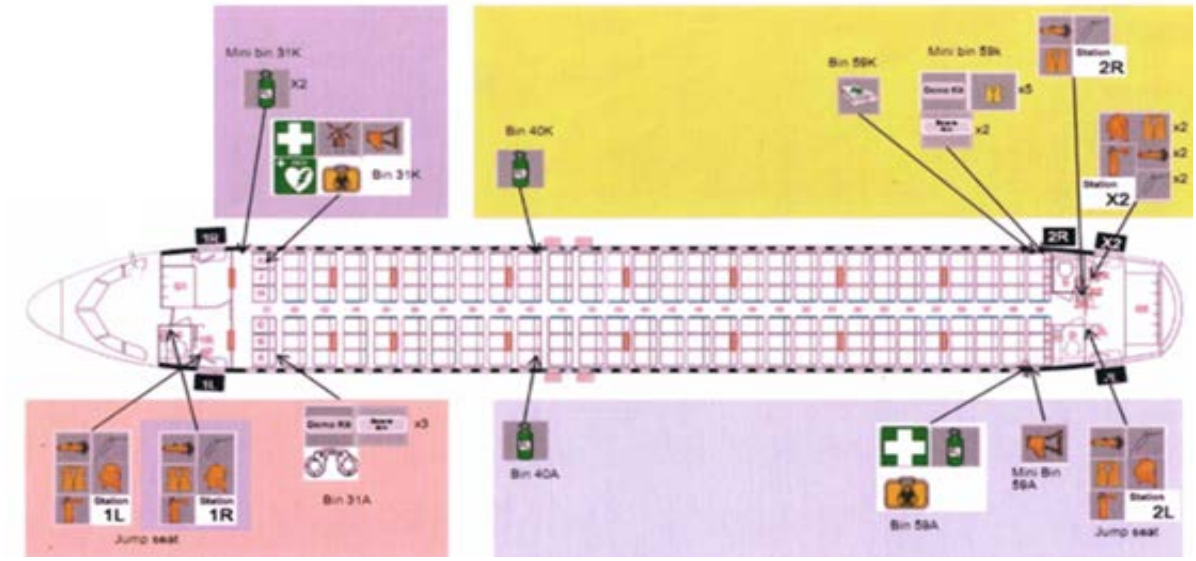

Figure A1 The interior diagram of emergency and medical equipment locations carrying on the Airbus A320 series aircraft.
Source Thai Airways International

Figure A2 Oculus Rift VR devices consist of headsets, hand controllers, and track markers

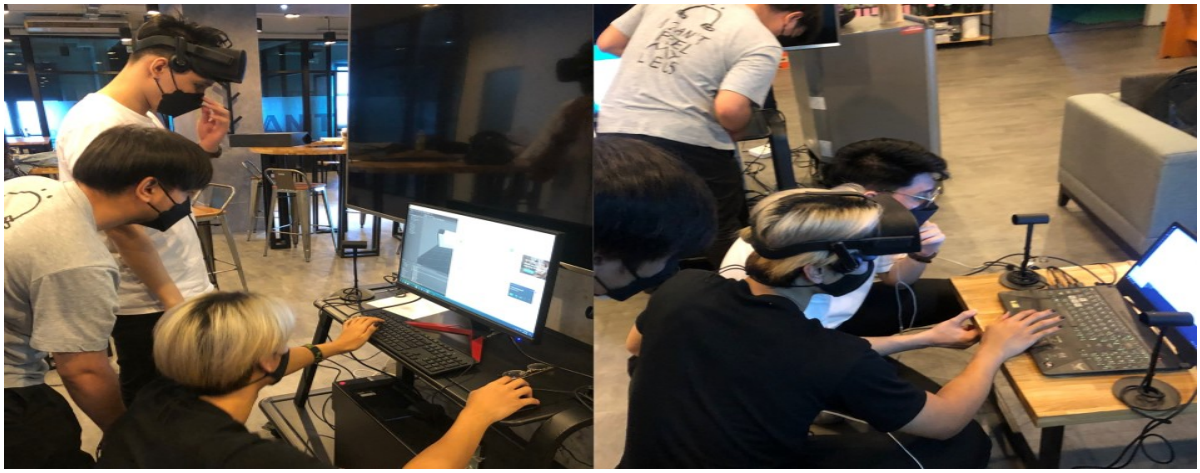

Figure A3 Students were helping each other set up the VR devices with the application

Figure A4 Student explored content using the Oculus Rift headset and hand controllers

Figure A5 The simulated virtual cabin interior design inside the Airbus A320

Figure A6 Virtual hands' movement interaction of the student using VR controllers

Figure A7 Digital content inside the simulated virtual aircraft cabin