Assessing Aviation Knowledge Among Bs Air Transportation Students Through Flight Simulation Training

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***Abstract*: This study examined how flight simulation training supports aviation knowledge among BS Air Transportation students across all academic levels. Findings from the survey revealed clear improvement in students' post-test performance, stronger procedural recall, and better comprehension of flight tasks after structured simulator exposure. Students reported that realistic visuals, accurate instrument behavior, and repeated practice helped them connect classroom lessons with hands-on application. Repetition enhanced their timing, situational awareness, and ability to correct errors during maneuvers such as landings. Lower-year students benefited from early familiarity with cockpit layout through basic desktop simulators, easing their transition into more advanced training. Upper-year students demonstrated strengthened decision-making, emergency handling, and confidence under high-pressure scenarios. Preparatory lectures and demonstration videos supported learning by giving students a clear understanding of each task prior to simulator use. Using ANOVA, results showed no significant difference across year levels ($p = 0.055$), indicating that simulation supports aviation knowledge consistently for both beginners and advanced students. Interview insights confirmed the quantitative results, as students emphasized the value of a safe environment, visual feedback, and repeated correction in strengthening their understanding and execution of flight procedures. Overall, the study demonstrates that flight simulation provides a practical, structured, and engaging learning platform that helps aviation students integrate theory with hands-on application, develop procedural discipline, and build essential skills needed for professional flight training.**

***Keywords*: Aviation, BS Air Transportation Students, Flight Simulation, Knowledge Retention, Simulator Training.**

1. Introduction

Aviation is a highly technical discipline that demands precision, safety awareness, and the ability to apply theoretical knowledge in real-world contexts. While classroom instruction provides the necessary foundation in principles and concepts, knowledge retention can be challenging when learning remains largely abstract. To address this gap, flight simulation training has been introduced as a complementary instructional tool. By replicating flight conditions and operational scenarios in a safe

and controlled environment, simulation allows students to engage in experiential learning. This not only reinforces theoretical understanding but also strengthens decision-making skills and prepares learners for the complex demands of the aviation profession.

In an Aeronautical School, the BS Air Transportation program is designed to prepare students for the demands of the aviation industry, where precision, safety, and applied knowledge are essential. Aviation is a technical discipline where classroom lectures on aerodynamics, navigation, meteorology, and safety procedures provide the theoretical foundation, but knowledge retention is often difficult when the learning process remains abstract. To strengthen retention and bridge theory with practice, the Redbird R-FMX 100438 full-motion flight simulator has been integrated into training as a complementary instructional tool. The simulator replicates realistic flight conditions and operational scenarios in a controlled environment, allowing students to practice maneuvers, build decision-making skills, and apply their academic learning in a risk-free setting.

Training through flight simulators improves students' understanding and knowledge retention because it turns abstract lessons into applied tasks. Guthridge and Clinton Lisell (2023) showed higher post-test scores after simulator sessions, which indicate stronger recall and improved learning. Nasir et al. (2024) explained that structured simulation builds confidence and competence by giving students a safe space to practice procedures without operational risk. Wu (2020) also reported measurable gains in primary flight training after repeated simulator exposure. Khalid (2020,2021) emphasized that combining lectures, readings, and videos with simulation strengthens memory.

and supports better performance than classroom methods alone. Dincer (2023) added that immersive simulations improve engagement and decision making, while Ng et al. (2023) found that online simulations increase motivation and strengthen knowledge even for beginners. These studies show that simulation directly supports retention by allowing active practice, repeated correction, and immediate application of theory.

Realism and accuracy in simulation are essential because they shape how students interpret aircraft behavior and flight conditions. Lefrançois, Mattin, and Causse (2021) demonstrated that simulator-based training improves landing performance and vertical control under poor weather conditions, with results similar to experience by pilots. Kaufeld et al. (2022) reported higher altitude and navigation accuracy in PC and VR-based simulators, while Guthridge and Clinton (2021) found better altitude maintenance among students exposed to realistic visual and instrument cues. Wang (2022) noted that improvements in aerodynamics modeling increased realism, and Xu et al. (2021), together with Wei et al. (2023), showed that advanced navigation and alignment systems improve reliability during training. Hariri et al (2022) linked realistic simulation environments to higher institutional performance, including increased rates. Smith et al. (2019) highlighted that simulators support cockpit interface testing with high precision. These studies confirm that realism and accuracy strengthen training by giving learners conditions close to real flight.

Flight simulation supports aviation knowledge for both lower- and upper-year students, although the experience differs at different levels. For lower-year learners, Puiu (2019) explained that basic simulators help students build early familiarity with cockpit layout and procedural flow without a high workload. Mora Soto et al. (2021) added that simulation develops early motor coordination and basic control handling. For upper-year students, Shortle (2023) showed how structured evaluation models strengthen competence in advanced tasks, while Cross and Ryley (2025) demonstrated improved situational awareness and teamwork during multi-crew VR simulations. Hariri et al. (2022) reported that simulation reduces student failure rates during complex training stages. Li et al. (2020) highlighted stronger safety awareness when students train using simulated terrain and emergency cues. These findings show that lower year students gain fundamental skills, while upper year students develop advanced judgement, emergency procedures, and crew coordination, making simulation useful across all stages of aviation training.

Collectively, these studies demonstrate that simulation contributes to measurable gains in knowledge retention, technical proficiency, situational awareness, and decision making while creating an effective and safe training environment. The Redbird R-FMX 100438 provides BS Air Transportation students with structured opportunities to reinforce classroom learning, apply theoretical principles to realistic flight operations, and experience scenarios that prepare them for actual flight tests and professional responsibilities. By situating this research within the local context, assessing knowledge retention through simulation training is critical, as it evaluates not only how effectively students master theoretical contents but also how they apply it under conditions that mirror real-world aviation. This study seeks to contribute to the advancement of aviation education by evaluating the effectiveness of flight simulation in reinforcing student learning and knowledge retention.

The findings are anticipated to benefit students by demonstrating how simulation-based training supports deeper understanding, assist instructors by providing insights that can enhance teaching methodologies, and guide academic institutions in strengthening curriculum design and instructional strategies. The study also emphasizes the importance of incorporating innovative training approaches to ensure that future aviation professionals are not only equipped with theoretical knowledge but also capable of applying such knowledge effectively in practical contexts.

A. Background of the Study

The RedBird flight simulator currently provided at a Parañaque-based aeronautical school is the SD/CL Model 1: R-FMX 100438, classified as a Level A flight simulator, which offers fundamental flight simulation capabilities. According to the Head of Academic Affairs, the Memorandum of Agreement (MOA) between the school and the First Aviation Academy (FAA) was officially signed on April 1, 2024, and is set to remain in effect until its termination date on March 21, 2027.

Globally, flight simulators have been recognized as effective platforms for enhancing student learning outcomes, particularly in decision making, situational awareness, and procedural accuracy. Research indicates that simulation-based training supports knowledge retention by providing repetitive and experiential learning opportunities that strengthen memory recall under conditions similar to real-world aviation operations (Salas, Tannenbaum, Kraiger, & Smith Jentsch, 2012). Assessing the impact of simulation on knowledge retention is therefore vital for institutions that prepare students for professional pilot practice.

In the Philippines, higher education institutions offering aviation programs have increasingly integrated simulation into their curricula to align with international standards in pilot education (Civil Aviation Authority of the Philippines, 2020). Parañaque City has been a center for aviation-related education, with the school being one of the pioneering schools since its establishment in 1969. Over the decades, it has continually adapted its curriculum to meet evolving industry requirements and technological advancements.

Recently, the aeronautical school entered into a partnership with First Aviation Academy (FAA) to further strengthen its training framework. Through this collaboration, a RedBird flight simulator was installed on the campus, giving students access to hands-on flight operations in a controlled environment. However, the simulator experience provided to students during the study was conducted **solely** for exposure purposes and was limited to a 30-minute hands-on session per student. This limited duration was intended to familiarize students with cockpit controls, basic maneuvers, and procedural flow rather than serve as full-scale training. The RedBird simulator replicates cockpit conditions with precision, allowing learners to practice navigation, instrument use, and emergency procedures in line with international training practices (Federal Aviation Administration, 2021).

The introduction of simulation technology into the BSAT curriculum demonstrates a significant progression in aviation education at the local level. Historically, the school has maintained its relevance by aligning with both domestic regulatory requirements and international best practices. The integration of the RedBird simulator reflects a global trend where simulation is recognized not only as a cost-efficient alternative to actual flying but also as a reliable platform for assessing knowledge retention and pilot readiness (European Union Aviation Safety Agency, 2022).

1) Scope and Limitation of the Study

This study focuses on assessing aviation knowledge retention among BS Air Transportation students through exposure to flight simulation training at a selected aeronautical school in Parañaque City. It encompasses both lower-year and upper-year students enrolled in the BS Air Transportation program. The scope includes their experiences and perceptions after engaging in a **limited 30-minute hands-on session** with the RedBird R-FMX 100438 flight simulator, as well as their observations during preparatory lectures and demonstration activities.

However, the study is limited to short-duration simulation exposure conducted within an academic setting and does not extend to full flight training, graded simulator assessments, or programs implemented by other aviation institutions. The findings rely on self-reported responses and instructor observations, which may reflect subjective perceptions of learning. Variables such as simulator fidelity, instructor approach, prior knowledge, and student motivation are beyond the control of the researchers. Despite these constraints, the study provides valuable insights into how even brief simulation exposure contributes to aviation knowledge retention and supports continuous improvement in aviation education methodologies.

In addition to the training, the study acknowledges that many BS Air Transportation students independently utilize desktop-based flight simulators and supplement their classroom learning. These accessible, self-directed learning tools allow students to repeatedly practice fundamentals of aviation concepts, including aircraft control, navigation procedures, and situational awareness.

B. Theoretical Framework

This study focuses on experiential learning. It demonstrates how students build knowledge by performing tasks, reflecting on results, adjusting their actions, and practicing in a structured environment.

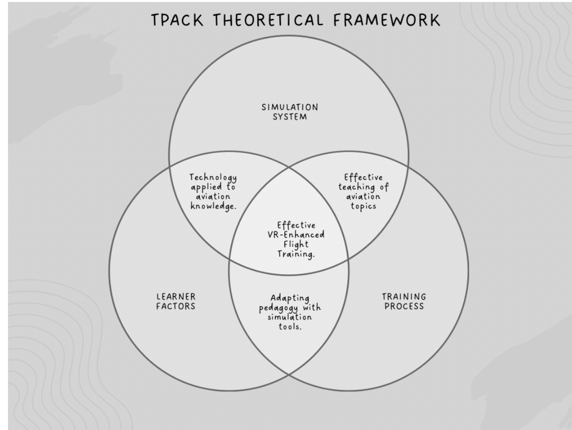

Fig. 1: TPACK Theoretical Framework

The flight simulator aids this process by providing repeated exposure to real operational tasks, clear feedback, and a controlled setting that limits distractions. Students perform flight procedures, observe the outcomes, and fix mistakes through guided repetition, which boosts long-term retention.

The adapted TPACK framework also plays a role in this study by highlighting three elements that influence learning during simulation. The system offers realistic visuals, instrument responses, and task scenarios. The training process includes pre-session briefings, support during sessions, repeated procedures, and focused corrections to help students grasp each task. Factors like year level, prior experience, and familiarity with concepts affect how students tackle tasks, how quickly they improve, and how well they remember information. By combining action, reflection, realistic systems, structured instruction, and learner characteristics, this approach explains why students show measurable improvement after repeated practice with consistent controls, visuals, and procedures throughout their training.

C. Conceptual Framework

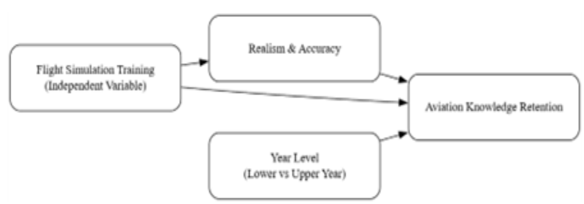

Fig.2. conceptual framework on the effect of flight simulation training on aviation knowledge retention

The conceptual framework presents the relationship between simulation systems, training processes, learner factors, and aviation knowledge retention. Simulation systems include the visuals, instrument controls, and environmental features that shape how students perform tasks. Training processes include organized steps that guide students through practice, feedback, repetition, and correction. Learner factors reflect the year level of the student, past exposure to flight procedures, and the level of familiarity with the operational tasks included in the sessions. These three elements influence each other, and their interaction shapes the overall training outcome measured in this study. SOP 1 connects to how training processes influence retention, which shows the role of guided tasks and structured practice in strengthening memory. SOP 2 connects to simulation systems because the accuracy, responsiveness, and realism of the simulator influence how students understand and apply procedures. SOP 3 connects to learner factors because different year levels show different levels of familiarity with flight concepts, which influences how fast they improve during simulation sessions. The center of the framework shows aviation knowledge retention as the final point where these elements combine. Students who experience realistic systems, receive structured guidance, and enter with specific learner characteristics show measurable changes in performance. This framework illustrates how the environment, instruction, and learner attributes interact to produce the outcomes measured in the study.

D. Statement of the Problem

The study aimed to find how effective flight simulation training is in enhancing and retaining aviation knowledge among BS Air Transportation students. Specifically, the study sought the answers to the following questions:

1. How does undergoing training using a flight simulator influence students' understanding and knowledge retention?
2. To what extent are realism and accuracy attainable through flight simulation during training?
3. Assessing aviation knowledge among BS Air Transportation students through flight simulation training
   a) Lower year (1st and 2nd year)
   b) Upper year (3rd years and 4th year)
4. Is there a significant difference in aviation knowledge retention between lower year (1st and 2nd year) and upper year (3rd years and 4th year) BS Air Transportation students after flight simulation training?
5. How did simulator-based training improve your landing skills, situational awareness, and ability to correct habits during flights, and what role did repetition and visual play play in helping you retain procedures?
6. Based on the collected information, how do preparatory lectures, demonstration videos, and early desktop simulator practice improve future training?

E. Hypothesis

There is no significant difference in aviation knowledge retention between lower-year and upper-year BS Air Transportation students after undergoing flight simulation training.

F. Significance of the Study

The study is important to the following recipients:

BS Air Transportation Students: As primary participants, students' experiences and perspectives will be documented and analyzed. The study will help them recognize the value of simulation in their training, encourage reflection on their learning experiences, and foster personal growth and confidence in using simulator equipment.

Aviation School: In partnership with the First Aviation Academy, will directly benefit from the development of flight simulation centers for more realistic pilot training. They have already inaugurated a new flight simulation center equipped with a RedBird flight simulator, a direct investment in enhanced aviation training, and a partnership between the institutions to raise aviation standards.

Flight Simulator Instructors: This study provides instructors with insight into how students perceive instruction and simulator sessions. By identifying common learning challenges, it highlights opportunities to improve teaching methods and communication. The findings aim to support the creation of a more engaging and student-centered training environment that aligns with learner needs.

Airline Company: Being the largest operator of the A330-neo in Asia, this new simulator will provide additional training capacity and heighten the safe operation of this state-of-the-art aircraft. This expansion will help meet the growing demand for pilot training as Cebu Pacific continues to grow its network and widebody fleet.

Future Researchers: This study can serve as a valuable reference for future scholars interested in flight simulation training satisfaction or instructional effectiveness. By providing local data and context from an Aeronautical School, it offers a foundation for comparative studies, deeper investigation into training technologies, and further exploration of student learning experiences in aviation education.

2. Methodology

A. Research Design

The researchers utilized a mixed-method approach, combining both quantitative and qualitative techniques to achieve a comprehensive assessment of aviation knowledge retention among BS Air Transportation students. Since the study includes qualitative statements of the problem (SOP), especially those requiring deeper insight into student experiences, perceptions, and explanations, the qualitative component played an important role in supporting and expanding the quantitative findings. The qualitative SOP was addressed through thematic analysis of students' and instructors' interviews, allowing the researchers to capture personal experiences, behavioral observations, and learning patterns that cannot be fully measured by numerical data alone.

For the quantitative phase, the study employed a quantitative explanatory design supported by evaluative components. A structured survey questionnaire was used as the main research instrument to measure students' perceptions of realism, accuracy, and learning effectiveness before and after flight simulation training. The explanatory component sought to clarify how factors such as simulator realism, instructional interaction, and repetition contributed to aviation knowledge retention.

To determine which aspects of flight simulation students found most influential, a MaxDiff Analysis was conducted. This analytical approach allowed the researchers to identify priority learning factors and perceived strengths of simulation-based instruction. Statistical treatments, including frequency, percentage, weighted mean, and ANOVA, were used to analyze variations in learning outcomes across age groups and year levels.

To complement and deepen these results, qualitative interviews were performed with one aviation professor and two students representing lower- and upper-year levels. These interviews provided richer explanations regarding student experiences, skill development, and behavioral changes observed during simulator training. Themes gathered from qualitative responses helped validate the numerical findings and offered a clearer understanding of how simulation supports long-term aviation knowledge retention

B. Respondent

The respondents of this study are students from an aviation institution who have participated in flight simulator training as part of their academic activities, although the use of a flight simulator is not a mandatory requirement for the BS Air Transportation program.

The total population of the BS Air Transportation program comprises 775 students from the lower years to the upper years. Using Slovin's formula, the researchers calculated a target sample size of 264 students. Considering the voluntary nature of participation, the researchers relied on an expected acceptance rate of 30–40% for participation; the projected number of respondents from a sample of 264 would be between 79 and 106 students. In actual data collection, 112 students responded, which represents 42.42% of the sample. This proportion is higher than the expected acceptance rate, indicating a greater level of participation than anticipated.

To further enhance the quantitative findings, the researchers conducted qualitative interviews after the survey phase. Three individuals were interviewed. One validator who is an aviation professor at the institution and two students who are divided into their respective year levels, which are lower-year and upper-year. The qualitative responses support the quantitative findings and contribute to a more holistic understanding of the students' simulator training experience.

Table.1. Profiling of Respondents According to Year Level

Year Level	Frequency	Percentage
Lower Year	48	42.86%
Upper Year	64	57.15%
Total	**112**	**100%**

Table 1 presents the distribution of respondents according to their year level in the BS Air Transportation program. A total of 112 students participated in this study.

The data shows that respondents are composed of students from all academic year levels, specifically lower-year to upper-year. Among them, the upper year has the highest participant with a frequency of 64 (57.15%), on the other hand, the lower year has 48 (42.86%). This composition ensures that data were collected from students with varying levels of academic exposure and simulation experience.

The relatively higher participation of upper-year students suggests that upper-level students are more engaged and familiar with flight simulation activities; their greater exposure to practical training may contribute to stronger retention of aviation knowledge compared to lower-year students, who are still developing foundational understanding. This distribution supports a comparative analysis of knowledge retention across different academic levels.

It is advised that simulation-based learning be gradually implemented throughout all year levels in order to improve knowledge retention and practical competence (Guthridge & Clinton-Lisell, 2023; Lefrança et al., 2021; Khalid, 2021; Dincer, 2023). While advanced simulation for upper-year students can strengthen critical decision-making and operational proficiency, early integration of flight simulation in lower years can help students connect theoretical lessons with applied scenarios.

Table.2. Profiling of Respondents According to Year Level

Age	Frequency	Percentage
Below 18	3	2.68%
18-20	63	56.25%
21-23	41	36..61%
23 and above	5	4.46%
Total	112	100%

Table 2 presents the age distribution of 112 BS Air Transportation students who participated in the study on assessing aviation knowledge retention through flight simulation training. Identifying the respondents' age range provides context for the demographic characteristics that may be involved in learning performance.

The table shows that most of the respondents are aged 18-20 years old, with 63 students (56.25%), followed by 21-23 years old with 41 students (36.61%). On the other hand, 5 students (4.46%) are 23 and above, and only 3 students (2.68%) are below 18 years old. This shows that the majority of the respondents are within the usual college age range.

The 18-20-year-old range shows that many participants are in the early stage of their academic training. Moreover, the 21-23 and above likely possess more exposure to advanced flight simulation training, which could contribute to deeper aviation knowledge retention.

Guthridge & Clinton-Lisell, 2023; Lefranço et al., 2021; Khalid, 2021; Dincer, (2023. Future studies should look at how exposure to simulators interacts with age and academic maturity to influence learning outcomes. While older students can be challenged with advanced flight scenarios that improve situational awareness and decision-making, younger students may benefit from greater simulation integration early in the curriculum to strengthen foundational understanding. This method guarantees that students of all ages acquire both theoretical mastery and applied competence through simulation, supporting the ongoing improvement of aviation training programs like the BS Air Transportation curriculum.

C. Settings

The study was performed in an aviation institution, chosen for its specialized facilities, particularly its access to flight simulators. The participants of the survey were selected through a combination of simple random sampling and snowball sampling to ensure a broad representation of students of all year-levels in the BS Air Transportation program.

This method ensured that representation and fairness are both proportional, which was really important to students who took and experienced flight simulator training, which influences students' knowledge retention and learning outcomes.

D. Instrumentations

A quantitative research approach was used to ensure accurate responses to the results. The primary research instrument was a validated questionnaire using a 4 point likert scale, it is used to measure students' agreement on various aspects of simulator training.

The researchers developed the questionnaire based on the review of related literature (RRL) and the statement of the problems (SOPs) presented in their study. It was designed to collect data that would directly address the researchers' objectives. The questionnaire was divided into several parts for better organization and focus. These survey questions aimed to gain deeper insights and explanations that would help support the quantitative results.

The questionnaire was then validated by the researchers' professors, who provided feedback and suggestions for improvement. Based on the validation results, several revisions were made. Some questions were rephrased for better understanding, redundant items were removed, and technical terms were simplified. Through these modifications, the final version of the questionnaire became more organized, valid, and reliable for data collection. After finalizing the instrument, a pilot test was conducted to check the clarity, reliability, and consistency of the questions. The pilot test data were computed using Cronbach's Alpha, a statistical measure used to determine the reliability of the survey questions. The computed Cronbach Alpha was valued between 0.89 and 0.91, which is considered excellent reliability, meaning that the items in the questionnaire consistently measured students' perception regarding flight simulation training.

Quantitative data were processed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize demographic information and general trends in student responses. These analyses provided insights into overall satisfaction with the simulator training and highlighted key areas of strength and improvement. Analysis of Variance (ANOVA) was employed to determine if significant differences existed between student experiences across year levels. A significance level of $\alpha = 0.05$ was set to guide the interpretation of results and the acceptance or rejection of the null hypotheses.

Furthermore, for the quantitative analysis, qualitative data were collected through interviews with one aviation professor and two student participants. Responses were examined using thematic analysis to identify recurring patterns and insights that complemented the survey findings.

The researchers utilized a semi-structured interview guide consisting of six open-ended questions to collect deeper qualitative insights. The interview process involved one validator, an aviation instructor, and two student respondents representing the lower- and upper-year levels. The questions explored their experiences with simulator training, focusing on how it affected landing performance in difficult conditions, changes from pretest to post-test, understanding and retention of lessons, skill improvement in a simulated environment, the effectiveness of preparatory lectures and demonstration videos, and early cockpit familiarization gained from using a basic desktop simulator. These questions were aligned with the study's statement of the problem to support and validate the quantitative findings. The open-ended format allowed respondents to freely describe challenges, improvements, and specific learning moments, generating rich narrative data. Their responses were examined using thematic analysis, enabling the researchers to identify recurring patterns and insights that reinforced the overall conclusion that simulator-based training significantly enhances aviation knowledge retention among BS Air Transportation students.

E. Data Analysis

The collected data were analyzed using appropriate statistical techniques to interpret the students' experiences with flight simulation training. Frequency and percentage were used to summarize the demographic content of the respondents, including age and year level, while the weighted mean described their perceptions of simulation, accuracy, and its impact on aviation knowledge retention. These descriptive measures allowed the researchers to assess overall trends and compare responses across different student groups.

Slovin's formula was utilized to determine the required sample size for the survey from the BS Air Transportation population of the aviation school. The researchers employed convenience sampling through direct student contacts, supplemented by snowball sampling to increase participation from other year levels.

To further analyze the differences in perceptions and learning outcomes, the study utilized Analysis of Variance (ANOVA). This method allowed the researchers to identify significant differences among student groups and determine whether the null hypothesis would be accepted or rejected. ANOVA was specifically used since it is appropriate for comparing multiple groups rather than two groups alone.

All survey responses were cleaned and processed using Statistical Package for the Social Sciences (SPSS) to simplify and arrange the entire analytical process. Both the computation of the ANOVA results to evaluate significant differences across student groups and the compilation of the descriptive statistics used to summarize respondent demographics and weighted mean scores were made possible by SPSS. By using this approach, the analysis yielded precise and comprehensible results that validated the study of BS Air Transportation students' retention of aviation knowledge

F. Ethical Considerations

Personal information is kept confidential by the researchers. The surveys used to collect the data required for the study were carried out in compliance with established protocols, protecting participant privacy. Participants were assured that their participation in the study would be kept private and confidential and that it would not interfere with their day-to-day activities. Ensuring that all data is gathered and stored securely requires adherence to data protection laws, such as the Data Privacy Act of 2012. Participants will be informed by the research team about the type of data being collected and its intended use.

Confidentiality and anonymity were guaranteed, no personal identifiers were collected, and all responses were used solely for academic analysis. Participation was voluntary, and students could withdraw at any stage without repercussions. The researchers adhered to the ethical principles of respect, integrity, beneficence, and non-maleficence in handling data and reporting results.

3. Result And Analysis

A. Training using a flight simulator enhances students' understanding and improves their retention of aviation knowledge.

This section presents the students' assessment of how flight simulator training affects their understanding and retention of aviation knowledge. The use of simulators aims to enhance the theoretical and practical learning experiences of BS Air Transportation students by providing a realistic and interactive training environment that mirrors real-world flight conditions.

A 30-minute flight simulation session effectively assesses aviation knowledge among both lower- and upper-year BS Air Transportation students. For early-year students, simulation links classroom concepts to real cockpit tasks, especially in practicing basic landings and situational awareness. Upper-year students benefit by refining their techniques, correcting habits, and managing more advanced scenarios. Repetition strengthens their familiarity with procedures, while visual cues—such as runway markings and instrument displays—enhance recall. Together, these elements show how simulator-based training improves landing skills, situational awareness, and procedural retention.

The data were gathered through a structured questionnaire focusing on seven indicators related to students' performance, competence, and confidence during simulation training. Responses were measured using a four point likert scale, with computed weighted means ranging from 3.44 to 3.61. These values fall within the "Strongly Agree" interpretation range, indicating a high level of agreement among participants regarding the positive effects of flight simulator training.

The consistently high mean scores imply that flight simulation significantly improves students' understanding and retention of aviation concepts. Items such as "Flight simulation training provides a better learning experience for my aviation studies" (WM=3.61) and "Simulator training improved my performance after the post-test compared to the pre-test" (WM=3.58) show that experiential and immersive learning leads to enhanced comprehension and skill application. These findings align with TPACK, suggesting that learners retain more information when actively engaged in practical scenarios that simulate authentic flight operations.

The findings are consistent with the reviewed literature. Moesl et al. (2023) found significant improvement in post-test performance among trainees exposed

Table.3. Summary of students' perceptions on the influence of flight simulator training.

Questions	S.D	W.M	Remarks
1.1 Simulator training improved my performance after the post-test compared to the pre-test.	0.51208	3.58	Strongly Agree
1.2 Simulator training increased my competence in handling real flight tasks.	0.53685	3.50	Strongly Agree
1.3 Simulator training improved my ability to demonstrate correct flight behaviors.	0.5149	3.57	Strongly Agree
1.4 Simulator training improved my landing performance in challenging flight conditions.	0.56695	3.44	Strongly Agree
1.5 Virtual Reality training increases my confidence in performing flight maneuvers.	0.56942	3.49	Strongly Agree
1.6 Flight simulation training provides a better learning experience for my aviation studies.	0.52411	3.61	Strongly Agree
1.7 Flight simulation provides a more comfortable experience in my training.	0.50663	3.61	Strongly Agree
Total	0.43414	3.54	Strongly Agree

to augmented reality-based flight training, supporting the idea that simulator experiences enhance retention and accuracy. Belt et al. (2020) demonstrated that motion cueing systems improved workload management and flight precision, validating the simulator's contribution to performance realism. Similarly, Guthridge and Clinton-Lisell (2021) confirmed that VR and PC-based simulators enhanced altitude accuracy and cross-track distance control. These parallels substantiate the present results, confirming that flight simulator training is an effective educational tool that bridges theoretical instruction with real-world aviation application, resulting in higher knowledge retention, situational awareness, and student confidence.

B. Flight simulation provides a high degree of realism and accuracy, effectively supporting practical learning outcomes.

Table.4. Students' perception on the realism and accuracy of flight simulation training.

Questions	S.D	W.M	Remarks
2.1 Simulation based environment enhance flights and training while encouraging learners to strengthen their knowledge and skills	0.51918	3.52	Strongly Agree
2.2 Realistic flight simulators using accurate models and visuals can improve pilot training while lowering risks and costs.	0.51794	3.54	Strongly Agree
2.3 The use of flight simulators in pilot training highlights the importance of knowledge retention compared to traditional PC-based methods.	0.53211	3.57	Strongly Agree
2.4 Advanced system for detecting and managing risks, showing its potential to enhance pilot awareness and improve flight safety	0.50861	3.60	Strongly Agree
2.5 Using accurate flight instruments and models ensures reliable navigation, a principle also applied in flight simulators to ensure knowledge retention.	0.54988	3.56	Strongly Agree
2.6 The study underlines the significance of human-system interaction in ensuring accuracy and throughput in navigation tasks.	0.51208	3.58	Strongly Agree

2.7 Improving navigation systems shows how combining information from different tools can make flying more accurate, even in difficult conditions.	0.53211	3.57	Strongly Agree
Total	0.41148	3.56	Strongly Agree

Legend: 3.25-4.00 - strongly agree 2.50-3.24 - agree 1.75-2.49 - disagree 1.00-1.74 - strongly disagree

This section presents the students' perception of the realism and accuracy attainable through flight simulation training. Realism and accuracy are key indicators of effective simulation-based learning because they determine how closely the simulator replicates real-world flight conditions and operations. Achieving high levels of realism strengthens the student's ability to transfer theoretical knowledge into accurate flight practices.

The table summarizes responses to seven indicators that evaluate the authenticity, reliability, and precision of flight simulators. Using a four-point Likert scale, the computed weighted means range from 3.52 to 3.60, interpreted as "Strongly Agree". This consistent high agreement signifies that students recognize the simulator's ability to replicate real flight experiences accurately while maintaining safety and cost-effectiveness.

The results reveal that students view flight simulators as highly realistic training tools that enhance both skill and accuracy and situational awareness. Statements such as "Advanced systems for detecting and managing risk enhance pilot awareness and improve flight safety". (WM=3.60) and "Simulation-based environments encourage learners to strengthen their knowledge and skills" (WM=3.52) highlights the simulator's role in fostering precision under controlled yet authentic flight scenarios. These findings demonstrate that flight simulators not only mimic real-world aeronautical dynamics but also improve decision-makin,g instrument interpretation, and safety responses, factors essential in aviation education and performance reliability.

The findings are consistent with the reviewed literature. Wang (2022) emphasized that computational aerodynamics and flight modeling technologies significantly enhance simulator realism and flight performance accuracy. While Belt et al.. (2020) noted measurable performance improvements through motion cueing, increasing pilots' sense of realism during training. Guthridge and Clinton-Lisell (n.d.) also confirmed that VR and PC-based simulators improve altitude and navigation accuracy.. Together, these studies support the conclusion that advanced simulation technologies provide a realistic, accurate, and effective learning environment that enhances pilot competence, safety, and knowledge retention.

C. Flight simulation training influences the aviation knowledge of BS Air Transportation students with varying effects across different year levels

Table.5. Students' assessment of aviation knowledge gained through flight simulation training.

Questions	S.D	W.M	Remarks
3.1 Using both lectures and demonstration videos before flight simulation helps me retain aviation knowledge.	0.60023	3.50	Strongly Agree
3.2 Different teaching methods (reading, lectures, and videos) improve my performance in flight simulations.	0.58448	3.52	Strongly Agree
3.3 Game-based simulations help retain aviation knowledge and improve decision-making.	0.5528	3.52	Strongly Agree
3.4 Online flight simulation contributes to improving my aviation knowledge.	0.52603	3.60	Strongly Agree
3.5 Collaborative flight simulation enhances my teamwork and situational awareness.	0.56695	3.55	Strongly Agree
3.6 Flight simulation technology significantly improves safety by allowing pilots to practice emergency procedures in a risk-free environment.	0.50663	3.61	Strongly Agree

Legend: 3.25-4.00 - strongly agree 2.50-3.24 - agree 1.75-2.49 - disagree 1.00-1.74 - strongly disagree

Flight simulation is a vital tool in aviation education, providing BS Air Transportation students with immersive, risk-free environments that enhance their understanding of flight concepts and cockpit operations. According to Gheorghiu (2013), flight simulation replicates human–aircraft interaction for training, performance evaluation, and research, making it an essential component of both foundational and advanced aviation learning. For lower-year students, basic desktop simulators allow safe and affordable hands-on practice with fundamental cockpit controls, helping them master visual references and procedures in a dynamic, interactive way (Puiu, 2019). For upper-year students, high-fidelity simulators develop decision-making, crew management, and emergency response skills, preparing them to handle in-flight emergencies with confidence (FAA, 2016a; Li et al., 2020).

Research supports the effectiveness of flight simulation when paired with multimodal instruction. Khalid (2021, 2020) found that combining lectures, readings, and demonstration videos significantly improves simulator performance compared to single-mode instruction. Emerging technologies, such as VR, immersive simulations, and game-based platforms, further enhance engagement, knowledge retention, and decision-making (Dincer, 2023). Online flight simulations have also been shown to strengthen aviation knowledge and motivation, even for students outside the aviation field (Ng et al., 2023). Collaborative simulation promotes teamwork and situational awareness, supporting the development of essential crew coordination skills (Cross & Ryley, 2025). These findings are mirrored in student feedback from Table 5, where all indicators, including multimodal instruction, game-based simulation, online learning, collaborative simulation, and emergency procedure practice, received Strongly Agree ratings (W.M = 3.50–3.61), demonstrating widespread recognition of the benefits of flight simulation training across different year levels.

Based on these findings, aviation programs should integrate multimodal instruction, including pre-reading, lectures, and demonstration videos before flight simulation sessions to maximize learning outcomes. Lower-year students should continue using basic desktop simulators to build foundational skills, while upper-year students should access high-fidelity and collaborative simulation environments to refine advanced competencies such as decision-making, situational awareness, and emergency management. Incorporating VR, game-based learning, and online simulation platforms is also recommended to increase engagement, knowledge retention, and overall preparedness for real-world flight operations. Flight simulation, therefore, serves as an indispensable tool for developing both the foundational and advanced aviation knowledge of BS Air Transportation students.

1) Lower-year students show significant improvement in aviation knowledge following flight simulation training

Table.6. Students’ assessment of aviation knowledge gained through flight simulation training in the lower year.

3.7 Basic desktop flight simulator allows lower-year students to safely and affordably gain hands-on experience with fundamental cockpit controls.	0.5528	3.52	Strongly Agree
3.8 Flight simulation is an essential mechanism for lower-year students, helping them master cockpit procedures and visual references in a dynamic way.	0.58172	3.56	Strongly Agree

Legend: 3.25-4.00 - strongly agree 2.50-3.24 - agree 1.75-2.49 - disagree 1.00-1.74 - strongly disagree

This section presents the perception of lower-year BS Air Transportation students on the importance of flight simulation in their foundational learning. For novice aviation students, simulation serves as a critical platform for acquiring basic cockpit familiarity, procedural discipline, and confidence before progressing to actual flight experiences.

Table 6 shows responses from lower-year students, evaluated through two key statements measuring their agreement on the value of basic simulation experiences. Weighted means ranged from 3.52 to 3.56, both interpreted as “Strongly Agree”. This indicates that lower-year students highly value simulation as a safe and cost-effective tool for developing early aviation skills.

The results suggest that beginners perceive Simulation as a gateway to practical learning, helping them transition from theoretical lessons to hands-on cockpit operations. Lower-year students recognize that simulation improves their understanding of flight controls, visual references, and procedural coordination, key foundations in aviation training.

These findings support Khalid (2021), who emphasized that blended and simulation-based instruction enhances early skill acquisition and learning efficiency. Likewise, Puiu (2019) noted that immersive simulation provides a dynamic environment where new learners develop fundamental operational awareness. The results confirm that for lower-year aviation students, flight simulators are not merely supportive tools but essential instruments that foster skill readiness, confidence, and knowledge retention at the early stages of aviation education.

2) Upper-year students demonstrate greater aviation knowledge acquisition and retention through flight simulation training compared to lower-year students.

Table.7. Students’ assessment of aviation knowledge gained through flight simulation training in upper years.

3.9 High-fidelity flight simulators are crucial for upper-year students to enhance their decision-making and crew management skills under pressure.	0.5149	3.57	Strongly Agree

3.10 Upper-level students, flight simulators are crucial for building the confidence to handle any in-flight emergency by safely practicing critical procedures before their final flight test.	0.53203	3.65	Strongly Agree
Total	0.4158	3.56	

Legend: 3.25-4.00 - strongly agree 2.50-3.24 - agree 1.75-2.49 - disagree 1.00-1.74 - strongly disagree

This section focuses on the perceptions of upper-year BS Air Transportation students regarding the role of high-fidelity flight simulation in advanced training. By this stage, students are expected to refine their decision-making, situational awareness, and crew management skills in preparation for actual flight testing and professional practice.

Table 7 presents responses to two indicators evaluating how simulation supports upper-year learning. Weighted means range from 3.57 to 3.65, both rated as "Strongly Agree". The high mean scores indicate that upper-year students find simulator training essential in strengthening advanced competencies such as emergency handling, multitasking, and confidence during critical in-flight procedures.

The consistently strong agreement implies that upper-year students experience greater simulator benefits in complex decision-making and crew coordination tasks. Having already built foundational knowledge, these students now apply simulation to realistic and challenging flight scenarios, demonstrating the simulator's ability to replicate the stress, workload, and communication demands of actual flight operations. This phase represents the transition from skill practice to professional readiness, highlighting how simulation contributes to developing operational competence and safety awareness.

These results align with Li et al. (2020), who found that advanced simulators enhance situational awareness and safety in high-pressure environments. Cross and Ryley (2025) also observed that collaborative VR flight simulation improves teamwork, decision-making, and performance in multi-crew settings. Furthermore, Guthridge and Clinton-Lisell (n.d.) confirmed that simulator use increases accuracy and procedural reliability among advanced trainees. Collectively, these studies validate that upper-year students benefit most from high-fidelity simulation experiences that cultivate professional confidence, technical precision, and readiness for real-world aviation challenges.

D. Is there a significant difference in aviation knowledge retention between lower year (1st and 2nd year) and upper year (3rd year and 4th year) BS Air Transportation students after flight simulation training?

1) Year Level (ANOVA)

Table.8. Analysis of Variance in year level

Year Level						
Statements		**Sum. of Square**	**Mean Square**	**f**	**Significant**	**Decision**
Game-based simulations help me retain aviation knowledge and improve decision-making.	Between Group	2.292	0.765	2.609	0.055	Accept
	Within Group	31.627	0.293			
	Total	33.920				

Legend:
= or ↓ 0.05 is significant difference/relation - Reject
↑ 0.05 is no significant difference/relation - Accept
= or ↓ 0.01 - very significant

Table.9. Significant Difference between year level

Statement	Significant	Decision
Game-based simulations help me retain aviation knowledge and improve decision-making. 2nd year,4th year	0.052	Accept

The one-way ANOVA comparing aviation knowledge retention among different year levels produced a p-value of 0.055, which is greater than the 0.05 significance level. This indicates that there is no significant difference in knowledge retention between lower-year and upper-year BS Air Transportation students after undergoing flight simulation training.

To determine the strength of the relationship, the effect size (η^2) was calculated using the formula:

$\eta 2 = SStotal/SSbetween$
$\eta 2 = 2.292/33.920$
$\eta 2 = 0.0676$

The computed $\eta 2=0.068$ represents a small to moderate effect size, indicating that year level explains approximately 6.8% of the variance in aviation knowledge retention scores. While the difference among year levels was not statistically significant, the small effect suggests that learning progression and exposure levels may have influenced the results to a limited degree.

These findings suggest that flight simulation training provides consistent learning benefits across all academic levels.

Both lower-year and upper-year students demonstrated comparable retention of aviation knowledge, highlighting that simulation serves as an equalizing instructional tool that supports understanding regardless of academic standing. This aligns with the findings of Guthridge and Clinton-Lisell (2023) and Moesl et al. (2023), who emphasized that simulation enhances learning outcomes for both novice and advanced students through repeated practice and structured visual engagement. The uniform design of the simulator environment and standardized procedures ensured that all participants experienced similar learning conditions, leading to consistent improvement in performance and retention.

The analysis used a one-way ANOVA to compare the mean responses among four levels regarding the statement, " VR and game-based simulations help me retain aviation knowledge and improve decision making." The computed F-value was 2.609 with a significant level of 0.055, leading to acceptance of the null hypothesis (Ho). This indicates that there is no significant difference in knowledge retention between lower- and upper-year students after flight simulator training. Although the values are close to the threshold, they still do not meet the requirement for a significant difference. This indicates that aviation knowledge retention does not differ across the lower-year and upper-year levels.

The analysis result suggests that flight simulation training provides consistent learning benefits across all academic levels. Both lower and upper year students perceive that Vr and game-based simulation contribute similarly to their understanding and retention of aviation concepts. This implies that the simulator's experiential nature effectively supports students regardless of their prior experience or theoretical background. Furthermore, it highlights the adaptability of flight simulation as a pedagogical tool capable of enhancing learning outcomes at every phase of aviation education.

2) Age (ANOVA)

Table.10. Analysis of Variance in age

Age						
Statements		**Sum. of Square**	**Mean Square**	**f**	**Significant**	**Decision**
Simulator training improved my performance after the post-test compared to the pre-test.	Between Group	2.371	0.790	3.193	0.027	**Reject**
	Within Group	26.736	0.248			
	Total	29.107				
How does undergoing training using a flight simulator influence students' understanding and knowledge	Between Group	1.465	0.488	2.710	0.049	**Reject**
	Within Group	19.456	0.180			
	Total	20.921				

retention?						

Legend:
= or ↓ 0.05 is significant difference/relation - Reject
↑ 0.05 is no significant difference/relation - Accept
= or ↓ 0.01 - very significant

Table.11. Significant Difference between age

Statement	Significant	Decision
Simulator training improved my performance after the post-test compared to the pre-test. 21-23, 24 and above	0.078	Accept
How does undergoing training using a flight simulator influence students' understanding and knowledge retention? Sop 1	0.100	Accept

The ANOVA analysis for age groups revealed a p-value of 0.027, which is less than the 0.05 significance level. This indicates that there is a statistically significant difference in aviation knowledge retention among students of different age groups.

$\eta 2 = SStotal/SSbetween$
$\eta 2 = 2.371/29.107$
$\eta 2 = 0.0815$

The computed $\eta^2 = 0.082$ represents a moderate effect size, meaning that approximately 8.2% of the variance in aviation knowledge retention can be explained by age differences.

The results indicate that older students (21 years old and above) demonstrated higher post-test performance and stronger procedural recall compared to younger participants. This may be attributed to greater cognitive maturity, accumulated academic experience, and familiarity with simulation-based learning. These findings are supported by Dincer (2023) and Li et al. (2020), who reported that learners with higher exposure and advanced academic grounding tend to display stronger situational awareness and procedural discipline. The significant effect of age suggests that simulation-based training interacts with learner maturity, allowing older students to connect theoretical concepts with applied scenarios more effectively.

This outcome supports Kolb's Experiential Learning Theory, which states that learning occurs through active experience, reflection, and conceptualization. Older students, having greater prior exposure to flight principles and academic content, may have been better prepared to engage with the simulator tasks, resulting in improved knowledge retention and practical application.

The findings suggest that age plays a meaningful role in students' abilities to retain aviation knowledge after simulator-based training. Older students, likely in the upper year levels, may possess stronger prior knowledge, focus, and experience, allowing them to apply simulation-based learning more effectively. In contrast, younger students may still be developing foundational technical and cognitive skills, which could explain the variance in retention levels. These results emphasize that while simulation benefits all learners, its impact may vary according to maturity and prior exposure to aviation principles.

The results align with Moesl et al. (2023), who found significant performance improvements across trainees after augmented reality-based flight instruction, indicating that experiential learning effectiveness can differ among groups. Belt et al. (2020) also reported variations in workload and performance efficiency during simulation trials, implying that physical and cognitive readiness often related to age affects learning gains. Similarly, Guthridge and Clinton-Lisell (n.d) demonstrated that VR and PC based simulation enhances precision and retention, but the magnitude of improvement may depend on learner characteristics. Collectively, these studies reinforce that age differences influence how students internalize and retain aviation knowledge through simulator training, with older participants generally showing higher retention and performance accuracy.

3) Summary of ANOVA Findings

Variable	p-value	ηη2	Interpretation	Decision
Year Level	0.055	0.068	No significant difference; small to moderate effect	**Accept Ho**
Age	0.027	0.082	Significant difference; moderate effect	**Reject Ho**

4) Discussion

The results of the ANOVA reveal that flight simulation training led to improvement in aviation knowledge retention across all respondents. Although there was no significant difference among year levels, students from all groups demonstrated comparable learning gains. This supports the concept that simulation-based instruction fosters equal learning opportunities by engaging both novice and advanced learners in the same structured environment.

On the other hand, the significant difference observed among age groups implies that maturity and academic exposure contribute to enhanced retention and performance. Older students exhibited stronger comprehension and recall due to their ability to integrate previous theoretical learning with hands-on simulation experience.

The overall improvement can be attributed to the experiential and repetitive nature of simulation training, which enables students to apply theoretical concepts in realistic scenarios, receive immediate feedback, and correct procedural errors. This finding is consistent with Khalid (2021) and Ng et al. (2023), who emphasized that simulation bridges the gap between theoretical instruction and real-world practice by reinforcing procedural understanding and promoting active learning.

Additionally, Guthridge and Clinton-Lisell (2021) and Lefrançois et al. (2021) found that realistic simulation environments enhance situational awareness and precision, while Moesl et al. (2023) highlighted that immersion and visual realism increase motivation and retention. These perspectives explain the positive post-test outcomes in this study, demonstrating that even with a limited 30-minute simulator exposure, students achieved measurable knowledge gains through focused experiential engagement.

5) Flight Simulator Training Experience

Table 12: Flight Simulator Training Experience

Master Theme	**Superordinate Theme**
Simulator training improved my landing performance in challenging flight conditions.	• Better landing control in difficult conditions
	• Stronger confidence through repeated practice
Simulator training improved my performance after the post-test compared to the pre-test.	• Stronger skill reinforcement through repetition
	• More controlled task execution during evaluation
How does undergoing training using a flight simulator influence students' understanding and knowledge retention.	• Clearer understanding through visual review

	• Stronger retention through repeated correction
Simulation based environments enhance flights and training while encouraging learners to strengthen their knowledge and skills.	• Higher situational awareness during task
	• Safer environment for learning advanced procedures
Using both lectures and demonstration videos before flight simulation helps me retain aviation knowledge.	• Clearer connection between concepts and practice
	• Stronger preparation from lectures and videos
Basic desktop flight simulator allows the lower year students to safely and affordably gain hands-on experience with fundamental cockpit controls.	• Early familiarity with cockpit lay out and control flow
	• Smoother transition to Flight Simulator

Master Theme 1: Simulator training improved my landing performance in challenging flight conditions

Superordinate Theme 1.1: Better landing control in difficult conditions

Informant 1: "Simulator training, especially when done through consistent repetition, greatly improved both my confidence and mastery during landings… especially valuable during my First Solo Flight and later during Instrument Rating Training".

Informant 2: "Simulator sessions improved my control during rough landings. Repetition helped me stay calm and apply procedures with more accuracy during unstable approaches".

Informant 3: "Simulator improved my landings during rough conditions because I practiced without stress. Each session helped me to improve my timing and aircraft alignment".

Superordinate 1.2: Stronger confidence through repeated practice

Informant 1: "Simulator training through repetition improved my confidence and mastery during landing. It helped me during my First Solo Flight and Instrument Rating".

Informant 2: "Training improved my control in rough landing. Repetition helped me stay calm and follow procedures with accuracy".

Informant 3: "Training improved my landings in rough conditions because I practiced without any stress. Each run helped me with my timing and alignment".

Informants shared clear experiences about repeated simulator work that improved their landing performance in difficult situations. They described steady progress in confidence, timing, and control as they practiced approaches with unstable conditions. They explained that the simulator let them repeat the same sequence many times, which helped them correct small errors, understand their own reaction patterns, and adjust control inputs with more accuracy. They noted that this steady exposure helped sharpen judgment during approach and timing because they felt calmer and more focused. They also mentioned fewer hesitations during high-stress moments because they already practiced the same situation in a safe setting. They also pointed out that the simulator helped them understand how early mistakes in attitude or speed affect the entire landing, which encouraged more disciplined control from downwind to touchdown. These insights match the results of Farquerabao Dimaano(2023), who reported higher accuracy and lower stress during landings after repeated simulator training. Chen et al.. (2025) linked steady practice to stronger motor memory, which supports students' reports of smoother and more consistent control inputs. Flynn et al. (2022) noted that training in a controlled environment helps students correct technique without safety concerns, which reflects the experience shared by the informants.

Master Theme 2: Simulator training improved my performance after the post-test compared to the pre-test.

Superordinate Theme 2.1: Stronger skill reinforcement through repetition

Informant 1: "My performance improved significantly…the structured training strengthened my skills further and made me feel more confident during actual flights."

Informant 2: "My post-test scores improved because structured sessions exposed my weak areas. Focused practice helped me respond faster and manage workload with more control."

Informant 3: "My performance improved from pre-test to post-test due to consistent repetition. Frequent exposure to the same tasks builds stronger muscle memory."

Superordinate Theme 2.2: More controlled task execution during evaluation

Informant 1: "My performance improved because structured sessions strengthened my skills and increased my confidence."

Informant 2: "My post test scores improved because structured tasks exposed weak areas. Focused practice improved my responses and workload control."

Informant 3: "My performance improved from pretest to post test because repeated tasks built muscle memory."

The informants consistently described that structured simulator sessions produced measurable performance improvements by revealing weak areas, strengthening procedural accuracy, and supporting better task management. They emphasized that structured repetition helped them maintain control during evaluation and promoted more organized cockpit performance. Their statements show that this method allowed them to analyze specific errors, adjust strategies, and approach complex tasks with increased clarity. They noted faster responses, stronger workflow sequencing, and smoother transitions into real flight. These insights support Ikram and Kenayathulla 2023 who found that structured instruction improves student proficiency. Asiimwe 2024 stressed that repeated guided activities correct procedural gaps. Shamsiev 2022 identified structured simulation as an effective method for refining accuracy in performance evaluations.

Master Theme 3: How does undergoing training using a flight simulator influence students' understanding and knowledge retention?

Superordinite Theme 3.1: Clearer understanding through visual review

Informant 1: "The simulator provides a complete and clear view of my performance through recorded tracks and data… This allows me to review my errors and reinforce checklist discipline."

Informant 2: "Recorded tracks helped me review mistakes. Visual feedback made each step easier to remember, and repeated runs fixed procedures in my memory."

Informant 3: "Seeing my flight path each run helped me store the steps clearly."

Superordinite Theme 3.2: Stronger retention through repeated correction

Informant 1: "Recorded tracks and data helped me review errors and reinforce checklist steps."

Informant 2: "Visual feedback helped me remember procedures. Repeated runs strengthened my memory."

Informant 3: "Seeing my flight path helped me remember each step."

Informants shared clear experiences about how repeated simulator work improved their landing performance in difficult situations. They described steady progress in confidence, timing, and control as they practiced approaches with unstable wind, limited visibility, or uneven glide paths. They explained that the simulator let them repeat the same sequence many times, which helped them correct small errors, understand their own reaction patterns, and adjust control inputs with more accuracy. They noted that this steady exposure helped sharpen judgment during approach and flare because they felt calmer and more focused. Several students mentioned fewer hesitations during high-stress moments because they already practiced the same situations in a safe setting. They also pointed out that the simulator helped them understand how early mistakes in attitude or speed affect the entire landing sequence, which encouraged more disciplined control from downwind to touchdown. These insights match the results of Farquerabao Dimaano 2023 who reported higher accuracy and lower stress during landings after repeated simulator work. Chen et al. 2025 linked steady practice to stronger motor memory, which supports the students' reports of smoother and more consistent control inputs. Flynn et al. 2022 noted that training in controlled environments helps students correct technique without safety concerns, which reflects the experiences shared by the informants.

Master Theme 4: Simulation-based environments enhance flights and training while encouraging learners to strengthen their knowledge and skills.

Superordinate Theme 4.1: Higher situational awareness during task.

Informant 1: "Training in a simulated environment mainly improved my situational awareness… and allowed me to experiment with techniques safely".

Informant 2: "The simulated environment helped me manage pressure while learning new tasks. Safe practice helped me correct habits before entering aircraft"

Informant 3: "The simulated setup helped me build stronger situational awareness. I learned to scan faster and manage procedures without wasting flight hours".

Superordinate 4.2: Safer environment for learning advanced procedures.

Informant 1: "Simulated environments improved my situational awareness and gave me a safe space to try new techniques".

Informant 2: "The simulation helped me manage pressure.. It also helped me correct habits before flying an aircraft".

Informant 3: "The setup helped me develop faster scanning and better task control without wasting flight hours".

The informants described simulation as a space where they strengthened situational awareness, corrected habits, and practiced complex tasks without the operational risks present in real flight. They explained that the ability to pause, repeat, and adjust their approach supported better scanning techniques, more organized task flow, and clearer decision-making under pressure. Their accounts show that simulation helped them manage workload more efficiently and reduce errors before entering the aircraft. These insights align with Farquerabao Dimaano 2023 who emphasized the importance of simulation for developing decision-making skills. Shamsiev 2022 reported that simulation supports emergency readiness and scanning habits. Flynn et al. 2022 observed that early practice in simulated environments helps learners correct patterns before they influence real flight performance.

Master theme 5: Using both lectures and demonstration videos before flight simulation helps me retain aviation knowledge.

Superordinate Theme 5.1: Clearer connection between concepts and practice

Informants:

Informant 1: "Demonstration videos supported my understanding and greatly improved my retention."

Informant 2: "Lectures and videos gave me a clear picture of each maneuver before the session… helping me link theory with practice."

Informant 3: "Seeing procedures beforehand helped me recall key steps during simulation."

Superordinate Theme 5.1: Stronger preparation from lectures and videos

Informant 1: "Demonstration videos supported my understanding and improved retention."

Informant 2: "Lectures and videos showed each maneuver clearly. This helped me connect theory with practice."

Informant 3: "Seeing procedures beforehand helped me recall during simulation."

The informants described lectures and demonstration videos as valuable preparation tools that strengthened their understanding before simulator sessions. They explained that these resources helped them build a mental model of each maneuver, understand the required steps, and retain essential actions once inside the simulator. Their observations show that visual preparation allowed them to enter the simulated environment with clearer expectations, stronger recall, and more organized execution. These insights correspond with Ikram and Kenayathulla 2023 who found that instructional materials support effective skill transfer in technical fields. Ng 2023 reported that pre-briefing enhances procedural comprehension. Admane and Mondhe 2021 noted that visual learning resources strengthen understanding of technical sequences.

Master Theme 6: Basic desktop flight simulator allows 1st and 2nd year students to safely and affordably gain hands-on experience with fundamental cockpit controls.

Superordinate 6.1: Early familiarity with cockpit layout and control flow

Informant 1: "Using a desktop simulator helped me become familiar with cockpit layout, control locations, and the behavior of the aircraft when specific control inputs are applied. This early practice made actual flights much smoother and safer once I moved into real flight training".

Informant 2: "The desktop simulator helped me learn to switch locations and the basic control flow of the aircraft. I'm familiar with it when it was my first try".

Informant 3: "This early practice reduced my workload when I tried an actual Flight Simulator".

Superordinate 6.2: Smoother transition to Flight Simulator

Informant 1: "The desktop simulator helped me learn and be familiar with the cockpit layout and the aircraft responses

Informant 2: "It helped me to transition to a Flight Simulator and be familiar with the basic controls".

Informant 3:" Repetition of practice lowered my workload when I tried an actual Flight Simulator".

The informant expressed that early use of a desktop Flight Simulator helped them understand cockpit layout, switch locations, and the behaviour of the aircraft controls. They noted that this early exposure lowered cognitive workload when transitioning into a real Flight Simulator and reduced confusion during initial training. Their accounts show that basic simulators prepared them with the fundamental skills that supported safer and smoother performance during advanced sessions. These insights correspond with those of Flynn et al. (2022), who identified basic simulators as effective tools for developing early motor coordination. Asiimwe (2024) reported that early familiarization reduces workload during later training stages. Chen et al (2025) emphasized that repeated foundational practices build strong procedural habits that support more effective real aircraft performance.

4. Discussion

A. *Conclusions*

This study examined the effectiveness of flight simulation training in enhancing aviation knowledge retention among BS Air Transportation students across different year levels. Based on the quantitative results, thematic analysis, and integration of supporting literature, the following conclusions were formulated.

4.1.1. Students reported marked improvements between pre-test and post-test scores, demonstrating that simulation provides meaningful learning reinforcement. Simulator-based tasks allow learners to repeatedly practice procedures, correct errors, and internalize standard operating procedures, resulting in stronger memory retention and improved technical accuracy.

4.1.2. High weighted means in realism-related indicators show that students strongly recognize the simulator's capability to replicate real-world flight conditions. Accurate visuals, instrument behavior, and flight dynamics enable students to apply theoretical concepts effectively. The high-fidelity environment also increases confidence, decision-making ability, and situational awareness, leading to more authentic aviation experiences.

4.1.3. ANOVA results reveal no significant difference in aviation knowledge retention across year levels. This shows that simulation is universally beneficial—whether students are beginners building foundational skills or advanced learners refining complex decision-making tasks. Lower-year students particularly benefit from early exposure, while upper-year students gain deeper competence in emergency procedures and multi-crew operations.

4.1.4. Qualitative interviews emphasized that lectures, demonstration videos, and pre-briefing sessions provide mental models that help students understand maneuver sequences before entering the simulator. Repetition then strengthens procedural memory, enhances confidence, and improves execution during evaluation 4.1.5. Students consistently expressed that simulation provides a safer, more engaging, and more realistic avenue to apply classroom knowledge. This experiential learning process supports better decision-making, stronger situational awareness, and the development of habits essential for professional aviation practice.

4.1.6. Students overwhelmingly agree that simulators enhance safety by allowing them to practice emergency scenarios without real-world risks. This exposure strengthens their readiness for abnormal and emergency procedures, contributing to safer future flight operations.

B. *Recommendations*

These recommendations are provided to help improve the use of flight simulation training based on the results of the study.

4.2.1. To strengthen students' aviation knowledge retention, the simulator sessions should be incorporated more frequently in the curriculum, allowing learners to revisit key maneuvers and correct errors through repetition. This benefits BS Air Transportation students by reinforcing their confidence and skill development, and supports instructors in understanding which procedures need more emphasis during training.

4.2.2. To enhance the realism and instructional value of simulator training, the school may upgrade visuals, instrument accuracy, and scenario complexity to further mirror real flight conditions. This supports the aviation school's goal of improving its training facilities in partnership with other airline companies and helps flight instructors deliver more accurate and safety-aligned lessons for future airline operations.

4.2.3. To reinforce learning across all year levels, the program should adopt varied instructional methods such as lectures, videos, guided practice, and collaborative simulation, to help students connect theory with application. This approach strengthens students' comprehension, assists instructors in delivering structured training, and gives the aviation school a stronger foundation for instructional improvement.

4.2.4. To support foundational knowledge retention among lower-year students, early exposure to desktop simulators should be expanded so beginners can familiarize themselves with cockpit layout and procedures before using more complex equipment. This prepares students for smoother learning progression and aligns with the aviation school's aim to build strong training foundations that benefit future flight instructors and airline partners seeking well-prepared future aviators.

4.2.5. To deepen advanced competencies in upper-year students, simulators should include complex, high-pressure scenarios that enhance decision-making, crew coordination, and emergency management. This directly supports the safety goals of airlines and helps instructors train students for real-world demands while strengthening the school's capability to produce industry-ready graduates.

4.2.6. To maintain equal learning benefits across age groups, the program should continue implementing structured simulator sessions that guide all students through step-by-step procedures regardless of age or experience. This ensures consistent learning for students, supports instructors in providing standardized training, and strengthens the aviation school's commitment to producing uniformly competent future aviation professionals.

4.2.7. To holistically enhance simulator-based learning across all student levels, the aviation program should adopt a structured, standards-aligned improvement plan involving curriculum developers, flight instructors, and partner airlines. The curriculum developers should increase required simulator hours per semester, particularly for core maneuvers, instrument procedures, and abnormal operations, following ICAO and FAA guidelines that emphasize repetition, scenario-based training, and competency checks. This ensures that students regularly revisit essential skills, improving retention and readiness for advanced training. Through coordinated action among curriculum developers, instructors, and the aviation school's airline partners, these targeted improvements will reinforce foundational skills, elevate realism, and ensure graduates meet industry-level competency expectations.

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