Computer- Based Flight Planning Tools and their Role in Advancing Navigational Accuracy and Efficiency of Aviation Students

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Abstract: **This study sought to determine how computer-based flight planning tools help aviation students in Metro Manila improve their navigation skills. With the aviation industry focusing more on technology, shifting from traditional to computer-based flight planning has become important for developing relevant skills. This study also wanted to acknowledge the importance of traditional flight planning while emphasizing that this study promotes integration and advancement, not replacement. Using a mixed-method design, data were gathered through surveys and interviews from 28 respondents including 3 informants, that are Air Transportation students and student pilots. The gathered data were analyzed through Statistical Package for Social Sciences (SPSS) and thematic analysis. The quantitative results showed that most respondents strongly agreed that computer-based flight planning significantly improves efficiency, lowers workload, and increases accuracy compared to traditional methods. The qualitative findings further emphasized that traditional flight planning is important for developing critical thinking and discipline, while computer-based tools promote quicker learning, accuracy, and readiness for operations. This study concluded that computer-based flight planning has a big role in enhancing the navigational experience of aviation students, equipping them with the necessary skills, adaptability, and technical competence required in today's digitally driven aviation industry. The study recommends integrating both traditional and computer-based flight planning methods in aviation education. Strengthening both approaches in the curriculum will better equip aviation students with comprehensive skills required for safe, efficient, and technology-driven flight operations.**

Keywords: **Aviation Education, Aviation Students, Computer-based Flight Planning, Navigational Accuracy and Efficiency, Traditional Flight Planning**

1. Introduction

Technological advancement is rapidly changing traditional practices in the aviation industry, with traditional-based flight planning enhanced by computer-based flight planning. For aviation students, learning how to use these digital tools is essential, as it not only improves efficiency and accuracy in flight planning but also equips them with industry-relevant skills demanded in modern aviation. This study aims to know how transitioning from traditional to computer-based flight

planning benefits the students, and how the use and practices of digital tools prepare them for the increasing use of advanced technology in modern aviation.

The adoption of Information and communication technology or ICT in aviation education is influenced by factors like social influence, effort expectations, enabling circumstances, motivation, perceived usefulness and ease of use, perceived behavioral control, organization culture, individual traits, content quality, cooperation, institutional-level factors, technological aspects, logistical considerations, and instructor attitudes and abilities (Gonzalo, 2024). A positive transfer of learning between the computer-based training device and the aircraft: CBTD-trained students took an average of 12 minutes, while the others took 20 minutes to complete the maneuver (Oritz, 2023). The potential for AI to revolutionize air travel. By leveraging Artificial Intelligence, the Flight Management System can automatically generate optimized flight routes based on real-time data inputs, such as Aeronautical Information Regulation and Control data. (Chittayil, 2024). The findings indicate that participants' response time was significantly lower using electronic charts over paper ones. Flight performance, as observed via video footage, indicated far worse control of altitude and course when using paper charts than when electronic charts were used. (Winter et al., 2020). Results show that the Augmented Reality tool enhances and accelerates orientation, and can result in flight trajectories being more accurate with Augmented Reality than without Augmented Reality. Situation awareness, measured with a subjective self-rating, was not increased with Augmented Reality support (Weber, 2025).

As the aviation sector witnesses rapid technological progress, it opens new avenues to improve training methodologies and optimize performance results. The aviation sector can effectively tap into the possibilities offered by technology, resulting in better-equipped professionals, augmented safety norms, and heightened operational competence (DİNÇER, 2023). These include a 15% reduction in average flight delays

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and a substantial 20% increase in airspace capacity utilization following the introduction of AI-driven traffic flow management. Moreover, a remarkable 30% decrease in reported near-misses and a 25% reduction in aviation accidents reflect the tangible improvements in safety measures derived from AI technologies (Whig et al., 2024). This work applies state-of-the-art machine learning technologies to automatically determine the quality of generated flight plans to enable rapid verification and approval for plan filing. It also identifies preferred routes that are input into the planner, resulting in higher flight plan acceptance rates (Vaidyanathan et al., 2024). Major aviation organizations have highlighted the need to adopt artificial intelligence (AI) to transform operations and improve efficiency and safety. Producing graduates equipped with AI literacy and collaboration skills will be key to aviation's intelligent future (Kabashkin et al., 2023). In response to the growing digital landscape, airlines are leveraging advanced IT solutions to streamline operations, drive innovation, and enhance overall performance. This fosters the ongoing modernization of traditional industries, while also boosting societal productivity and operational efficiency (Horkay et al., 2024).

Historically, VFR flight planning has been accomplished using an E6B flight computer, paper chart, and navigation plotter. Pilots have used these tools to determine the course, speed, and fuel required for a particular flight. These conventional tools have been a cornerstone of private pilot training for many years (Babb & Babb, 2023). The results of our cartographic analysis show that aeronautical charts produced by different countries all fulfil the need of pilots to be able to orient themselves. According to our evaluation, the Swiss aeronautical chart scored slightly more favourably than the other evaluated charts for effective map-reading (Sarbach et al., 2023). The aviation industry is dynamic due to many uncertain processes such as meteorological conditions, economy, wars, pandemics, and aircraft failures. This situation makes decision-making processes difficult, and decision makers need forecasting techniques to solve this problem. Results of the research, Machine learning, deep learning, data mining, and statistical techniques and data mining have been found to be used extensively in solving problems (Uçar, 2024). For the safe performance of VFR (Visual Flight Rules) air operations, it is essential that current, comprehensive, and authoritative sources of navigational information are always available, and aeronautical charts are well-suited for providing this type of information in a manageable, concise, and coordinated manner. Aeronautical charts require high accuracy and up-to-date data to be used in air navigation and to ensure a safe flight (Simić et al., 2023). According to the theory of the core competence of a pilot, the evaluation index system of the manual manipulation level of student pilots in a typical scene is constructed. The research can provide a theoretical reference for quantitatively evaluating manual manipulation levels and improving flight training quality (Qian et al., 2024).

Thus, the method could be easily implemented in current flight operations. The developed performance indicators could help operators to evaluate the re-optimization and to initiate its activation as a new flight plan accordingly (Rosenow et al., 2021). The resulting approach captures temporal trends of user-specific and program-wide student performance to recommend a feasible set of graded flight events for evaluation in a student's next training exercise to improve their progress toward fully qualified status (Forrest, 2020). Extended Reality (XR) technology has been widely used in aviation, in particular in pilot and crew member training. Flight planning in 3D XR outperforms traditional 2D environments in terms of user experience (Wang et al., 2024). Flight planning and optimization—AI can analyze weather patterns, air traffic, runway conditions, and other variables to generate optimal flight plans that minimize fuel costs and emissions while maintaining safety (Prasad & Thakur, 2024). While technology ensures long-term competitiveness and sustainability, an often-ignored source of challenges is human resources and education. The effects of severe concerns with the current aviation education system, which need to be solved by extended skill sets, modern technology, and better career perspectives (Sun et al., 2021).

Exposing emerging professionals, particularly aviation students, to computer-based setups for training and study, it greatly improves performance in areas such as flight planning for safe and efficient flight operations. Recent studies show a shift from manual methods like plotters and paper charts to digital platforms such as ForeFlight and SkyVector, which not only bridge gaps in aviation education but also enhance the overall learning experience by combining foundational knowledge with industry-relevant digital proficiency.

A. Background of the Study

In recent years, the aviation industry has continued to evolve in technology-driven fields, where innovation continuously reshapes operations, safety standards, and training approaches. With this kind of innovation, digital transformation has become a key factor in preparing emerging professionals for the demands of modern aviation. This rapid technological advancement also brings different challenges. Since traditional methods and training have long been part of aviation education culture, aviation students may not be fully equipped with the digital skills required to meet industry expectations.

One area where digital transformation is most visible is flight planning, a detailed and strategic process that sets the foundation for safe and efficient flight operations. In traditional aviation education, students were trained using manual tools like plotters, compasses, and paper aeronautical charts, which helped them develop non-technological skills. In some cases, with the emergence of computer-based platforms like ForeFlight and SkyVector, flight planning has become more accurate, efficient, and increasingly required in aviation practices, contributing to safer planning procedures.

For aviation students, being knowledgeable in computer-based flight planning is essential, not only to improve efficiency

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but also to increase planning accuracy, which leads to safer flight operations in modern aviation. As the aviation sector witnesses rapid technological progress, it opens new avenues to improve training methodologies and optimize performance outcomes (DINCER, 2023). It highlights and explains how the use of technology benefits other aviation sectors, such as education, by improving the quality of experience that is in demand in the aviation industry.

Despite the growing demand for computer-based flight planning in the aviation industry, many aviation programs in the Philippines, particularly aviation schools in Metro Manila, are still relying on the traditional one, so that the aviation students are still knowledgeable in manual workload if the technology-driven field is not applicable or available. Although traditional methods remain the foundation of instruction, some institutions transition to digital tools at varying degrees depending on instructor preference. This creates differing levels of exposure to computer-based flight planning among students. With that being provided, this study seeks to explore the role of computer-based flight planning benefitting aviation students, particularly in improving efficiency, accuracy, and preparedness for the digital demands in today's aviation industry.
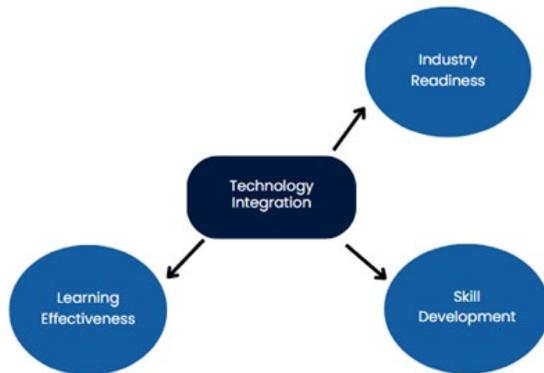
B. Theoretical Framework

Fig. 1. Research framework of technology integration in aviation education

Due to rapid technological advancement, it is only a matter of time before the aviation industry becomes more and more advanced. During the integration of technology, the industry must be ready to adopt and adapt to new systems and innovations. Learning effectiveness focuses on implementing new training methods in line with technological advancements, including the use of simulators and modernized tools and equipment. Skill development emphasizes the need for proficiency in these new tools and equipment, as well as training to upskill students, to meet evolving technological demands.

Research by (DİNÇER 2023) highlights the importance of incorporating technology in aviation training as a crucial element in addressing the sector's dynamic demands and obstacles, including technological progress, safety and efficiency, skills retention and transfer, tackling workforce challenges, and personalization and adaptability. All of this considered, it will be an advantage for the aviation students if they have developed their experience and skills in using the modern tools and equipment to meet the demand of every airline company in the aviation industry.

This study focuses on how important having experience in using computer-based flight planning tools is, and their impact on the aviation students. This study also aims to find if the new methods of teaching, skill development, and readiness of the aviation students can help them in their role in advancing navigational accuracy and efficiency.
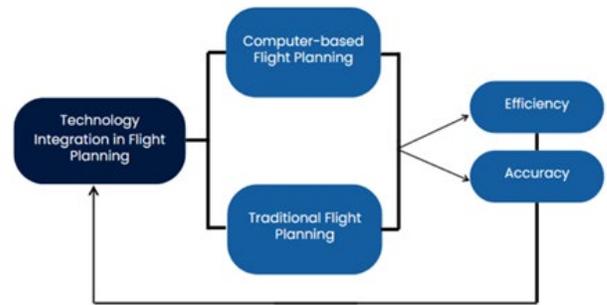
C. Conceptual Framework

Fig. 2. A Conceptual framework showing the influence of flight planning approaches on aviation student preparedness

The main focus of this study is the dependent variable of technology integration in flight planning, specifically the two approaches: the computer-based and traditional methods. These approaches are examined in terms of their benefits to aviation students regarding efficiency and accuracy, highlighting how each method influences the development of their skill set.

The conceptual framework emphasizes the importance of technology integration in flight planning. Since the traditional approach is still part of aviation education, aviation students may face challenges in adapting to modern tools as computer-based platforms are increasingly used in practice. Within this framework, efficiency and accuracy are key concerns, as both approaches influence how well students develop the skills necessary for safe and effective flight operations.

The framework also highlights the role of technology integration in improving learning effectiveness, industry readiness, and skill development, which relates to the Research Framework of Technology Integration in Aviation Education. This framework emphasizes how digital tools enhance student engagement, learning, and preparedness for today's aviation demands.

D. Statement of the Problem

This study aimed to determine the effectiveness of computer-based flight planning compared to traditional flight planning in the navigational experience of aviation students in aviation schools in Metro Manila.

Specifically, the study sought to answer the following

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questions:

1. How can transitioning from traditional flight planning to computer-based flight planning benefit aviation students in terms of:
   a) Efficiency
   b) Accuracy
2. What is the significance of enhancing the skill set of aviation students through the use of:
   a) Computer-based Flight Planning
   b) Traditional Flight Planning
3. How does exposure to computer-based flight planning prepare aviation students for the increasing use of digital tools in modern aviation operations?
4. Is there a significant difference between computer-based flight planning and traditional flight planning methods in shaping the skill development of the aviation students?
5. How does the gap between traditional flight planning training and the technological demands of modern aviation affect students' preparedness for industry practice?

E. Hypothesis

Null Hypothesis: There is no significant difference between computer-based flight planning and traditional flight planning methods in shaping the skill development of the aviation students.

F. Significance of the Study

1. *Aviation Students* - This study aims to assist aviation students in understanding the importance of computer-based flight planning to prepare them for their future roles in the aviation industry.
2. *Air Transportation Professors* - This research aids air transportation professors in understanding the appropriate methods to teach and train aviation students for effective flight planning.
3. *Aviation Institutions & Companies* - This study helps aviation institutions and flight operation organizations by producing graduates equipped with computer-based flight planning skills and supporting industry adaptation.
4. *Future Researchers* - This study provides a foundation for future research on computer-based flight planning and its role in aviation education, encouraging further exploration of its long-term effects on student performance, industry readiness, and integration with emerging aviation technologies. Future researchers may also conduct experimental tests, such as comparing time, accuracy, or error rates, to objectively verify the perceived benefits reported in this study.

2. Methodology

A. Research Design

The study used a mixed-method to examine the effectiveness of computer-based flight planning tools and their role in advancing the navigational performance of aviation students. The researchers used an explanatory approach since the research investigates cause-and-effect relationships. Through these approaches, the researchers first collected quantitative data, followed by qualitative data to gain deeper insights and validation of the findings. Data were collected through surveys, questionnaires, and one-on-one interviews.

The data analysis of this study utilized cross-tabulation to identify the differences among variables obtained from the survey responses, and thematic analysis to process and interpret the data collected from interviews, providing deeper insights into participants' experiences.

B. Respondents

This study was employed to determine the sample of 28 aviation students from inside and outside of the school for the quantitative and qualitative study. The primary objective is to gather demographic information such as age and sex. Additionally, specific questions will be posed to students.

The respondents were categorized into two age groups: 21 years old and below, and 22 years old and above. This classification enabled the researchers to compare how each age group perceives and experiences flight planning, allowing for the identification of possible variations in perspectives based on age.

In addition, the survey classified respondents by gender to identify potential differences in behavior and preferences related to flight planning. This approach allowed the researchers to gain deeper insights into how male and female participants may vary in their perspectives and experiences.

To determine the required sample size, the researchers applied Slovin's Formula with a 5% margin of error, resulting in a target of 28 respondents. The researchers used a judgment sampling technique, wherein respondents were selected based on the researchers' assessment of their relevance and ability to provide valuable insights. The chosen participants consisted of Bachelor of Science in Air Transportation students (internal) and student pilots (external), as both groups possess firsthand experience in flight planning practices. Additionally, recognizing that while student pilots use flight planning primarily for situational awareness, BSAT students use it for operational dispatch functions or academic purposes. The comparison focuses on their shared learning outcomes, not their distinct operational roles. With that, a total of 28 responses were gathered, of which 23 were from Air Transportation students and 5 from student pilots, yielding a response rate of 93.33%. Through the formula for determining the appropriate survey response rate, this outcome was deemed acceptable for both internal (30–40%) and external (10–15%) respondents. To sum it up, the response rate of this study is highly acceptable and indicates strong participation. Despite the relatively small number of respondents, the results remain reliable. This aligns with Pandya (2020), who emphasized that acceptable survey response rates vary depending on the target population and

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context, and that no universal percentage defines adequacy. Considering the specialized nature of aviation students and student pilots as respondents, the achieved response rate is deemed satisfactory within the context of this research.

Table 1
Frequency distribution of respondents by age

Age	Frequency	Percentage
21 below	17	60.70
22 above	11	39.30
Total	28	100.00

From the table above, it shows that the majority of the respondents are aged 21 and below, with a percentage of 60.70%, while on the other hand, it is 39.30% for the respondents that are aged 22 and above. This means that most of the participants belong to the younger group of aviation students who are still studying early aviation learning. It is because younger students are more available and actively involved in academic research activities within the institution. With this, the result helps this study to better understand how exposure to computer-based flight planning influences the learning adaptation and skill development of students at different stages of their aviation education.

Table 2
Frequency distribution of respondents by gender

Sex	Frequency	Percentage
Male	25	89.30
Female	3	10.70
Total	28	100.00

From the table above, it shows that the majority of the respondents are male with a percentage of 89.30%, and 10.70% for females. This indicates that male students dominate the aviation field, which aligns with the general trend in aviation education where more males pursue student pilot training and air transportation programs. It is because the aviation field, particularly flight operations, has traditionally attracted more male enrollees. With this, the result helps this study to understand how gender representation may influence insights and experiences in learning computer-based flight planning.

For the qualitative part of the study, the researchers selected three informants to participate in one-on-one interviews to gather insights about their perspectives related to computer-based and traditional flight planning. Two of the informants were Bachelor of Science in Air Transportation students currently enrolled at PATTS College of Aeronautics, while the third informant was an Air Transportation professor from the same institution. He worked as a commercial pilot in the airline industry and now teaches various aviation-related subjects, including both traditional and computer-based flight planning. With his professional background and teaching experience, he and together with the two studnets, was considered highly capable of providing relevant insights related to the study.

C. Settings

The study on Computer-Based Flight Planning Tools and Their Role in Advancing Navigational Accuracy and Efficiency of Aviation Students focuses on the benefits to aviation students, specifically on their (1) efficiency and (2) accuracy, highlighting how each method influences the development of their skill set. It used a mixed-method approach to examine the effectiveness of computer-based flight planning tools.

This study aimed to determine the effectiveness of computer-based flight planning compared to traditional flight planning in the navigational experience of aviation students in aviation schools in Metro Manila.

In order to expand and give meaning to the data gathered, the researchers opted to have at least three people interviewed, one being a professor and two being students. This provides further details on the results of the survey questionnaires and also identifies the points of view of at least some respondents from the study, which can contribute to recommendations and improvements to the research.

D. Instrumentation

The researchers made questionnaires to survey aviation students, specifically students from the Air Transportation program, in alignment with the study's statement of the problem. To ensure accuracy, validity, and objectivity, the researchers requested three validators for review. The questionnaire consisted of 20 items and was tested in a pilot survey involving 30 aviation students. Responses were recorded using a 4-point Likert scale: 4 - Strongly Agree, 3 - Agree, 2 - Disagree, and 1 - Strongly Disagree.

Following the pilot testing, the final survey has the same set of questions, but is revised based on the results. The survey is created in Google Forms and is filled out by aviation students, both internal and external. It contains student consent in the first section, demographic profile of the respondent in the second section, 5 sets of questions in the third section, 9 sets of questions in the fourth section, and 6 sets of questions in the fifth section.

Following the survey, three participants were selected for one-on-one interviews to obtain deeper qualitative insights. The interviews were conducted online via Google Meet and documented via app recording. All recorded data were transcribed, translated, and organized to highlight common ideas and insights connected to the aims of the study.

E. Data Analysis

The researchers used both quantitative and qualitative methods for a comprehensive analysis of the effectiveness of computer-based flight planning tools and their role in enhancing aviation students' navigational performance. With the mixed-method approach, frequency and percentage were employed to describe the respondents' demographic profiles, such as age and sex, while the weighted mean was used for survey items utilizing summative scales to assess the respondents' level of agreement with statements related to

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flight planning methods and learning preparedness. The researchers utilized a judgment sampling technique, as respondents were selected based on the researchers' judgment about who would be most useful or representative for the study. The researchers selected student pilots and Air Transportation students because they could provide in-depth insights about the most effective ways of learning in terms of flight planning. The researchers also used Slovin's formula to determine the appropriate number of respondents, focusing on a relatively small group of student pilots and Air Transportation students. Statistical analyses, such as the t-test, were used to examine differences across characteristics such as age and sex. Additionally, data reliability was tested using Cronbach's alpha through the Statistical Package for the Social Sciences (SPSS) to ensure the consistency and validity of the survey results. Qualitative responses were analyzed through thematic analysis to gain deeper insights into the experiences and perspectives of the participants.

F. Ethical Consideration

This study was carried out with a strong commitment to protecting the rights, safety, and privacy of all participants. All gathered data were securely stored and handled with strict confidentiality. To ensure the accuracy and validity of the research instruments, the researchers sought formal approval from a professional validator through a letter signed by the

and were respectfully asked to complete it. The feedback helped refine the final questionnaire and address any remaining issues.

Before conducting the actual survey, the researchers obtained permission from relevant institutions and followed all ethical guidelines under the supervision of the research adviser. Each participant provided informed consent before taking part in the study. Confidentiality was ensured at all times, and respondents' personal information was securely protected. Participation was voluntary, and efforts were made to minimize any inconvenience or discomfort.

3. Result and Analysis

A. How can Transitioning from Traditional Flight Planning to Computer-Based Flight Planning Benefit Aviation Students in Terms of:

1) Efficiency

The result of the first statement of the problem is on how transitioning from traditional flight planning to computer-based flight planning benefits aviation students, in terms of efficiency. The majority of the students strongly agreed that transitioning from traditional flight planning to computer-based flight planning can complete tasks efficiently, improve the speed of learning, and be more effective in overall flight planning.

The result shows that students trained through computer-based methods, such as flight planning tools, can complete tasks more efficiently compared to those using traditional

Table 3
Aviation students' views on the benefits of computer-based flight planning in terms of efficiency

Statement	Standard Deviation	Mean	Decision
1.1.1. I find that transitioning from traditional flight planning to computer-based flight planning helps aviation students work more efficiently by faster learning and effective use of resources.	0.63413	3.57	Strongly Agree
1.1.2. I find that students trained through computer-based methods, such as flight planning tools, can complete tasks more efficiently compared to those using traditional approaches.	0.56695	3.61	Strongly Agree
1.1.3. I find that using computer-based in flight route building increases efficiency in overall flight planning compared to traditional methods.	0.63725	3.54	Strongly Agree
Total	0.48735	3.57	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

thesis adviser. The validators were approached at their convenience to prevent any disruption to their work schedule.

During the validation stage, the researchers clearly presented the study's objectives and significance to improve the quality of the questionnaire and the research process. Based on the validators' suggestions, necessary revisions were made, and the questionnaire underwent pilot testing with students from

approaches, with a highest mean score of 3.61. To support the idea, a mean score of 3.57 shows that transitioning from traditional flight planning to computer-based flight planning can help students to learn more efficiently and can also have an effective use of resources. Ortiz (2023) highlighted that students trained using computer-based tools demonstrated greater efficiency, completing required tasks in significantly

Table 4
Aviation students' views on the benefits of computer-based flight planning in terms of accuracy

Statement	Standard Deviation	Mean	Decision
1.2.1. I find that using electronic flight planning tools has greater accuracy compared to traditional tools, such as paper-based approach charts.	0.56695	3.61	Strongly Agree
1.2.2. I find that computer-based flight planning tools enhance geographical awareness in students that makes the flight path more accurate and precise.	0.57275	3.57	Strongly Agree
Total	0.52799	3.59	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

aviation institutions and individuals with air travel experience. Participants were informed about the purpose of the pilot test

less time than those using traditional methods. To sum it all up, transitioning from traditional flight planning to computer-based

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flight planning can help aviation students improve faster, finish tasks efficiently, and improve their skill in handling overall flight planning.

2) Accuracy

The analysis of the accuracy section shows that aviation students strongly agree that computer-based flight planning provides greater accuracy compared to traditional methods. The majority believe that the use of digital tools enhances their ability to perform flight planning tasks with higher precision and fewer errors. With the highest mean score of 3.61, the findings indicate that computer-based systems significantly

adjust to digital systems that increase flight operations' accuracy, efficiency, and safety as technology continues to shape the aviation sector. Knowing their viewpoints makes it easier to see how modern tools influence aviation education.

Findings show that students strongly agree that technology integration improves flight planning and navigation accuracy, with a mean of 3.79. They also agree that digital tools reduce pilot and dispatcher workload and enhance navigation and route management, with a mean score of 3.71. These findings suggest that digital tools are viewed positively as essential for modern and effective operations. Still, traditional methods hold value.

Table 5
Aviation students' views on significance of enhancing the skill set of aviation students through the use of computer-based flight planning

Statement	Standard Deviation	Mean	Decision
2.1.1. I find that integrating technology in aviation education improves the accuracy of my flight planning and navigation tasks.	0.41786	3.79	Strongly Agree
2.1.2. I believe that digital flight planning tools reduce the workload for pilots and dispatchers.	0.46004	3.71	Strongly Agree
2.1.3. I believe that the integration of digital tools in flight planning will transform the responsibilities of aviation experts in terms of navigation, route	0.46004	3.71	Strongly Agree
2.1.4. I find that adopting new technologies strengthens training quality and operational effectiveness in aerospace organizations.	0.5762	3.54	Strongly Agree
Total	0.34443	3.69	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

improve the accuracy and reliability of planning results. In support of this, a mean score of 3.57 suggests that students develop stronger geographical awareness and improved route interpretation skills when using computer-based platforms.

These results highlight that digital flight planning promotes automation, real-time data integration, and reduced computational errors compared to manual methods. It allows students to process information more efficiently and make better, data-driven decisions during the planning process. Exposure to these tools also strengthens their technical competence, adaptability, and readiness for modern aviation technologies.

Furthermore, it prepares them to operate effectively within the digital environment increasingly present in today's aviation industry. According to Winter et al. (2020), pilots using electronic charts demonstrate higher accuracy and situational awareness than those using paper-based methods. Their findings align with this study by emphasizing that digital systems minimize workload and improve navigational precision. Similarly, Weber (2025) found that next-generation navigation technologies, such as technological tools, enhance spatial awareness and flight accuracy in aviation operations. To sum it all up, computer-based flight planning equips aviation students with essential technical skills, enhances accuracy, and fosters readiness for the demands of modern, technology-driven flight operations.

B. What is the Significance of Enhancing the Skill Set of Aviation Students Through the Use of:

1) Computer-based Flight Planning

This section examines how aviation students' skills are improved using computer-based flight planning. Students must

Students agree that manual flight planning increases safety awareness with a mean score of 3.46 and discipline with a mean score of 3.29. This suggests that both digital and traditional approaches play important roles in developing well-rounded aviation professionals.

With mean scores ranging from 3.29 to 3.79 and low standard deviations from 0.41 to 0.85, the responses show strong agreement and consistency. A balanced integration of both approaches can best enhance the overall competence of aviation students

These findings align with the study of Dinçer et al (2023), which highlighted that integrating digital tools in aviation education enhances learning outcomes and flight planning efficiency. They also support the research of Odić et al. (2024), who discovered that AI in air traffic control increases navigation accuracy and decreases workload. Both studies emphasize the positive impact of technology on aviation operations. However, students still recognize the importance of traditional methods in developing safety awareness and discipline. In general, the literature supports the necessity of striking a balance between manual instruction and technical innovation in aviation education.

This segment explains how traditional flight planning is still supportive of navigation skills development among aviation students. The usage of manual planning alongside digital planning tools still helps the student pilot to get disciplined and critical of the flight preparation.

All items were rated between 3.29 and 3.64, which implies that the respondents strongly agreed overall. The highest mean score of 3.64 suggests that the majority of students consider themselves to be better prepared for handling the unexpected

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situations in flight if they have conducted traditional planning beforehand.

need for technology too much. This is in line with the research of Babb & Babb (2023), who found that one of the benefits of

Table 6
Aviation students' views on the contribution of computer-based flight planning to industry readiness

Statement	Standard Deviation	Mean	Decision
3.1. I believe that using digital tools in flight planning enhances sustainability and airspace efficiency.	0.48795	3.64	Strongly Agree
3.2. I believe using computer-based flight planning helps operators optimize their routes in-flight through the use of built-in dynamic weather forecasting.	0.62889	3.61	Strongly Agree
3.3. I believe that computer-based flight planning lessens the time on making the actual flight plan.	0.53452	3.71	Strongly Agree
3.4. I believe that by using digital tools in flight planning I can create better quality and well-structured flight plans that increase safety and reliability in flight operations.	0.63828	3.50	Strongly Agree
3.5. I believe that learning computer-based flight planning enhances my technical skills needed for the modern aviation industry.	0.63413	3.43	Strongly Agree
3.6. I can acquire a better skill set in flight planning with the help of digital tools that will prepare me for industry practices.	0.5762	3.54	Strongly Agree
Total	0.47016	3.57	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

The findings show that students perceive manual planning

traditional planning is safety awareness and precision of the

Table 7
Difference in the respondents' views between computer-based flight planning and traditional flight planning methods in shaping the skill development of the aviation students based on their age

Statement	Age	Mean	SD	F	Sig.	Decision
4.1.1. I find that integrating technology in aviation education improves the accuracy of my flight planning and navigation tasks.	21 below	3.82	0.39295	1.315	0.562	Accept
	22 above	3.73	0.46710			
4.1.2. I believe that digital flight planning tools reduce the workload for pilots and dispatchers.	21 below	3.65	0.49259	4.409	0.326	Accept
	22 above	3.82	0.40452			
4.1.3. I believe that the integration of digital tools in flight planning will transform the responsibilities of aviation experts in terms of navigation, route	21 below	3.65	0.49259	4.409	0.326	Accept
	22 above	3.82	0.40452			
4.1.4. I find that adopting new technologies strengthens training quality and operational effectiveness in aerospace organizations.	21 below	3.53	0.51450	1.054	0.944	Accept
	22 above	3.55	0.68755			
4.1.5. I believe that traditional flight planning sharpens critical thinking in flight preparation.	21 below	3.53	0.62426	0.043	0.671	Accept
	22 above	3.64	0.67420			
4.1.6. I feel more confident in my ability to read maps when practicing traditional flight planning.	21 below	3.35	0.78591	1.221	0.806	Accept
	22 above	3.27	0.90453			
4.1.7. I feel more prepared to face unexpected situations through the knowledge I gained from practicing traditional flight planning.	21 below	3.71	0.58787	1.935	0.551	Accept
	22 above	3.55	0.82020			
4.1.8. I have increased safety awareness when I do flight planning with traditional tools as opposed to digital.	21 below	3.53	0.62426	4.844	0.608	Accept
	22 above	3.36	0.92442			
4.1.9. I feel that I will be more disciplined and skilled when evaluated through traditional methods.	21 below	3.29	0.77174	0.547	0.950	Accept
	22 above	3.27	1.00905			

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

as a tool that keeps them mentally alert, patient, and detail-oriented. In addition to that, it increases their trust in themselves when reading charts and in making quick decisions without the

pilot.

It is recommended that aviation colleges keep on utilizing traditional flight planning methods as well as gradually

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incorporate computer-based planning tools. The combination of both ways equips the students with a comprehensive learning experience and gets them ready for the situations in the real world where they might have to depend on manual skills.

C. How Does Exposure to Computer-Based Flight Planning Prepare Aviation Students for the Increasing Use of Digital Tools in Modern Aviation Operation?

The result of the analysis for the last part of the questionnaire shows the same views of aviation students on how the use of computer-based flight planning contributes greatly to their

D. The Significant Difference in the Respondents' Views between Computer-based Flight Planning and Traditional Flight Planning Methods in shaping the Skill Development of the Aviation Students

1) Significant Difference in the Respondents' Views between Computer-based Flight Planning and Traditional Flight Planning Methods in shaping the Skill Development of the Aviation Students based on their Age?

The results presented in this table illustrate how aviation students, based on their age groups, perceive the influence of

Table 8
Difference in the respondents' views between computer-based flight planning and traditional flight planning methods in shaping the skill development of the aviation students based on their sex

Statement	Sex	Mean	SD	F	Sig.	Decision
4.2.1. I find that integrating technology in aviation education improves the accuracy of my flight planning and navigation tasks.	Male	3.76	0.43589	7.516	0.011	Reject
	Female	4.00	0.00			

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

preparation for today's modernized aviation practices. The majority of the students strongly agree that using digital tools in flight planning can improve not just their navigational

computer-based and traditional flight planning methods on their skill development. Aviation students aged 21 and below have a mean ranging from 3.82 to 3.29, with a standard deviation

Table 9
Master theme the influence of computer-based flight planning on student learning

Master Theme	Superordinate Theme
Improving Flight Planning Performance through Digital Tools	Error Reduction
	Efficiency
Enhancing Learning and Skill Development through Computer-Based Flight Planning	Balanced Foundational Knowledge
	Digital Adaptability
Bridging Traditional and Modern Flight Planning for Industry Readiness	Adaptability
	Industry Alignment

experiences but also help to produce a sustainable industry that is more technology-driven, enhance safe and quality workload, and acquire a better skill set in flight planning. With the highest mean score of 3.71, it can be interpreted that aviation students strongly agree that computer-based flight planning significantly reduces the time required to create flight plans. This means that digital tools really improve efficiency by streamlining the planning process compared to traditional methods. To further support the idea, a mean score of 3.43 implies that if aviation students continue to learn computer-based flight planning both during institutional level and ground schooling, their technical skills would be further improved to be useful for the digital demand of flight operation. The findings in this part were aligned with the literature that explores how advanced tools prepare students for the current industry. In fact, Wang et al. (2024) state that exposure to such tools, like computer-based flight planning, builds student readiness for modern operations. In summary, exposure to computer-based flight planning equips aviation students with the necessary technical competence, adaptability, and practical experience to meet the digital demands of modern aviation operations. It enhances their efficiency, strengthens their skill development, and prepares them to perform effectively in a technology-driven aviation environment.

ranging from 0.79 to 0.39, compared to aviation students aged 22 and above, who have a mean ranging from 3.82 to 3.27 with a standard deviation of 1.01 to 0.40.

However, this difference is not significant because the null hypothesis is not rejected, with a frequency ranging from 4.844 to 0.043 and a significance ranging from 0.95 to 0.33, which is greater than the significance level of 0.05 (> 0.05). Therefore, computer-based flight planning and traditional flight planning methods have no significant effect or difference in shaping the skill development of aviation students based on their age groups.

The analysis shows that age does not play a major role in determining how students perceive or benefit from these methods. Regardless of their age group, aviation students demonstrate comparable adaptability and understanding when it comes to learning and applying digital tools in flight planning. This result aligns with the findings of DİNÇER (2023), who emphasized that adaptability in technology-based aviation training can be achieved across various learner groups when modern tools and methods are effectively integrated. This suggests that exposure to technology-driven learning materials equally enhances skill development across different age ranges.

2) Significant Difference in the Respondents' Views between Computer-based Flight Planning and Traditional Flight

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Planning Methods in shaping the Skill Development of the Aviation Students based on their Sex?

The results shown in this table illustrate how aviation students, based on their sex group,s perceive the influence of computer-based and traditional flight planning methods on their skill development. Most indicators showed no significant sex-based differences. However, Item 4.2.1 displayed a p-value of 0.011 (< 0.05), revealing a significant difference in this specific aspect of skill development between male and female students.

This means that while sex generally does not influence most skill development perceptions, there is one particular area where male and female students differ significantly. This supports the idea of Sun et al. (2021), who stated that aviation education challenges often arise from individual differences in adapting to modern technologies, which can lead to variation in skill development among learners.

E. The Influence of Computer-Based Flight Planning on Student Learning

Master Theme 1: Improving Flight Planning Performance through Digital Tools

Superordinate Theme 1.1.: Error Reduction

Informant 1: "...traditional flight planning is more prone to errors, specifically human errors."

Informant 2: "...It minimizes human error, optimizes routes automatically"

Informant 3: "...if you are going to use computer-based, for sure it already is, there is an integrated formula for the applications of the software."

The transition from traditional to computer-based flight planning has introduced significant improvements in operational accuracy and reliability. One of the most notable advantages identified by the informants is the reduction of human error, which has long been a concern in manual flight planning processes.

Informant 1 mentioned that traditional methods are more prone to mistakes, while Informants 2 and 3 highlighted that automated route optimization and integrated software formulas make flight planning more accurate and dependable. This shows that technology provides a more consistent and efficient approach to navigation, allowing students to focus on understanding flight concepts rather than manual computations. The automation built into these tools not only enhances accuracy but also fosters confidence and precision in future aviation professionals. This finding aligns with Prasad and Thakur (2024), who noted that AI and computer-based systems optimize routes and minimize errors by analyzing real-time data such as weather and traffic conditions, ensuring safer and more reliable flight operations.

Superordinate Theme 1.2.: Efficiency

Informant 1: "...For both traditional flight planning and computer-based flight planning, it is better air navigation for aviation students.

Informant 2: "...saves time in preparing flight plans."

Informant 3: "...Efficiency is one of their factors, so I would

definitely agree that it will smoothen the operational flow of the workplace."

Efficiency is the most notable benefit of computer-based flight planning that this study likes to focus on for aviation students.

All informants agreed that computer-based flight planning improves workflow efficiency. Informant 1 noted that both traditional and digital methods contribute to better air navigation, while Informant 2 emphasized that digital tools save time in preparing flight plans. Informant 3 further explained that efficiency in computer-based systems smoothens operations and simplifies workplace processes. This highlights that automation not only accelerates flight planning tasks but also enhances productivity, allowing students to allocate more focus to analysis and decision-making rather than repetitive manual procedures. This supports DİNÇER (2023), who stated that incorporating technology into aviation training improves learning effectiveness and operational efficiency by automating complex processes and aligning educational practices with modern aviation standards.

Master Theme 2: Enhancing Learning and Skill Development through Computer-Based Flight Planning

Superordinate Theme 2.1.: Balanced Foundational Knowledge

Informant 1: "...focus on both, for example 50% on computer-based flight planning and 50% on traditional flight planning."

Informant 3: "...it is still important that we are able to learn the basics."

It is really reasonable that a balanced type of learning modality would be much better. However, an essential development for education is to adapt more and more advanced learning modalities. As a result, Informants emphasized the importance of maintaining a balance between traditional and computer-based learning. Informant 1 suggested a 50-50 focus to ensure that students gain both manual and digital proficiency, while Informant 3 highlighted that understanding the basics through traditional training remains vital for foundational knowledge. This demonstrates that while modern aviation relies heavily on technology, traditional methods still play a critical role in strengthening comprehension, problem-solving, and analytical thinking, which serve as the groundwork for mastering digital tools. This aligns with DİNÇER (2023), who noted that integrating both conventional and modern technologies in aviation training enhances adaptability and skill development, preparing students for diverse operational environments in the aviation industry.

Superordinate Theme 2.2.: Digital Adaptability

Informant 1: "...easily adapt to computer-based flight planning since, in our generation, we are more used to technology."

Informant 2: "...adapt quickly to computer-based flight methods because they are generally tech-savvy and familiar with digital learning tools."

Informant 3: "...not everyone is capable of retaining the

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knowledge"

As aviation education transitions toward modernized methods, digital adaptability has become an essential skill for aviation students to effectively engage with computer-based flight planning systems.

Informants generally agreed that most aviation students can easily adapt to computer-based flight planning due to their familiarity with technology. Informants 1 and 2 highlighted that today's students are part of a tech-savvy generation accustomed to using digital devices and learning tools. However, Informant 3 noted that not all students may retain the same level of understanding, emphasizing the need for proper guidance and training to ensure a smoother transition. This suggests that while digital adaptability is a natural strength among students, it must still be supported by structured instruction and continuous practice to achieve full competency in computer-based flight operations. This finding supports DİNÇER (2023), who emphasized that technological integration in aviation training enhances learners' adaptability and engagement, enabling them to meet the evolving digital requirements of the modern aviation industry.

Master Theme 3: Bridging Traditional and Modern Flight Planning for Industry Readiness

Superordinate Theme 3.1.: Adaptability

Informant 1: "...better understand and comprehend the fundamentals of computer-based flight planning."

Informant 2: "...allows them to appreciate the efficiency and accuracy of computer-based systems."

Informant 3: "...the format being taught in a traditional method is kinda like the same in computer-based flight

evolving digital demand of the aviation industry.

Superordinate Theme 3.2.: Industry Alignment

Informant 1: "...industry is digital centered, and this serves as a sign of competence and credibility to the employers."

Informant 3: "still depends on the outcomes of the student projecting after college."

Aligning aviation education with industry practices ensures that students develop the competencies and professionalism required in an increasingly technology-driven aviation environment.

Informants emphasized that proficiency in computer-based flight planning reflects industry expectations and enhances students' employability. Informant 1 stated that since the aviation industry is now digitally centered, mastering computer-based tools demonstrates competence and credibility to employers. Informant 3 added that the relevance of these skills depends on each student's career path after college, suggesting that the depth of learning and exposure directly influence professional readiness. This shows that aligning academic training with current industry practices not only improves technical proficiency but also prepares aviation students to meet workforce standards confidently. This finding also supports DİNÇER (2023), who highlighted that integrating technology-focused training in aviation education bridges the gap between classroom learning and real-world operational demands, ensuring that graduates are industry-ready and adaptable to modern aviation systems.

F. Recommendations of the Informants to Further Improve the Use of the Computer-Based Flight Planning Tool to Benefit More Aviation Students

Table 10

Master Theme recommendations to further improve the use of the computer-based flight planning tool to benefit more aviation students

Master Theme	Superordinate Theme
Balancing Technology with Fundamental Knowledge	Safety Awareness
Further improve the use of computer-based flight planning tools to benefit more aviation students	Wider Implementation

planning."

Adaptability plays a crucial role in helping aviation students transition smoothly from traditional to computer-based flight planning methods, ensuring they can perform effectively in both educational and professional environments.

Informants highlighted that a strong understanding of traditional flight planning enhances students' ability to grasp computer-based systems. Informant 1 emphasized that mastering the fundamentals allows for better comprehension of digital platforms, while Informant 2 added that this foundation helps students appreciate the efficiency and accuracy of computer-based systems. Similarly, Informant 3 pointed out that the similarity in structure between traditional and computer-based planning makes the transition easier for students. This indicates that adaptability is strengthened when students are first grounded in traditional concepts, allowing them to adjust more effectively to digital aviation practices. This finding also aligns with DİNÇER (2023), who stated that exposure to both traditional and modern technological tools enhances learners' adaptability and preparedness for the

Master Theme 1: Balancing Technology with Fundamental Knowledge

Superordinate Theme 1.1.: Safety Awareness

Informant 1: "...having knowledge and experience of traditional flight planning methods is also essential for safety."

Informant 2: "...always keep safety in mind when using computer-based flight planning. They should learn how to spot and handle system errors or wrong data."

The informants emphasized the importance of integrating traditional flight planning knowledge with digital tools. While recognizing the efficiency of computerized systems, the informants believe that traditional methods are still essential for ensuring flight safety and minimizing human or system errors. This suggests that computer-based planning should not entirely replace manual methods but rather incorporate their core principles to maintain accuracy and safety.

According to Alamri (2022), blending traditional and modern flight planning approaches enhances student understanding of navigation principles and reduces overreliance on automated systems. Similarly, Nguyen & Pham (2023) highlight that

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aviation education must balance digital literacy with foundational flight planning skills to prepare students for diverse operational contexts.

Master Theme 2.: Further improve the use of computer-based flight planning tools to benefit more aviation students

Superordinate Theme 2.1.: Wider Implementation

Informant 3: "...suggest this to schools who have this subject, even maybe to institutions, or like companies where they're still doing it."

The informant emphasizes the importance of expanding the implementation of computer-based flight planning tools beyond the current study setting. They suggest that once the tool produces positive outcomes, it should be introduced to other schools, educational institutions, and aviation companies that still rely on traditional methods. This recommendation highlights the potential of the tool to enhance learning and operational efficiency across a broader network of aviation stakeholders.

By advocating for wider application, the informant underscores the tool's scalability and relevance in improving aviation education and industry practices. This aligns with Martínez and Ramos (2022), who state that extending innovative educational tools to multiple institutions fosters knowledge sharing and consistent skill development. Similarly, Smith and Patel (2023) emphasize that promoting the adoption of digital tools in various aviation settings strengthens the integration of technology in both academic and professional training environments.

4. Discussion

A. Conclusions

Based on the results and analysis, the following were concluded:

1. The findings of this study present a comprehensive view of how the transition from traditional to computer-based flight planning influences the learning, efficiency, and industry readiness of aviation students. The results reveal that the integration of digital tools in flight planning enhances both the speed and precision of task execution, allowing students to complete complex flight plans more efficiently while developing stronger analytical and problem-solving skills. This transition minimizes manual workload and promotes focus on higher-order thinking, reflecting the technological realities of today's aviation operations.

2. This study also highlights that computer-based flight planning significantly helps to improve navigational accuracy and operational reliability by reducing human error and automating repetitive calculations. The incorporation of real-time data and digital route optimization enables students to make data-driven decisions, reinforcing their technical competence and situational awareness. Despite these advancements,

the findings also emphasize the continuing value of traditional flight planning as a foundation for developing mental discipline, patience, and manual computation skills, which are the traits that remain critical for aviation safety and adaptability in unexpected scenarios.

3. This study also proves that aviation students who are trained under this integrated model demonstrate stronger skill sets and are better equipped to meet the evolving standards of a technology-driven industry. Exposure to computer-based systems in aviation education fosters adaptability, confidence, and digital literacy, ensuring that students are well-prepared for the modernization of flight operations and future employment demands.

4. The analysis found no significant difference in the adaptability of students based on age and sex, indicating that technological competence and learning effectiveness are not determined by demographic factors. Both male and female students, regardless of age group, exhibited similar readiness and capacity to learn digital tools when provided with sufficient training and exposure. This suggests that effective educational design and guidance play a greater role than demographic variables in shaping aviation students' ability to adopt computer-based flight planning.

5. Qualitative insights from informants reveal that the integration of computer-based flight planning not only strengthens learning outcomes and operational efficiency but also aligns academic practices with current industry expectations. Informants recognize that the aviation field's shift toward digital operations demands graduates who are both technologically competent and grounded in traditional principles. Thus, fostering balanced, technology-oriented education ensures that aviation students are not only efficient and accurate in their workload but also adaptable, credible, and fully prepared to thrive in the rapidly evolving aviation industry.

Additionally, the researchers recognize that traditional flight planning serves as the foundation for understanding the technical aspects of aviation operations and remains a reliable fallback when digital systems are unavailable. This study does not aim to disregard traditional methods but rather to emphasize their evolution through integration with modern technology. If aviation students can expand their learning beyond the limitations of manual planning, adopting advanced digital approaches will allow them to gain broader, more practical competencies aligned with the needs of today's aviation industry.

To conclude, this study determines that computer-based flight planning plays a vital role in enhancing the navigational experience of aviation students, equipping them with the necessary skills, adaptability, and technical competence

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required in today's digitally driven aviation industry.

B. Recommendations

Based on the discussed conclusions, the recommendations are as follows:

1. It is recommended to begin with a strong foundation in traditional flight planning to help aviation students understand the fundamental concepts and processes before transitioning to computer-based systems. Building on this foundation, aviation institutions should implement computer-based flight planning and incorporate hands-on training to better prepare students for real-world aviation operations. Further research on integrating traditional and computer-based methods is essential to improve training outcomes and equip future aviation professionals with both technical and practical skills. Additionally, the study measured perceived accuracy and efficiency. Actual experimental comparison (e.g., time trials, error counts) was not conducted. Future researchers are encouraged to compare the two methods using real performance data.

2. Aviation Institutions are advised to continue using traditional flight planning methods while progressively integrating computer-based planning tools. Air Transportation Instructors must teach students the necessary foundations, to be able to know how Computer-based Flight Planning works. Further research on the skill set of aviation students in Computer-based Flight Planning is preferable; this will greatly help support the study of transitioning from Traditional Flight Planning to Computer-based Flight Planning.

3. Continuous learning and exposure of aviation students to computer-based flight planning, both at the institutional level and during ground schooling, are highly recommended. Through this, their technical skills can be further enhanced to meet the growing digital demands of modern flight operations. Conducting similar studies involving a larger number of participants or across different aviation institutions to validate and expand these findings is highly recommended for future researchers.

4. It is recommended that aviation students continue practicing both traditional and computer-based flight planning to enhance their adaptability, regardless of demographic differences. Air transportation professors should integrate digital tools alongside manual methods to provide equal learning opportunities for all students. Moreover, aviation institutions and companies are encouraged to invest in modern flight planning technologies and continuous instructor training to align education with current industry standards.

Aviation institutions and companies are encouraged to invest in modern flight planning technologies, simulation tools, and continuous instructor training programs to maintain alignment with current aviation standards and practices.

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