Enhancing Drone Education in Malaysia: STEM and TVET Framework Perspective

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Abstract: *The integration of drone technology into education is increasingly recognised as a means to enhance Science, Technology, Engineering, and Mathematics (STEM) learning and Technical and Vocational Education and Training (TVET). Despite its potential, Malaysia faces challenges in fully integrating drones into the education system, including a lack of structured curricula, insufficient training for educators, and regulatory constraints. This study explores the integration of STEM and TVET principles into drone education and training in Malaysia, aiming to bridge the gap between technological advancements and workforce readiness. The primary objectives of this study are to analyse the current state of drone education in Malaysia, identify key implementation challenges, and develop a structured framework for integrating drone education into STEM and TVET programs. A mixed-methods research approach was employed, combining quantitative assessments, qualitative evaluations, pre- and post-assessment, and workshop-based training to measure participants' knowledge improvement and engagement. Initial findings reveal that structured drone training programs significantly enhance students' technical competencies, safety awareness, and career preparedness, but are not very effective from a regulatory compliance perspective. The Reusable Learning Object (RLO) approach has been used for the Safety and Regulations module, and it has significantly improved candidates' understanding.*

Keywords: *STEM, TVET, drone education, Reusable Learning Object (RLO), drone operation*

1. INTRODUCTION

Unmanned Aerial Vehicles (UAVs), commonly known as drones, are aircraft operated without an onboard pilot (Antony & Rodrigo, 2025). The initial stage of drone applications focused on data acquisition and reconnaissance for military intelligence, or they were used in risky missions for human-pilot aircraft (Watts et al., 2012). Recently, UAVs have been used for data collection in various research studies, driving the need to incorporate them into education. As technology has advanced, the cost of UAVs has decreased, and their use has expanded into recreation and research (Salami et al., 2014).

The use of UAVs has seen a significant surge in the Science, Technology, Engineering, and Mathematics (STEM) fields. Consequently, there is a growing necessity to incorporate UAV training into STEM education. Three distinct approaches can be adopted to introduce UAVs into educational settings: involving students in a capstone project with UAVs, integrating a UAV education module into an existing course, or creating a dedicated course solely focused on UAVs (AL – Tahir, 2015). In support of this idea, Alkaabi et al. conducted a study wherein a hands-on UAV workshop was organised for students at the United Arab Emirates University. Remarkably, this workshop led to improved teamwork, communication, and critical-thinking skills among the students. Furthermore, the study revealed that the UAV workshop effectively equipped students with real-world problem-solving capabilities (Alkaabi & Abdelgadir, 2017). In light of these findings, it is evident that UAV education has immense potential across various STEM disciplines, offering students valuable skills.

Recent studies on the drone market in Malaysia indicate that the drone industry could add RM50.71 billion to the Gross Domestic Product (GDP) and create 100,000 jobs by 2030. So far, over 200 drone technology companies have been identified in Malaysia and with the increasing demand, the number of companies (domestic players) is expected to grow exponentially. While some developed countries have successfully incorporated drone technology into STEM education, Malaysia faces challenges such as insufficient infrastructure, limited teacher training, and the absence of a structured drone-education curriculum. Additionally, stakeholders lack awareness and understanding of the potential of drones as an educational tool.

A significant concern is the risk of drone crashes due to inadequate operational skills or poor understanding of safety protocols, which can lead to financial losses, equipment damage, and safety hazards. One of the latest drone incidents that was reported was in July 2023. The accident involving an agricultural drone took place on Nomination Day in Kedah. The drone, originally used for agricultural purposes, lost control and crashed into a bystander, injuring them. This incident raises important concerns about the safety protocols for using drones in public areas, particularly when they are not intended for recreational or commercial use. It also underscores the need for stricter regulations and better training for operators to prevent such mishaps in the future (CAAM, 2023). One of Malaysia's leading drone companies, the Official DJI Service Centre, has reported that the cost of repairing drones in the country is approximately RM400,000 per month. As drones become an essential part of industries, this repair cost underscores the need for advanced technology and skilled technicians to ensure they remain functional and safe to operate. Furthermore, it emphasises the importance of developing more durable and efficient drone models to reduce long-term repair costs. Embarking on this issue, drone education needs to plan properly.

The integration of drone technology into TVET and STEM education represents a forward-thinking approach to enhance technical skills and stimulate interest in science and technology. According to Mazlan et al. (2020), TVET institutions in Malaysia have increasingly recognised the potential of incorporating drone training into their programs. The hands-on experience in drone assembly, flight operations, and data analysis equips TVET students with practical skills relevant to the drone industry. In STEM education, drone technology has been utilised to enrich learning experiences and increase student engagement. Integrating drones into STEM activities allows students to explore real-world applications, such as aerial surveys and environmental monitoring, fostering a deeper understanding of scientific concepts and enhancing problem-solving skills (Yusof et al., 2021). While the integration of drones into TVET and STEM education offers numerous benefits, it also presents challenges that need to be addressed. Limited resources for drone equipment and training can hinder the implementation of drone-based programs (Azmi et al., 2021). Ensuring that educators are well-prepared to teach drone technology effectively is also crucial, as discussed by Ng et al. (2019). Additionally, safety and ethical considerations related to drone operation must be carefully addressed to ensure responsible and legal usage.

The integration of drones into TVET and STEM education aligns with industry needs and enhances graduates' employability. According to Mohd Zaid et al. (2018), drone training in TVET equips students with technical skills in demand across sectors such as aerial surveying, agriculture, and construction. For STEM graduates, drone technology provides valuable exposure to cutting-edge applications, making them competitive in the job market, as noted by Yusof et al. (2021). The literature on TVET and STEM education with a focus on drones in Malaysia showcases the nation's dedication to developing a skilled and innovative workforce. The integration of drone technology into TVET and STEM education offers promising opportunities to enhance technical competencies and stimulate interest in science and technology. Addressing challenges related to resources, educator readiness, and safety considerations will be essential in maximising the benefits of drone-based TVET and STEM education. Overall, the incorporation of drones reflects Malaysia's commitment to nurturing a skilled workforce capable of driving economic growth and technological advancement.

As of December 1, 2021, CAAM requires all drone operators, whether individuals or organisations, to obtain a Remote Pilot Certificate of Competency (RCoC) to operate drones in Malaysia legally. This certification ensures that individuals and organisations operating drones in Malaysia possess the necessary knowledge and skills and comply with aviation safety regulations. This certification is mandatory for operating drones within Visual Line of Sight (VLOS) under specific conditions. By equipping participants with both theoretical understanding and practical expertise, the program seeks to mitigate operational risks, enhance the efficiency of drone applications, and support the development of a well-regulated drone industry in Malaysia. The Basic RCoC-B Training focuses on foundational aspects, including aviation regulations, drone flight principles, safety protocols, and hands-on flight training, enabling participants to operate drones safely within Visual Line of Sight (VLOS).

The training programs typically cover a comprehensive range of topics, including Air Law and Responsibilities: Understanding the legal framework governing drone operations, UAS/Drone Airspace Operating Principles: Navigating airspace and adhering to operational rules, Airmanship and Aviation Safety: Promoting best practices for safe flight operations, Operational Procedures: Developing standard operating procedures for various missions, Human Performance Limitations: Recognizing factors that affect pilot performance, Meteorology: Assessing weather conditions for safe drone operations, Navigation: Planning and executing precise flight paths, UAS General Knowledge: Gaining insights into drone systems and functionalities. Malaysia's drone training programs are structured to produce competent remote pilots who adhere to CAAM regulations and industry best practices. The collaboration between regulatory bodies and training institutions ensures that the country's drone operators are well-equipped to meet the growing demands of various industries, thereby advancing drone technology and its applications in Malaysia.

Malaysia has implemented several policies to promote STEM (Science, Technology, Engineering, and Mathematics) education and regulate drone operations. The Malaysian Education Blueprint 2013–2025 emphasises the integration of STEM education to prepare students for future challenges. The blueprint outlines strategies to enhance STEM teaching and learning, aiming to increase student interest and proficiency in these fields (Siti et al., 2022). Drone training in Malaysian schools represents a significant step toward aligning education with technological advancements and industry demands. While challenges like cost and regulatory hurdles exist, the benefits, including enhanced STEM education, innovation, and career readiness, make it a valuable investment in the nation's future. Malaysia's diverse landscapes and natural beauty make it an attractive destination for drone enthusiasts seeking breathtaking aerial views.

However, this growing industry also faces challenges related to safety, privacy, and regulatory compliance. The Malaysian government has been actively addressing these concerns by implementing guidelines and regulations to ensure responsible drone use. As the industry continues to expand, stakeholders are focusing on raising awareness, providing education, and promoting sustainable practices to harness the full potential of recreational drones in Malaysia. In this study, the integration of STEM education and the TVET

SKM program will be reviewed, with a focus on its suitability for creating a drone education and training framework. To achieve this, several activities will be conducted, including a pre-assessment test, on-site workshop activities, sampling, and a post-assessment, to verify the effectiveness of the workshop and the prior activities. Addressing these issues is critical to ensuring that Malaysia remains competitive globally while fostering a culture of responsible and safe drone use. This research aims to investigate these challenges and develop a comprehensive framework to effectively integrate drone technology into Malaysia's education system, with a strong emphasis on safety measures to mitigate risks and prevent operational failures.

2. METHODOLOGY

This chapter outlines the research methodology employed in this study on STEM and TVET in drone education and training in Malaysia. The objective of this research is to examine the integration of STEM (Science, Technology, Engineering, and Mathematics) and TVET (Technical and Vocational Education and Training) in drone-related education and training programs, assessing their effectiveness, challenges, and potential improvements. To achieve these objectives, a mixed-methods approach is adopted, combining both qualitative and quantitative research methods.

2.1 PRE AND POST-TEST

To provide a quantitative view to complement the study, a set of questions on the focus content was selected. With that, it was possible to compare participants' performances within the same group before and after the activity/event. The material was prepared by an engineering lecturer and a student, aiming to serve as a pre- and post-test. This set of questions is derived from the basic drone operational scope and will be created in Google Forms. This study did not cover teaching people how to fly drones (since many resources already exist), flying drones for commercial profit or business (which requires special licenses), or building and/or coding drones (since these are too heavy for recreational use). The questions focus more on safety, basic regulations, drone components, and a feedback column for users to respond. Also, the set of questions is being developed based on STEM and TVET elements, which favours basic drone operation. Before the start of the Workshop, a pre-assessment test was conducted to evaluate participants' prior knowledge, covering three key areas: drone applications, drone components, and safety and regulations.

2.2 WORKSHOPS / ACTIVITIES

A workshop named the Fundamentals of Drone Technology Workshop has been organised in line with the objective.

2.2.1 ACTIVITY 1: INTRODUCTION TO DRONE TECHNOLOGIES AND APPLICATIONS

This first activity was conducted through an engaging combination of lecture and multimedia presentation. Participants attentively followed along as a series of informative slides was displayed, accompanied by high-quality images and video. These visual elements provided a more comprehensive perspective on drones, their components, and their real-world applications. The session lasted one hour and was structured into three 20-minute modules. The first module introduced participants to drone technology, covering fundamental topics such as the definition of drones, their types, and the physics of flight. This segment provided a solid theoretical foundation, helping participants understand how drones achieve stability, manoeuvrability, and control in flight. The second module explored the practical applications of drones across various industries and introduced participants to key sectors that utilise drone technology.

2.2.2 ACTIVITY 2: UNDERSTANDING DRONE LAWS AND REGULATIONS

The second activity aimed to gather information on related drone regulations, particularly those in Malaysia. This activity aims to increase participants' understanding of the regulatory concepts involved in flying a recreational drone and to raise awareness. Activity 2 was a comprehensive 1-hour session focusing on drone laws and regulations. The session was conducted through a structured lecture and multimedia presentation, incorporating slides, images, and video to enhance participants' understanding of legal and safety aspects of drone operations. This session aimed to provide participants with crucial knowledge about responsible drone usage, legal requirements, and regulatory frameworks governing drone activities in Malaysia.

The session was divided into three 20-minute modules: Drone Safety Guidelines, Drone Laws in Malaysia & Regulatory Authorities, and Permit Applications & Licensing Requirements. By the end of the session, participants had a clear understanding of the legal, safety, and regulatory aspects of drone operation in Malaysia. The session emphasised the importance of complying with aviation laws to ensure safe and responsible drone use in both personal and professional settings. Extensive work was done for this part, which focused on analysing the videos and the UAV simulation. It consisted of a sequence of Reusable Learning Objects (RLOs) and was part of Activity 3.

2.2.3 ACTIVITY 3: REUSABLE LEARNING OBJECTS (RLO)

RLOs are defined by Valderrama et al. (2005) as "any digital resource that can be reused to support web-based learning." Documents, webpages, live or pre-recorded video or audio, or other content that can be accessed independently and combined to create an instructional lesson can be part of an RLO. The RLOs in this study include: (1) a pre-assessment online survey in Google Forms, (2) a video lecture on UAV law in Malaysia on flying a drone and a series of UAV flight videos, (3) a multiple-choice online quiz on Google Forms, and (4) a post-assessment online survey in Google Forms. The results of this activity include participants' understanding of the concepts involved, increased awareness of the importance of regulations applied to drone operations, and the educational value gained from involvement in this field. Activity 3 focused on Reusable Learning Objects (RLO) to enhance participants' understanding of drones through a structured, self-paced learning approach. This session utilised online assessments, video-based learning, and interactive quizzes to evaluate participants' knowledge before, during, and after the workshop. The activity was divided into four parts, each designed to track learning progress and reinforce key concepts effectively. The activity lasted one hour, with participants engaging in both individual and guided learning exercises.

2.3 SAMPLES, DATA COLLECTION PROCEDURES

The target population for this study consists of diploma students from various universities in Malaysia. Specifically, the sample includes first-year and second-year diploma students enrolled in various academic programs. A total of 60 students were selected as the sample size for this study. The rationale for choosing this sample size is based on practical feasibility, while ensuring sufficient representation for analysis. All selected participants have no background in drone technology. Data collection is conducted through structured surveys distributed in Google Forms to the students. The questionnaire consists of multiple-choice and Likert-scale items designed to gather information efficiently. The survey is administered online and in person to maximise participation and ensure data reliability.

3. RESULTS AND DISCUSSION

The second set assesses the effectiveness of the workshop in enhancing participants' understanding of drone technology.

3.1 ANALYSIS OF PRE AND POST-ASSESSMENT ON DRONE TECHNOLOGIES

To evaluate the effectiveness of the workshop on drone technologies, a pre- and post-assessment questionnaire was administered to participants to measure their understanding of key concepts before and after the workshop. The assessment covered multiple aspects of drone technologies, including components, applications, and safety regulations. The pre-assessment provided a baseline for assessing participants' prior knowledge, while the post-assessment measured their learning outcomes. By comparing the results, improvements in understanding and knowledge retention were analysed. This section presents a detailed comparison of the scores from both assessments, highlighting areas of significant improvement and identifying any gaps that may require further reinforcement. The categorises questions by their respective modules—Components, Application, and Safety & Regulation —to provide a clearer view of knowledge improvement across different topics. A significant increase in post-assessment scores would indicate that the workshop successfully improved participants' knowledge. In contrast, minimal improvement or decline in certain areas may highlight concepts that require further clarification or additional training.

It is important to note that the question numbers in the pre- and post-assessment are not fully synchronised. This discrepancy arises from the way some questions in the post-assessment are structured to better align with the workshop content and learning objectives. While most core concepts remained consistent, some questions were refined, merged, or slightly modified to enhance clarity and relevance. Despite these adjustments, the fundamental themes assessed in both pre- and post-assessments remain comparable. Therefore, the analysis focuses on overall trends in knowledge improvement rather than direct one-to-one comparisons between specific question numbers.

3.2.1 PERFORMANCE ANALYSIS OF THE COMPONENTS MODULE

The Components Module aimed to assess participants' understanding of fundamental drone components, including flight controllers, GPS functionality, control methods, and video transmission systems. The performance analysis reveals notable improvements across all assessed areas, indicating that the workshop effectively reinforced key concepts and addressed prior misconceptions. The result is shown in Figure 1. The Flight Controller Function pre-assessment results indicate that only 32% of participants correctly identified the function of a drone's flight controller. A large proportion of responses incorrectly associated stability and movement control with propellers or flight controllers, and GPS modules with GPS modules, suggesting a gap in understanding of this component's primary role. However, following the workshop, the post-assessment results show a 47% increase in correct responses, with 79% of participants accurately recognising that the flight controller regulates the drone's stability and movement. This significant improvement suggests that, prior to the workshop, participants may have been more familiar with visible drone components, such as propellers, but less aware of the internal control mechanisms. The workshop's content, likely including explanations and demonstrations of flight control systems, played a crucial role in clarifying this concept.

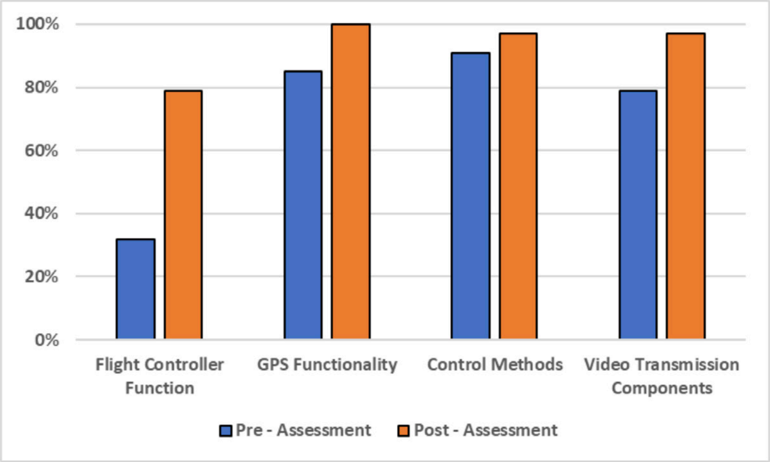

Figure 1. Overview of the Component Module Assessment

In contrast to the flight controller question, participants' understanding of GPS functionality was relatively high even before the workshop, with 85% answering correctly in the pre-assessment. The post-assessment results show a significant improvement to 100%, a 15% increase, indicating that participants already possessed a strong foundational knowledge in this area. This suggests that participants were either previously exposed to or inherently understood GPS technology and its role in navigation and positioning. While the workshop reinforced this knowledge, future sessions may consider incorporating more advanced GPS topics, such as RTK corrections, GPS-denied navigation, or integration with other positioning systems. The question on Control Method, assessing participants' understanding of how drones are controlled, also showed a notable increase in performance. Before the workshop, 91% of participants correctly identified a remote controller or a smartphone app as the standard method for operating a drone. This figure rose to 97% in the post-assessment, representing a 6% improvement. This suggests that the workshop was successful in reducing uncertainty about drone control methods. Likely, practical demonstrations of remote controllers and mobile applications, along with their functionalities, contributed to this improvement. Hands-on experience may have reinforced theoretical knowledge, ensuring that all participants grasped the concept.

A key aspect of drone operation involves video transmission, which requires both a camera and a video transmitter. In the pre-assessment, 79% of participants correctly identified these as the essential components for transmitting live video from a drone. Post-assessment results show 97% accuracy, reflecting an 18% increase in correct responses. This improvement indicates that while some participants may have had a general understanding of video transmission, the workshop played a crucial role in clarifying the specific hardware requirements involved. The significant gain suggests that discussions on payload systems, data transmission, and onboard video processing effectively improved participants' understanding of the topic.

The results of the Components Module assessment suggest that the workshop was highly effective in enhancing participants' knowledge. The most significant improvement was in understanding the flight controller's function, an area where participants initially struggled. Conversely, knowledge of GPS functionality showed only minor gains, likely due to participants' prior familiarity with the topic. The increase in correct responses for drone control methods and video transmission components further demonstrates the workshop's effectiveness in addressing key knowledge gaps. These findings highlight the importance of interactive learning methods, particularly hands-on demonstrations, in reinforcing conceptual understanding.

3.2.2 PERFORMANCE ANALYSIS OF THE APPLICATIONS MODULE

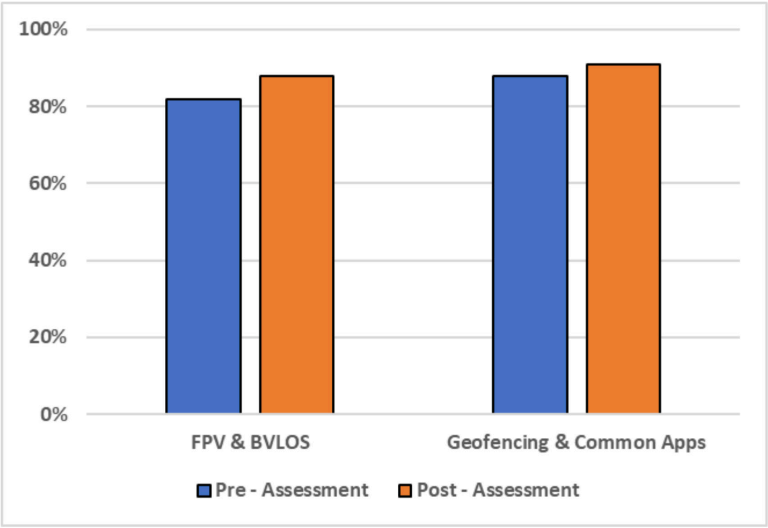

Figure 2. Overview of the Application Module Assessment

The Application Module assessed participants' understanding of key drone applications, including First-Person View (FPV), Beyond Visual Line of Sight (BVLOS) operations, geofencing, and common drone uses. The performance trends shown in Figure 2 indicate significant improvements in some areas. A direct comparison between FPV and BVLS reveals a 6% increase in correct responses, from 82% to 88%. This increase suggests that while participants grasped FPV operation well, they had greater difficulty distinguishing BVLOS from other flight modes, such as autonomous flight and manual control. The confusion may stem from the overlap between FPV and BVLOS, as FPV can be used for BVLOS operations in certain cases. The post-assessment results indicate that additional emphasis on the distinction between FPV-based piloting and regulatory restrictions of BVLOS flights would be beneficial in future training sessions. Similarly, a 3% increase in accuracy is observed between

Geofencing and Common Drone applications. This slight increment suggests that while participants understood the technical function of geofencing, they may have found it more challenging to categorise practical drone applications correctly. Strengthening the link between geofencing and real-world scenarios, for example, through interactive case studies or hands-on simulations, could help improve retention in future training programs. While participants retained knowledge of drone safety features, they may have experienced some confusion when distinguishing among various practical applications. One possible explanation is that the workshop emphasised safety and operational aspects, leading participants to be more confident in technical features (e.g., flight restrictions and automation) than in real-world applications such as agriculture, environmental monitoring, or traffic observation.

3.2.3 PERFORMANCE ANALYSIS OF THE SAFETY AND REGULATIONS MODULE

The Safety and Regulations Module aimed to strengthen participants' understanding of drone safety protocols and regulatory compliance. The post-assessment results highlight notable declines across all areas, indicating that reinforcement is needed. A direct comparison of pre- and post-assessment scores for specific question pairings provides deeper insight into learning outcomes, as shown in Figure 3. For Airspace Safety, a significant decline was observed in the question on recommended action when encountering a manned aircraft, with scores dropping from 94% in the pre-assessment to 50% in the post-assessment. This suggests a gap in knowledge retention or in the practical application of airspace safety protocols. The training should incorporate real-world scenario-based exercises and simulation-based decision-making drills to ensure that participants can effectively recall and apply this knowledge under real flight conditions.

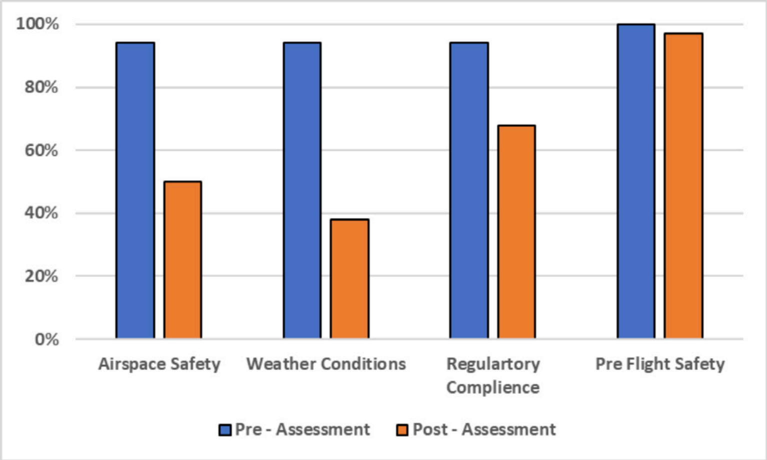

Figure 3. Overview of the Safety and Regulations Module Assessment

A major reduction was observed in the assessment of safe weather conditions for drone operations, with the score decreasing from 94% in the pre-assessment to 38% in the post-assessment. A moderate reduction was observed in participants' retention of legal altitude limits for drone operations, as assessed through Regulatory Compliance, with scores decreasing from 94% to 68%. While this still reflects a relatively strong understanding of regulations, the decline suggests that some participants may struggle with retaining specific legal requirements over time. Given the dynamic nature of drone regulations, ongoing refresher assessments, interactive regulatory case studies, and real-world application exercises could help reinforce these legal constraints and ensure compliance awareness remains high. For Pre-Flight Safety, a slight decrease was observed in responses to pre-flight safety procedures, with the score declining from 100% to 97%. While the change is minimal, it indicates that even well-understood concepts can experience minor lapses in retention. To maintain near-perfect performance in this area, training should continue to emphasise routine pre-flight checklists and integrate mandatory hands-on practice during flight exercises to build strong procedural habits.

3.3 ANALYSIS OF THE RLO APPROACHED

Since the initial achievement of the Safety and Regulations Module was not very convincing, an RLO approach has been implemented to improve participants' understanding. A multiple-choice quiz was administered covering all areas of the Safety and Regulations module. The results indicate that students demonstrated a strong understanding of the "Pre-Flight" module, with all three questions achieving high accuracy scores (91%-100%). This suggests that the instructional videos for this module effectively conveyed the necessary information. Conversely, the "Safety & Regulation" module showed more variability in performance. While most questions had high correct-answer percentages (above 90%), assessments of Uninvolved Public and GPS Signal recorded significantly lower scores (41% and 38%, respectively). These results suggest that certain concepts in this module may require further clarification or additional instructional support. Further analysis of responses to these assessments indicates potential misunderstandings about drone operational safety. For the assessment of drones losing GPS signal during a flight, students were split between "immediately land the drone" and "switch to manual flight mode," indicating confusion about the correct response when GPS is unavailable. For the drone's assessment distance from uninvolved people, most participants selected "50 meters," while some chose "100 meters" or "10 meters," suggesting uncertainty about regulatory distance requirements. As the RLO approach is not suitable for this kind of assessment, recommendations for additional instructional materials or interactive discussions should be introduced to reinforce the challenging concepts, and practical demonstrations or simulations should be incorporated to enhance understanding of GPS failure scenarios and regulatory distance requirements.

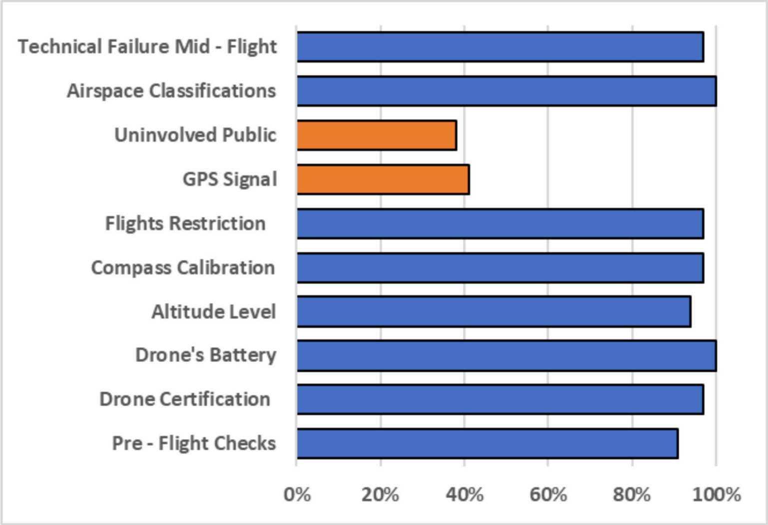

Figure 4. The RLO approach of the Safety and Regulations Module Assessment

4. CONCLUSION

The findings demonstrated significant improvements in knowledge across key areas, including drone components, applications, and safety regulations. The workshop effectively enhanced participants' comprehension, with notable increases in post-assessment scores, particularly in understanding flight controllers, GPS functionality, and video transmission components. However, some areas, such as airspace safety and regulatory compliance, showed slight declines, indicating the need for further reinforcement. The RLO approach has been implemented, and the results show significant improvement in participants' understanding. The results suggest that hands-on, competency-based training plays a crucial role in bridging the gap between theoretical knowledge and practical application. The insights gained from this workshop provide a foundation for refining drone education programs, integrating STEM and TVET principles, and enhancing industry collaboration. These findings support the need for a standardised curriculum, increased funding, and stronger partnerships between educational institutions and industry stakeholders.

Additionally, there exists a significant gap between commercial drone training and STEM and TVET-based drone education. While commercial drone training focuses on licensing and regulatory compliance, STEM and TVET training emphasise a broader educational framework that includes technical skills, innovation, and industry applications. The findings from the pre- and post-workshop assessments reveal that while participants demonstrated significant improvements in drone knowledge, certain areas, particularly airspace safety, regulatory compliance, and real-world industry applications, still require further reinforcement. The decline in post-assessment scores on airspace safety protocols and legal altitude limits suggests that students struggle to retain regulatory knowledge.

5. SUGGESTIONS

While this study provides a comprehensive analysis of STEM and TVET in drone education, further research is needed in several key areas, including longitudinal studies that assess the long-term impact of drone education on students' career prospects and industry development. Comparative Studies: Investigating how Malaysia's drone education framework compares with other leading countries. Technological Advancements: Exploring the role of emerging technologies such as artificial intelligence, machine learning, and 5G connectivity in drone education. Gender Inclusion: Examining strategies to encourage greater female participation in drone-related fields.

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8. AUTHOR'S CONTRIBUTION

Author1 conducted the fieldwork, compiled the literature review, and supervised the overall writing of the manuscript. Author2 was responsible for drafting the research methodology and performing data entry. Author3 conducted the statistical analysis and interpreted the results. Author4 managed the on-site activities during the drone workshop.

9. CONFLICT OF INTEREST DECLARATION

The authors have declared no conflict of interest in relation to this article.

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