Vol 2, No.3 (2022)

International TVET Academic and Research Symposium ITARS (2022)

ITARS 2022

Excellence in TVET and Entrepreneurship

Organiser:

PUSPANITA CAWANGAN KECIL JPPKK

Co-organiser and Publisher:

PERSATUAN KEDOKTORAN TEKNIKAL MALAYSIA
MALAYSIAN TECHNICAL DOCTORATE ASSOCIATION

e ISBN 978-967-18231-1-8

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ISBN 978-967-18231-1-8 (e-book)
Front cover image by PKTM
e-book design by PKTM

First e-book edition July 2020
Second e-book edition April 2022

Persatuan Kedoktoran Teknikal Malaysia (PKTM)
No 64, Persiaran Wira Jaya Barat 40,
Taman Ipoh Jaya Timur 1, 31350 Ipoh,
Perak.
http://www.pktm.org

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A STUDY OF THE EFFECTIVENESS OF A320 WING TRAINING KIT (A320-WTK)

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Abstract

Educational training kit is one of the teaching methods to strengthen the understanding of a students which addresses prevalent issue of conventional teaching approach. Due to the importance of training kit, this study shares the effectiveness of A320 Wing Training Kit (A320-WTK) in enhancing students understanding. Learning the part and operation of an aircraft wing demands a clear understanding because there are dynamically and interconnected. Students often have difficulty to determine aircraft wing control surfaces and identify the operations. They are unable to identify the angle or position of the flaps and slat during aircraft operations (take-off, cruise, landing and rolling). Conventional teaching method lack in helping students to understand the aircraft wing. A320-WTK creates an interactive tool that allows students to provide comprehensive picture of the wing which focuses on the overall part and operation. The construction highlight exposure, discovery, and interaction with moving mechanics such as slats, flaps, ailerons and spoilers during taking-off, cruising, landing and rolling. The research design was in a quasi-experimental method and the data were analysed quantitative approach. Sample size of 103 students at Polytechnic Banting Selangor (PBS) were involved in this study. A T-Test statistical analysis was used to address the research question. The finding revealed a significance difference in performance test between the group in different instructional strategy approach. A320-WTK seems very useful and helpful for the students in understanding the idea of aircraft control surfaces and high lift devices. Teaching and learning activities becomes enjoyable and interactive. Furthermore, it is mobile and convenient to bring to anywhere. Finally, since no one has ever produced an A320-WTK, this would certainly be useful not only for PBS, but also for the aviation industry and community.

Keywords: Educational Training Kit, teaching and learning, aircraft wing, part, operation

1. Introduction

Politeknik Banting Selangor (PBS) is the only polytechnic in Malaysia offers Diploma Engineering in Aircraft Maintenance (DAM). DAM is 3-year Diploma Programme with 6 semesters accredited by Engineering Technology Accreditation Council (ETAC). PBS also has been accredited as Approved Maintenance Training Organisation (MTO) for Category A1 Aircraft Maintenance Licence Technician by Civil Aviation Authority Malaysia (CAAM) in 2018 till present. As MTO, based on basic knowledge requirements of Civil Aviation Directive CAD1801 Aircraft Maintenance License (CAAM Part 66), personal needs to gain knowledge for 12 modules. One of the modules is Module 8 Basic Aerodynamics. In chapter 2 of Basic Aerodynamics, the learning outcomes are students is able to determine aircraft wing parts and explain the operation of aircraft wing.

Aircraft wing has many different control surfaces. Due to many control surfaces of aircraft wing, it leads student to forget the parts and confused with the control surfaces name. Moreover, every parts play their own operation and it is related each other. Consequently, the difficulty of the aircraft wing operation becomes harder which students needs their imagination for simulates the aircraft wing operation. Conventional teaching method lack in helping students to understand the aircraft wing. As Intervention, the study of an aircraft wing prototype equipped with interactive teaching and learning tools has been carried out. The characteristics of an aircraft wing prototype must shown a comprehensive picture of the aircraft wing control surface and operation, interaction with moving mechanics such as slats, flaps, ailerons and spoilers during taking-off, cruising, landing and rolling. Besides, tablet used to shown explanation about control surfaces and flight operation. Additionally, QR code is located to every control surface which student could scan QR code and directly link to video used to explain control surfaces and flight operation system. For mobility, it must be light and portable. The effectiveness towards student's understandings is measured by this research. This research can help students to improve in learning and teaching process.

2. Literature Review

The aerospace industry is geared for growth in 2019 and beyond. That growth naturally includes rising demand for production to meet the physical needs of these demanding applications. In the past, the traditional approach of teaching and learning was completely utilised. However, in the twenty-first century, technology has been widely developed with the goal of achieving a frictionless lifestyle. People benefit greatly from its breakthrough in terms of efficiency, ease, and advancement. Technology is beginning to alter the roles of instructors and students in education. The use of powerful gadgets in the classroom promotes a more diverse teaching and learning environment, which can lead to increased interaction and collaboration. According to Siew Chin Teoh et al (2019), Students are passive listener and passively to give response or comments in the lecturers under conventional approach.

However, in the twenty-first century, technology has been widely developed with the goal of creating a frictionless lifestyle. Education is changing in tandem with the advancement of current technology, and these advancements have influenced numerous innovations in teaching and learning methods. (Hong Ong Ace et al., 2022). Based on the research results by

(Akhmetshin et al., 2019), training kit can be improved only through the research on students' cognitive and creativity capabilities, their interest of diverse learning resources, and their priorities in the arrangement of information, contents, kinds and styles. Technology is beginning to alter the roles of teachers and students in education. The use of innovative devices in the classroom promotes a more diverse teaching and learning environment, which can lead to more interaction and collaboration. Incorporating training kit concept into learning has been reported to have better outcome than the traditional learning (Pinandito et al., 2021).

The Airbus A320 is a two-engine short- to medium-range narrow body aircraft developed by the European company Airbus S.A.S. with a maximum capacity of 180 passengers. The A320 was the first single-aisle variant in the A320 family. This type of aircraft has been selected for further this research prototype which is just one of the many reasons why it is s also the most successful aircraft of all time. Incorporating a versatile cabin that can be configured for a variety of seating options, the A320 usually seats from 140 to 170 passengers and has a maximum capacity to accommodate as many as 180 travellers. The learning kit aims to helps students understand the subject more easily and systematically. Students' performance can be improved by teaching and learning with kits, especially in technical courses. (Che Ghani Che Kob et al., 2019). It can be facilitated the process of information sharing among students with respect to subject taught more clearly (Abdul Samad et al., 2016). In the teaching and learning process, a learning kit is essential. It improves the effectiveness of the teaching and learning process. A learning kit could also provide in-depth and detailed information. It offers a new dynamic to the classroom. It inspires both teachers and students. (Rasul et al., 2011). The learning kit made students were engaged by the topic, asking an unusual number of questions and expressing interest in topics on comparable topics. (Martin et al., 2022)

Besides, a wing prototype with interactive teaching and learning tools is the main idea to make the learning kit. It must be measure by study on effectiveness towards student's understandings. The characteristics are this learning kit must show a comprehensive picture of the aircraft wing structure and operation. It will have the interaction with moving mechanics such as slats, flaps, ailerons and spoilers during taking-off, cruising, landing and rolling. To make it more interactive, tablet is used to shown explanation about control surfaces and flight operation. Furthermore, QR code is paste to the aircraft control surface and when user scan it, it will link the video to explain about control surfaces and flight operation system. Plus, it must be light and portable so that lecturer can bring it to anywhere

A320 Wing Training Kit (A320-WTK)

As intervention, a wing prototype with interactive teaching and learning tools is the main idea to make the learning kit. It must be measure by study on effectiveness towards student's understandings. The characteristics are this learning kit must shown a comprehensive picture of the aircraft wing structure and operation. It will have the interaction with moving mechanics such as slats, flaps, ailerons and spoilers during taking-off, cruising, landing and rolling. To make it more interactive, tablet is used to shown explanation about control surfaces and flight operation. Furthermore, QR code is paste to the aircraft control surface and when user scan it, it will link the video to explain about control surfaces and flight operation system. Plus, it must be light and portable so that lecturer can bring it to anywhere.

A320-WTK is a miniature version of the A320 aircraft wing primarily be assembled with a sheet of carbon fibre fabric reinforced material known as depron. A metal rod mounted inside the wing with dimensions. This rod would act as the spar of the wings. A320-WTK selection primarily concentrate on the flaps, slats, spoilers and ailerons, by using the depron material layered with carbon fibre cloths. Inside the wing will be included with a series of servo tabs and linkages so that the when given input from the Arduino UNO micro-controller, the control surfaces and high lift devices will operate as intended. The wing would be mounted on a solid metal surface after that. Within a perspective casing where a control panel is also mounted, the wing and the metal surface can then be positioned. When placed together, this control panel can be attached to the wing by soldering the circuits using the Arduino UNO micro-controller. In stated settings, the control panel would be used to illustrate the wing's function. Besides that, A320-WTK has a power cord to link to every power supply or source in order to power up. A thrust (engine) is mounted as an external function to mimic the motion of the pilot when adjusting the aircraft's thrust.

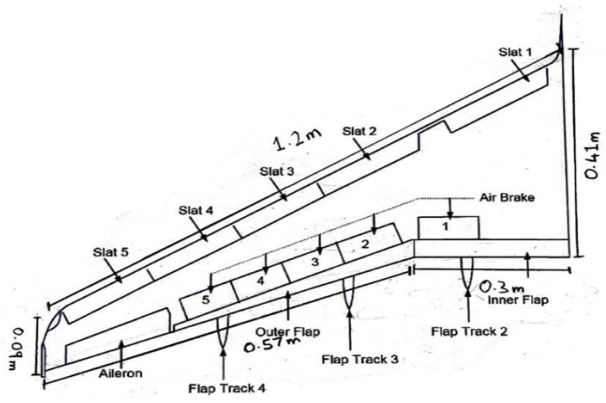


Figure 1: the Dimensions of A320 Wing Part of Product

A320-WTK has a control panel which is installed onto one side of the perspective casing, facing the cross-section of the wing root. With four buttons and some clarity notes next to it, this control panel will be given. The first button is the 'Take-Off' button, where the wing simulates the motion of the control surfaces of the wings and high lift equipment during the take-off of an aircraft. The second button is the 'Cruise' button, where the wing simulates the rotation of the control surfaces of the wings and high lift devices during the cruise of an aircraft. The third button is the 'Landing' button, where the wing simulates the rotation of the control surfaces of the wings and high lift devices during the landing of an aircraft. The fourth button represent 'Rolling' Button, where the wing simulates the roll to left or right with the help of aileron. Arduino UNO micro-controller is programmed so that the wing components will continue to run correctly and appropriately for each feature for each button specified.

A320-WTK also has a tablet put beside the control panel. This interface will function as an aid to enhance the understanding towards each button operation. For example, when the 'Take-Off' button is pressed, input will be given to the wing and so the wing will demonstrate the necessary operations. As for the interface, input will also be given to the tablet where it will provide animations and voice explanations to the user. This is to make the learning process more interactive and fun in a way.

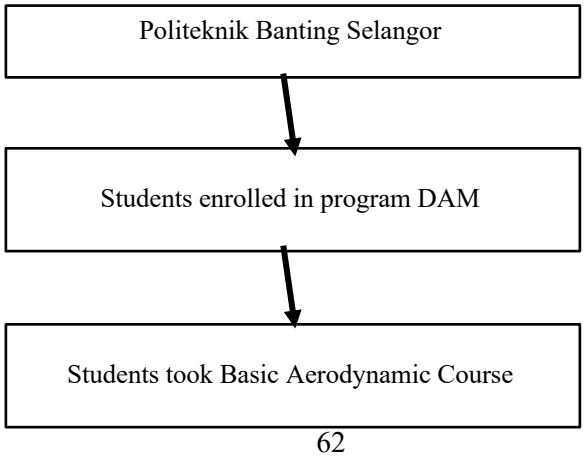
Figure 3: the A320 Wing Training Kit

3. Methodology

A study of the effectiveness of A320-WTK has been done at PBS once the A320-WTK development was fully completed. The research objective of this study are:

i. To determine the mean score difference for the aircraft wing control surface between Static and Dynamic Group
ii. To determine mean score difference for the aircraft wing operation between Static & Dynamic Group

Figure 4 shows the sampling framework of this study. The sampling method used in this study was stratified probability sampling. The population for this research is a 345 students who enrolled in Diploma Engineering in Aircraft Maintenance (DAM) programme at Politeknik Banting Selangor (PBS) on Semester December 2020. Only PBS offers DAM programs in the polytechnic system. A total of 103 students were chosen for this research from the population of DAM students who took the Fundamental Aerodynamics course. They were then placed into two groups based on the learning strategies proposed in this study.



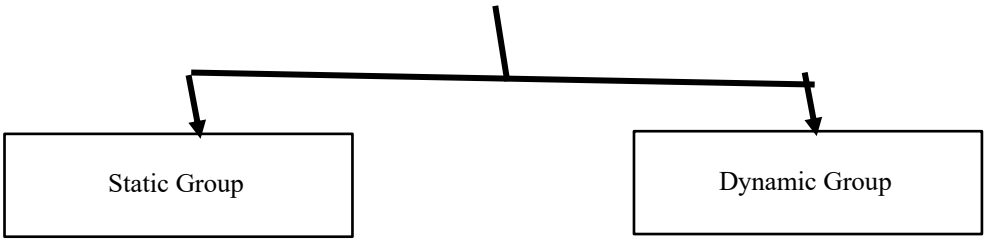


Figure 4: Sampling Framework

Table 1: Distribution of samples according to Learning Strategy

Learning Strategy	Class	Number	Total	Percentage
Static	DAM1A	26	51	49.5%
(Notes and Power point without simulation)	DAM1B	25		
Dynamic	DAM1C	27	52	50.5%
(A320 Wing Traning Kit)	DAM1D	25		
	Total	**103**	**103**	**100%**

The methodology employed in this study is quasi-experimental method. Figure 5 shows the research framework that involved 2 different learning strategies as independent variable (IV) and student performance test as dependent variable (DV).

IV **DV**

Figure 5: Research Framework

The learning strategy for Static Group was by using notes and power point without simulation, while Dynamic group used A320-WTK. Both group were thought about Chapter 2: aircraft wing control surface and aircraft wing operation. After learning, both groups need to answer 2 set of question. Questions are developed in accordance with the course learning objectives and Coursework Item Specification Table (CIST) in terms of the material and abilities being assessed. The first set was about determine the aircraft wing control surface. Students need to know about aircraft control surfaces such as slats, flaps, ailerons and spoilers which generation of lift, drag and thrust. Student also should be able to describes their application on aircraft. The second set of questionnaires was about understanding the principle of flight and the system which is required to ensure its operation interaction with moving mechanics such as slats, flaps, ailerons and spoilers during taking-off, cruising, landing and rolling. It explains the motion of air around an object which enables relationship and their interaction with all the related forces acting on the aircraft during flight. Each set had 10 Multi Choice Question (MCQ) and participant needs to answer in 25minutes.

To evaluate if there were significant variations in performance between the groups that employed the two different learning strategies, an independent-samples T-test was performed. For research objective with a statistically significant difference, a *Cohen's d effect size* (Cohen, 1988) will be calculated to provide an indication of the result's practical significance using the following formula:

$$d = \frac{|M_1 - M_2|}{s_{pooled}}$$

where:

$$s_{pooled} = \sqrt{\frac{s_1^2(n_1 - 1) + s_2^2(n_2 - 1)}{n_1 + n_2 - 2}}$$

The *Cohen's d* effect size will determine whether there is small, medium or large significance based on the Cohen's d guideline as shown on Table 2 below:

Table 2: *Cohen's d* guidline

Effect Size (d)	Strength
0.2	Small
0.5	Medium
0.8	Large

Source: Cohen, 1988

4. Results & Discussion

Below is the result of the research objectives that has been highlighted in this study.

RO1: To determine the mean score difference for the aircraft wing control surface between Static and Dynamic Group

An independent-sample t-test was used to determine if there were differences in performance score between two learning strategies. Refer to Table 3, there was a homogeneity of variances, as assessed by Levene's test. The value of Significant Levene's Test for Equality of Variances is p = 0.061. Because of significant value is 0.061 > 0.05, we can conclude that variants data student achievement mark between Static and Dynamic is homogene.

Table 3. Equality Variance Test for RO1

		Levene's Test for Equality of Variances	
		F	Sig
TEST A	Equal variance assumed	3.577	0.061

Table 4 shows the Static Group performance scores (M = 4.922, SD= .189) and Dynamic Group performance test (M = .829, SD= .142)

Table 4. Descriptive Statistics for RO1

	Strategy	**N**	**Mean**	**SD**
TEST A	Static	51	.492	.189
	Dynamic	52	.829	.142

From the Independent T-Test Result as shown on Table 5, there was a statistically significant difference in Identification of Wing Control Surface performance scores between static and dynamic group, MD= -3.367, SE = .033, t(101) = -10.254, p = .000. The difference of 3.367 in mean scores indicated a large effect size with the value of Cohen's d = 2.0.

Table 5. Independent T-Test Result for RO1

	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
TEST A	-10.254	101	.000	-.337	.033

RO2: To determine mean score difference for the aircraft wing operation between Static & Dynamic Group

An independent-sample t-test was used to determine if there were differences in performance score between two learning strategies. Refer to Table 6, there was a homogeneity of variances, as assessed by Levene's test. The value of Significant Levene's Test for Equality of Variances is p = .229. Because of significant value is 0.229 > 0.05, we can conclude that variants data student achievement mark between Static and Dynamic is homogene.

Table 6. Equality Variance Test for RO2

		Levene's Test for Equality of Variances	
		F	Sig
TEST A	Equal variance assumed	1.462	.229

Table 7 shows the Static Group performance scores (M = .439, SD= .156) and Dynamic Group performance test (M = .829, SD= .142)

Table 7. Descriptive Statistics for RO2

	Strategy	N	Mean	SD
TEST B	Static	51	.439	.156
	Dynamic	52	.762	.179

From the Independent T-Test Result as shown on Table 8, there was a statistically significant difference in Identification of Wing Control Surface performance scores between static and dynamic group, MD= -.322, SE = .033, t(101) = -9.711, p = .000. The difference of .322 in mean scores indicated a large effect size with the value of Cohen's d = 1.9.

Table 8. Independent T-Test Result for RO2

	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
TEST B	-9.711	101	.000	-.322	.033

The findings of this study shows that the use of A320 WTK helps students' understanding in building basic knowledge related to aircraft wing before they move on to more complex levels. (Rasul et al., 2011). By using A320-WTK, it involved innovation technology. This contributed to the goal of technology development in education which encouraged a new teaching and learning approaches. (Hong Ong Ace et al., 2022). Based on the result of using A320-WTK shows that students' performance is significantly improved especially in technical course. (Che Ghani Che Kob et al).

5. Conclusion

Overall, the result shows that there was a significance difference in the mean score of student achievement. The result shows that the students who carried out the Dynamic strategy instructional method outperformed the students who carried out the Static strategy. From our empirical result, we suggest a methodological approach to the educational used of A320-WTK (Dynamic Strategy). The A320-WTK seems very useful and helpful for the students in understanding the idea of aircraft control surfaces and high lift devices. Teaching and learning activities becomes enjoyable and interactive. Furthermore, it is mobile and convenient to bring to anywhere. Since no one has ever produced an A320-WTK, this would certainly be useful not only for PBS, but also for the aviation industry and community. We expect that by using the teaching kit as a teaching tool, the findings and analysis of this study data would assist students better grasp their subjects and enhance their performance. Overall, researchers were able to demonstrate the efficiency of A320-WTK to increase student performance on Basic Aerodynamics topics in the Diploma Engineering in Aircraft Maintenance curriculum. However, to ensure that students are able to master more complex topics, it is necessary to take into account the active involvement of students with A320 WTK. Most researchers agree that in order to produce a successful lesson, students need to be actively involved and have an awareness of the content of the lessons presented. (Dor et al., 2020; Eguchi (2016); Hartikainen et al., (2019). In

this regard, further research needs to be done on the active involvement of students using learning kits in mastering more complex learning topics.

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