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# Usability and user satisfaction of 3d turboshaft cross section model (turbo-s) as learning aids

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**Abstract**

Learning the operation of a turbo-shaft engine demands a clear understanding because there are parts of the engine that function dynamically and are interconnected. Students often have difficulty understanding and explaining engine operation, especially changes in airflow in the engine. A 3D Turboshaft Engine Cross Section Model (Turbo-S) was designed to demonstrate how Turbo-Shaft engines work to improve students' understanding of the engine working operation. Turbo-S was designed and developed using 3D printing technology with a cross section model that can show the inner workings of the model with labels of each section. It also comes with a QR code at each section of the engine that consists of all the information about the gas turbine engine and turboshaft. This product is moveable, so that it can show the inner workings of every engine section and the QR code can be accessed at any time and gives advantage to the students to get the information quick and fast. Usability and user's satisfaction have been conducted to evaluate the success of a 3D-Turbo Shaft Model regarding the learning objectives. A total of 30 Polytechnic students were asked to complete a questionnaire. The questionnaire consists of the following five dimensions of usability characteristics: design, functionality, ease of use, learnability, and satisfaction. Based on the questionnaire feedback, the developed tool seems very useful and helpful for the students in understanding the turbo-shaft engine operation.

*Keywords: Turboshaft Engine, usability, satisfaction*

## 1. Introduction

Using a turboshaft engine, helicopters may be propelled through the air by powering the primary transmission and rotor systems, as well as providing lift. (Federal Aviation Administration & Aviation Supplies & Academics, 2019). The functioning of a turboshaft engine is something that every student enrolled in the Diploma Engineering Maintenance (DAM) programme must study and comprehend. This is due to the fact that one of the first jobs they will have after graduation will be to service and maintain the turboshaft engine. While performing repair and maintenance work on the engine, they must be able to recognise and visualise the complicated engine components Students, on the other hand, are having difficulty describing and visualising the working turboshaft engine as well as the function of each section of the engine. Because the design and functioning of this sort of engine are very complex, students will need to put in more effort to study and comprehend it. Another issue that was noticed was limited access to the engine's functioning display. Students will need to devote more effort to visualising the engine's architecture and the inner part of it as well as comprehending how it works in order to succeed. Students will experience a significant increase in cognitive load as a result of this predicament (Barak, 2013; Sweller et al., 2011). These limitations lead to students having just a superficial understanding of engine function, making it difficult for them to develop a more detailed mental image of how the engine works.

In order to address the stated problems, an effective instructional strategy with the aid of appropriate learning support tool is crucial to ensure optimal learning outcome. Therefore, we innovate the 3D Turbo Engine Cross Section Model (TURBO-S) as learning aids to assist students explore about the turboshaft engine. During the learning process, students had limited access to engine functionality display. Rather to learning from books and listening to the instructor's explanations, the greatest way for improving student knowledge is to interact with the engine functioning display in real time. However, incorporating a real turboshaft engine into teaching and learning activities will be costly.

## 2. Literature Review

Learning without a proper visual aid will leads students to difficulties in understanding the topic that are complex especially about the components and parts. As stated by Ghulam,et al (2015), in education system visual aids are important as it will encourage students in learning process as well as making the process much easier and more interesting.

Visual aids are educational technologies that are used in the classroom to assist and motivate students to learn (Ghulam et al., 2015) The visual aids make teaching and learning process more functional. Visual aid can improve

student's understanding and one of the best mechanisms for education to make it more interactive since it is student-based learning because students can explore things on their own.

According to Baser (2013), the important of visual aids is to help the instructor to achieve their objective of teaching and for better understanding by showing the object itself. The visual object also can help students to understand better in a different angle rather than when they have to imagine themselves. In addition, the teacher should make use of a variety of visual learning tools to help students learn more effectively and efficiently throughout both the preparation phase of the class and the actual session itself (Wiyati & Marlina, 2021). Moreover, when dealing with complex system, it can be solved by using visual approach during teaching and learning or during class session. By looking to the exact model of the engine, the student will have the idea of how it works and functioning rather than when they need to imagine it by reading text or doing theoretical research thus create excitement in learning process.

According to Che Ghani (2019), in order to achieve effective learning process that can lead to better student understanding, conventional teaching methods which used chalk and talk should be replaced with effective learning method. Instructor can choose the correct method in order to increase student's attraction in the class. One of the methods is using interactive learning aid during learning process in the classroom. A part from that, a proper learning aid will assist the institution in carrying out teaching and learning activities effectively and produces an outstanding student that can raise the image of the institution.

In the study of Amali et al. (2020), the learning kit is designed to make studying and understanding the subject matter easier for student. A part from that, the technique of using the learning kit is a learning strategy that can be applied by teachers or instructors to help improve and increase student performance during the class thus lead to the achievement of the students and the quality of the learning process. This is because students can understand the more and become more interested and actively participate in the class. This will fulfil the learning objectives at the end of the teaching and learning process.

According to Che Ghani (2019), the learning kit is aims to make it easier for students to learn and understand the subject matter. Teachers or instructors can use the technique of using the learning kit in order to improve their performance. Therefore, the utilisation of learning kits will help students attain their goals more effectively.

Though the visual aid has strong arguments towards assisting learning, it cannot be ascertained whether the visual aid design developed is suitable for use by students. Once a visual aid is developed, it is important to value its usability. Additionally, user satisfaction testing is critical to ensuring that the visual tools produced do not add additional cognitive load to students, but rather aid lessen current cognitive load (Lee et al., 2006; Merkt et al., 2022). Therefore, this research will concentrate on the usability and satisfaction study of TURBO-S to get feedback from the user on whether the tools have the desired impact on their knowledge.

## 3. Methodology

The study employs a survey questionnaire which was adapted from existing instrument from Post-Study System Usability Questioanaire – PSSUQ (Segaran, Mohamad Ali, & Tan, 2014). PSSUQ was originally designed as a research tool for use in IBM's scenario-based usability evaluations. (Lewis, 1995). The modified version of the questionnaire for this study consists of 5 construct, which were divided: design, functionality, ease of use, learnability and satisfaction. Originally the questionnaires' items are seven-point scales with 1 for strongly agree, followed by next numbers in sequence with the end point 7 for strongly disagree. However, in order to avoid participants being confused with the scale, we have converted the scale rank with 1 for strongly not agree, followed by next numbers in sequence with the end point 7 for strongly agree.

The research participants were 30 students semester 5 enrolled in a Diploma Engineering Aircraft Maintenance, Politeknik Banting Selangor. The survey was carried out after the 3d Turbo-shaft design and development stages were completed. Student were divided into three members per group. Each group was given 2 hours to explore the 3D model. After using the 3D mode, the student need to evaluate the usability and satisfaction using PSSUQ questionnaire.

The descriptive analysis method was employed with SPSS (statistical package for social sciences) version 26 to analyse the data. Descriptive statistics are used to determine the mean value and standard deviation of study subjects' attributes.

By using the learning kits, students can access the engine functioning display and learn more about how the turboshaft engine works by using the 3D Turboshaft Model as a teaching aid, as illustrated in Figure 1. Aside from that, the learning process will become more participatory, encouraging students to think creatively. This will aid students in gaining a better understanding of the dynamic notion of turboshaft engine operating.

Figure 1: The 3D Turboshaft Cross Section Model (Turbo-S)

Figure 2 shows a 3D model cross section of the engine with a QR code and label attached to each part of the engine as well. By scanning the QR codes supplied at each segment of the model, students may learn more about the turboshaft engine's design and how it functions. Information regarding turboshaft engines may be found by scanning the QR code. The QR code is widely used because it is a straightforward means of disseminating information. For students, it is one of the most thorough methods of facilitating their learning. When the user scans the QR code, they will be sent to a file containing information on the workings of the turboshaft. QR codes are also helpful since they are user-friendly and assist students find information on the operation of a turboshaft engine.

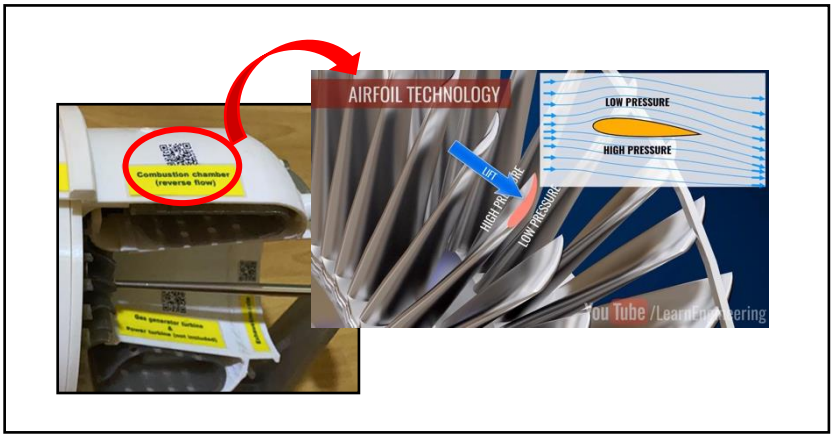


Figure 2: QR code attached into every section of the engine

## 4. Finding and Analysis

Cronbach alpha for usability and user satisfaction questionnaire was .78, indicating that overall, the scales had acceptable reliability (Bajpai & Bajpai, 2014)

Table 1 summarize the Design construct of the 3D model. Overall, the respondent agreed that the 3D Turbo-S model design assisted them in learning the engine operation visually as opposed to learning theoretically from a book, as they had previously done. According to N. Ismail et al (2019), the learning kit will serve as a tool to assist teachers in

their teaching rather of relying just on textbooks, and it will be a novel approach to engage students, enhance their motivation, and make the learning process pleasurable.

Table 1: Descriptive analysis of design construct

| Item | Mean | SD |
|---|---|---|
| The 3D Model was pleasant to use | 6.43 | .774 |
| The design of 3D Model assisted me in learning the engine operation | 6.10 | .995 |
| The organization of information presented through QR Code was clear | 6.47 | .860 |
| **Total** | **6.33** | **.661** |

Table 2 summarize the functionality construct of 3D Turbo-S model. The result shows that the 3D Model allows for more effective interaction between the responder and the 3D model. According to Che Ghani et al (2019) the use of appropriate and multifaceted learning kits can help students overcome passive behavior by piquing their interest in continuing to engage in the learning session and stimulating their motivation and want to learn more about the course.

Table 2: Descriptive analysis of functionality construct

| Item | Mean | SD |
|---|---|---|
| The 3D Model has all the functions and capabilities that I expect to have | 6.63 | .615 |
| The information retrieved from the QR Code was effective in helping me to understand the topic | 6.40 | .563 |
| All the features on the 3D model functions well | 6.50 | .682 |
| **Total** | **6.51** | **.417** |

Table 3 summarize the ease of use construct of 3D Turbo-S model. Respondent agreed that the 3D Turbo-S model was straightforward to use, and that seeing a helicopter engine model in action rather than reading about it in a book. In the study by R. Lewis (2006) usability testing is an essential skill for usability practitioners – professionals whose primary goal is to provide guidance to product developers for the purpose of improving the ease of use of their products.

Table 3: Descriptive analysis of ease of use construct

| Item | Mean | SD |
|---|---|---|
| The 3D Model of the helicopter engine simple to use | 6.73 | .521 |
| Seeing helicopter engine model working mechanism in front of your eyes is better than learning it in books | 6.47 | .776 |
| It was easy to find the information I needed | 6.80 | .484 |
| **Total** | **6.67** | **.420** |

Table 4 summarize the learnability construct of 3D Turbo-S model. A 3D Turbo-S model was used to study and grasp the functioning of a turboshaft engine, and the responder agreed that it was more effective than viewing video of the engine. This can be supported with the statement from Ghulam et al., (2015) stated that in order to make teaching process is effective and best dissemination of knowledge, the used of visual aids are the best tool.

Table 4: Descriptive analysis of learnability construct

| Item | Mean | SD |
|---|---|---|
| It was easy to learn by using the 3D Model helicopter engine | 6.43 | .679 |
| The information provided by the QR code easy to understand | 6.27 | .785 |
| Seeing a demonstration of an engine model and information provided by QR code is better than seeing just a video of it. | 6.63 | .809 |
| **Total** | **6.44** | **.589** |

Table 5 summarize the satisfaction construct of 3D Turbo-S model. The respondent felt at ease and satisfied to learning the turboshaft engine's operation. This can be supported with the statement from Virtanen et al. (2017) stated that, student satisfaction is an essential indicator of students' overall academic experiences and achievement.

Table 5: Descriptive analysis of satisfaction construct

| Item | Mean | SD |
|---|---|---|
| I felt comfortable using the 3D model of turboshaft engine | 6.40 | .855 |
| I enjoyed exploring the 3D Model | 6.30 | .750 |
| Overall, I am satisfied with this visualization kit | 6.33 | .802 |
| **Total** | **6.34** | **.590** |

Overall, the level of usability and user satisfaction shows that the visual of the 3D Turboshaft Cross Section Model (Turbo-s) will help the user to imagine the real turboshaft engine and understand the function of each section of the engine. Students can access the engine functioning display and learn more about how the turboshaft engine works by using the 3D Turboshaft Model as the teaching aid. Therefore, learning process will become more participatory, encouraging students to think creatively. This will aid students in gaining a better understanding of the dynamic notion of turboshaft engine operating

Apart from that, it is very useful for education and training purpose in order to increase the level understanding about the turboshaft engine in term of the design and how it works. However, to ensure that the 3D model has a positive influence on the learner's understanding of the information to be presented, the student should be actively engaged with it (Van Treuren, 2019). Furthermore, this 3D Model may be utilized during practical activities in the workshop as a group activity, allowing students to discuss and explore the activities more actively.

Based on the finding and analysis, it can be said that the most essential construct of the 3D Turbo-S model is learnability. Learnability construct of the engine is very important since the students need to understand clearly how each section of turboshaft engine works as it is the most crucial part of the learning and teaching process. By using the 3D Turbo-S model, all the information is easily gathered by seeing the demonstration of the engine model, and information provided by the QR code.

## 5. Conclusion

The level of user satisfaction shows that the visual of the 3D Turboshaft Cross Section Model (Turbo-s) will help the user to imagine the real turboshaft engine. Apart from that it is very useful for education and training purpose in order to increase the level understanding about the turboshaft engine in term of the design and how it works. The 3D Cross Section Model (Turbo-S) can be used in aviation field as an education and training purpose to make sure that the student knows and have a further understanding about the turboshaft engine since helicopter training aid has limitations as helicopters are small in number in the industry than the airplanes. This model also helps the instructor to ease their teaching about the turboshaft engine during class session. A part from that it is also useful for both student and instructor in future time and it more to practical way of understanding the theory as it is user friendly and easy to demonstrate

without any difficult and complex process to operate the model. The visual of the engine also helps the student or user to see clearly the engine itself as the 3D Cross Section Model (Turbo-S) is lighter and portable compared to the real engine as it will be quite difficult to be brought for learning and training purposes. With 3D Cross Section Model (Turbo-S), we can see the engine model visually, clearly and the information we provide from the QR code also helps the student to understand more about the mechanism and the operation of the engine.

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