

Functionality of an Air Duct Model as a Teaching Aid

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Abstract

There are some issues such as the lack of facilities in terms of the existing ABBM that does not focus on the installation process because it is only for taking readings or data. Students are only focused on the diagnosis process and not on the installation process. Also, not knowing whether the incoming and outgoing airflow is correct or not CFM which has been set where the existing ABBM does not have a damper. This study is the development of an Air Duct Model as ABBM for subjects at the FPTV Refrigeration and Air Conditioning Workshop. This ABBM model has been developed based on the ADDIE model and helps the teaching and learning process in terms of theory and practice where existing facilities are lacking. The researcher has obtained confirmation from three experts who have experience in the field of Refrigeration and Air Conditioning. The results of this study show that the model produced has a design that is suitable for use and can function well and there are improvements as ABBM. This ABBM model is a learning model for students that can increase a high level of understanding and give a real picture and it is very suitable to be used by lecturers as a teaching medium during Pdp sessions.

1. Introduction

Malaysia is a developing educational country that often undergoes significant changes as a result of its growth. The implemented education policy functions as a vehicle to achieve national unity in addition to delivering the curriculum in schools (Mior, 2011). A strategically organized education system can certainly help in producing a generation that is competent, authoritative and ready to deal with future problems. This education policy is able to provide both the quantity and quality of human resources required. Along with efforts to improve the quality of the country's education system, Malaysia has emphasized the aspect of education through the Malaysian Higher Education Action Plan 2022 - 2025 (Ministry, 2023).

The policy aims to improve the quality of TVET graduates, the fourth leap in the 10 leaps of education (Ministry, 2023). This involves strengthening the curriculum with industry and developing professionally qualified teaching staff. Challenges include improving teaching staff competence and financing infrastructure. The quality of teaching is crucial for student satisfaction, as it affects the efficiency of lecturers, delivery of teaching methods, and quality of services. The goal is to increase the skilled workforce, as producing qualified graduates can help a country achieve a developed country (Faizal Amin Nur, 2015). A high-income developed country requires a skilled workforce from quality graduates, as developed countries typically have high incomes.

Teaching is a communication-based process that involves asking, explaining, listening, and encouraging others (Sharifah Alwiah 1983). Effective teaching and learning (PdP) implementation can be measured by teachers' effectiveness. ABBM can enhance teaching by allowing teachers to think creatively and adapt to different scenarios. Mental and physical preparation is crucial for PdP sessions to increase student productivity and maintain attention. Teaching aids are an excellent medium to demonstrate system concepts and maximize students' understanding. According to Hassan (2007) using ABBM can make learning interactive, attracting students' interest and arousing deep curiosity.

Ahmad (2010) highlights the importance of ABBM in preparing PdPs due to the lack of energy and time. It helps clarify information, overcome space constraints, and stimulate students. Teaching aids are essential for maintaining student attention during PdP sessions (Sallehin, 2018). Many teachers do not incorporate ABBM initiatives, but using appropriate materials like slides and charts can help students understand the material faster and measure the effectiveness of the teaching and learning process. Therefore, using methods that attract students' attention and maintain focus is crucial for effective PdP preparation.

According to Shaliza, an air duct system is a channel used to move air from one place to another, used in various industries to maintain temperature, humidity, and air flow. It consists of ducts, grills, diffusers, dampers, fans, and filters. The diffuser spreads air around the space, while the fan moves air through the ducts. Filters filter dust before entering the mains. The air duct system is meticulously designed to ensure efficient air flow, providing fresh air throughout the desired space. An effective PdP (Professional Development Plan) can produce excellent teachers and students, raising the country's name globally. Therefore, ABBM is crucial for stimulating student interest and ensuring quality and quantity learning.

1.1 Background Of Problem

Technological advancements significantly impact education levels in countries. Teachers use various approaches to convey learning content, but Nasaha (2016) noted that students struggle with visualizing or understanding due to unique cognitive, effective, and psychomotor differences. Jamil (2016) suggests that engaging teaching materials and techniques can help students understand each learning content, addressing the challenges of PdP and ensuring effective learning.

The quality of teaching depends on various factors, including lecturers, students, and facilities (Ministry, 2023). The researcher emphasizes the need for modern, sophisticated facilities in the IR 4.0 era. The Bachelor of Technical and Vocational Education (Refrigeration and Air Conditioning) program at UTHM, which focuses on air duct systems, requires complete facilities to ensure students are proficient in understanding and operating these systems. This ensures the quality of teaching and the overall learning experience.

The survey indicates that the existing ABBM, which focuses on air ducts, needs improvement in terms of installation process. The current facilities are only available for readings or data, and students only know how to diagnose the process but not how to properly install the air duct system. The appendix highlights that two subjects, Air Conditioning Design and HVAC Diagnosis and Analysis System, have topics on air duct systems, but only focus on readings or data. Additionally, the existing ABBM lacks a damper, which controls the flow of incoming and outgoing air.

Students often struggle to determine the correct flow of air entering and leaving a CFM set. Existing simulators are expensive and may not be suitable for workshops due to their high cost (Peucker, 2013). An alternative assembly method could be more cost-effective but requires large space. The existing ABBM is inadequate for air duct installation, as it is primarily used for readings or data analysis. To help students understand and master this topic, an ABBM mechanism should be developed. According to Daud (2015), ABBM allows students to see, touch, feel, approach, and solve problems, enhancing their understanding of abstract concepts. This mechanism aims to provide students with the opportunity to see, touch, feel, approach, and solve problems.

1.2 Problem Statement

Based on the issues or problems that have been discussed in the background of the problem, that air duct system teaching requires ABBM to enhance learning effectiveness and follow the subject's learning process. However, the existing ABBM lacks facilities for installation, focusing only on readings or data. Students are primarily focused on diagnosis rather than installation, and they may not know the correct incoming and outgoing air flow due to the absence of a damper. A preliminary survey conducted at the Refrigeration and Air Conditioning workshop at the Faculty of Technical and Vocational Education UTHM revealed that there is no suitable ABBM for installation, and the cost of preparing the installation place is expensive and lacks sufficient space for students to complete the process.

This study developed an ABBM for the assembly process, focusing on medium size, portability, and flexibility. It emphasizes the need for appropriate teaching aids to meet the PdP process in workshops. Inappropriate ABBM issues can hinder the successful PdP process. Abd Talib (2016) suggests that a conducive learning atmosphere requires extensive preparation. ABBM should allow students to observe and install the air duct system themselves, enhancing learning. Mohd Faez et al. (2016) support the positive impact of ABBM on student learning.

1.3 Objectives Of Study

This study has several objectives to achieve the goals of the study. Among them are for:

- a. Designing an air duct model as a teaching aid (ABBM).
- b. Developing an air network model as a teaching aid (ABBM)
- c. Testing the functionality of the air network model as a teaching aid (ABBM) that was developed.

a. Methodology

The methodology section of this study explains the methods and design that were employed. The goal is to collect and analyse the data obtained so that the study's objectives can be met. In the opinion of Siti Sarah (2015), methodology is a strategy and technique for designing, collecting, and analysing data in order to generate evidence to support a research study. The researcher must arrange the methods and strategy for gathering information as thoroughly as possible in order for the research to be more organised

b. Research Design

The design of this study is product development that focuses on air duct model as a teaching aid. Furthermore, the development model used by the researcher is the ADDIE model. The primary goal of developing the air duct model as an ABBM that will be researched is to facilitate the learning process and provide clear and accurate exposure to methods and functions throughout the design employed.

The development of this model involves the process of designing, developing, and evaluating products. The form of this study is product evaluation. This study is divided into three stages:

- 1) Create an air duct model as an ABBM based on the ADDIE concept.
- 2) Conduct an examination of the model to determine its functionality. The questionnaire will be distributed to three experts in the field of Refrigeration and Air Conditioning for model evaluation purposes.
- 3) Analysis of data and information. Improvements resulting from expert recommendations and data analysis are descriptive in nature.

i. Analysis Phase

The researcher analyzed and identified the problem by conducting a preliminary survey conducted at the Refrigeration and Air Conditioning workshop, Faculty of Technical and Vocational Education, UTHM Johor. Findings show that the existing facility is lacking in terms of the installation process and it is only for taking readings or data only. In addition, there are air duct simulators in the market with high costs making it difficult for institutions to purchase this because the cost of providing a large space also requires high costs.

2.1.2 Design Phase

After the findings of the study made in the first phase, the researcher plans a strategy in developing the ABBM model. A functional design model is better than just learning about theory and it is very useful because it can describe the real situation and it is quite difficult for lecturers to explain to students. In the design phase this requires steps such as design specification such as portability, flexibility, installation process, measurement process, space size, safety, cost and variety of air duct types. Next, concept generation is the use of morphological charts to generate ideas for the design of air duct models, concept evaluation and design drawings is the model will be developed designed using Sketchup, AutoCad and other software.

2.1.3 Development Phase

In this model development phase, the researcher will carry out the development work of the air network model that has been designed in the previous phase. Among the things that the researcher will do in this phase consists of the selection of materials, colors, hand tools, aesthetic value, the process of model development, the process of measuring and marking, the process of cutting and punching, the process of welding, the process of making circuit connections, the process of joining and tidying and user manual production process.

2.1.4 Implementation Phase

The implementation phase which is the model that will be developed needs to be tested for functionality in order to identify problems or deficiencies found in the model and achieve the objectives of the study. The testing done on this model is to test in terms of the installation process whether it can be opened and re-installed, a diagnosis process where readings of the available air flow rate can be taken. If there are problems, improvements can be made to ensure the functionality of the teaching model built before the evaluation phase is done.

2.1.5 Evaluation Phase

Finally, in the evaluation phase the functionality of this air duct model will be evaluated at all levels so that improvements can be made if there are deficiencies in the model. There are 3 experts in the field of Refrigeration and Air Conditioning will evaluate model that will developed. In this phase also the researcher will be able to improve the model after obtaining validation from experts.

2.2 Research Instruments

A research instrument is any tool or way to obtain and collect research data. The collected data is needed to develop a high-quality ABBM model. In this study, the researcher collected research data by choosing 1 type of research instrument that was used to answer the research question. The instrument used is a questionnaire which will be filled out by three experts in the field of Refrigeration and Air Conditioning. This research instrument is necessary to obtain the opinion and confirmation from the selected experts for the model produced whether it is suitable to be used as an ABBM. Therefore, this set of questionnaires will be designed by the researcher using a questionnaire.

3. Analysis of Research Results

The findings of the study are intended to focus on research issues about design, development, and functionality. After this model has been effectively built, the researcher consults with the supervisor to make any adjustments that are needed, particularly in terms of design and functionality. The researcher next distributed a questionnaire to the selected experts for evaluation and verification of the model that had been built.

3.1 Demographic Analysis

The analysis in Part A is related to the demographics of the assessors or known as experts. Experts need to fill in background information such as age, experience in the HVAC field, career and educational institutions. Table shows the demographic information using frequency and percentage values. The experts involved in this study are a total of 3 people consisting of FPTV, UTHM lecturers from the HVAC field.

Demographics		Frequency	Percent (%)
Educational Institutions	UTHM	3	100
Age	20 to 29	0	0
	30 to 39	1	33.34
	40 to 49	1	33.33
	50 above	1	33.33
Experience in HVAC	1-6 Years	1	33.34
	11-15 Years	1	33.33
	16 Years and above	1	33.33
Career	Lecturer	1	33.34
	Assistant Engineer	1	33.33
	Others	1	33.33

Table 1: Demographic of Sample

Based on table 1 the data obtained from the questionnaire found that the one experts were aged around 30 to 39 (33.34%) while one experts aged between 40 to 49 (33.33%) and one experts aged between 50 to 59

(33.33%). Next, based on the results of the questionnaire, it was found that there are one assistant lecturer or other with experience in the field of PPU between 1-6 years (33.34%), one lecturer with experience in the field of PPU between 11-15 years (33.33%) and one assistant engineer with experience in the field of PPU 16 years and above (33.33%). In other, it was found that there is one experts working as a lecturer, one experts as a assistant engineer and one experst working others are assistant lecturers. Lastly, according to the data that has been obtained for the respondent's educational institution, it was found there is a lecturer, an assistant engineer and an assistant lecturer who teach at the same place which is at Universiti Tun Hussein Onn Malaysia (UTHM).

3.2 Design Analysis of Air Duct Model as a ABBM Model

The analysis in Part B is related to the model design. This section has as many as five items. For each item statement, the expert is asked to mark one answer option based on two (2) options i.e., yes or no. However, experts can provide comments on each question if necessary.

No	Question	Frequency	
		Yes	Nope
1.	Is the model design portable?	2	1
2.	Is the design of model safe to be used as ABBM?	3	0
3.	Do parts on each is this model easy to see?	3	0
4.	Does the model design have elements of visual appeal such as appearance, shape and color?	3	0
5.	Is the design size of this model suitable as ABBM?	3	0
Average percentage (%)		93.33	33.33

Table 1: Frequency of Design Analysis

Based on Table 2 above, the data collected shows that only two experts agree that the model design is portable. However, there is an expert who does not agree with the model design are not portable. In addition, all experts agree that the design of model safe to be used as ABBM. Other items which is the part of model that is easily seen, all experts agree that this model is easy to see with its design size. Next, all experts agreed that the model design has elements of visual appeal such as appearance, shape and color. Finally, all experts agree that the design of the model suitable for use as ABBM.

In conclusion, the data obtained has answered the research questions that have been set by the researcher regarding the extent of functionality in terms of air duct model design. Although there are some comments given by experts are also positive about the design of this model.

3.3 Analysis of Air Duct Model Development as ABBM

The analysis in Part C is related to the development of the model design. This section has as many as five items. For each item statement, the expert is asked to mark one answer option based on two (2) options i.e., yes or no. However, experts can provide comments on each question if necessary.

No	Question	Frequency	
		Yes	Nope
1.	Does the materials selection resemble the real material?	3	0
2.	Is the assembly process of the model material practical?	3	0
3.	Is the material assembly process on the reliable?	3	0
4.	Is the installation of electrical components on the model safe and suitable for use as ABBM?	3	0
4.	Is model finishing performed well?	3	0
Average percentage (%)		100	0

Table 3: Frequency of Analysis of Air Duct Model Development

Based on Table 3, the data that has been collected shows that all experts agree that the material selection process for the model resemble the real material with a good selection. In addition, all experts who agreed on the item of the assembly process of model materials is practical. As for the items for the material assembly process on the reliable , all experts agree that the installation found on the model is solid and reliable which is does not harm the user when using it. As for the item for installation of electrical components on the model safe and suitable for use as ABBM, all experts agree that model safe and suitable. Finally, all experts agree that the model finishing process is performed well. In conclusion, the data found has shown the extent of usability in terms of developing the design of this air duct model as suitable ABBM in the Refrigeration and Air Conditioning workshop, FPTV UTHM.

3.4 Analysis of Functionality of Air Duct Model as ABBM

The analysis in this Section D is related to the functionality of the air duct model as ABBM. This section has five items. For each item statement, the expert is asked to mark one answer option based on two (2) options ie yes or no. However, experts can provide comments on each question if necessary.

No	Question	Frequency	
		Yes	Nope
1.	Do model design ABBM this flexibility?	3	0
2.	Does the ABBM model developed work well?	2	1
3.	Is this ABBM model work in terms of the air duct installation process?	3	0
4.	Is this ABBM model serves to measure the value of CFM airflow reading with correct?	3	0
5.	Does this ABBM model work in terms of students's understanding of air duct components such as polyurethane duct, flexible duct and fabric duct?	3	0
Average percentage		93.3	33.33

Table 4: Frecuency fo Functionality of Air Duct Model

Based on Table 4, the data obtained shows that all experts agree that the model that has been developed has flexible. In addition, only two experts agree that model of ABBM developed work well meanwhile one experts does not agreed. However, there is an expert commenting that this item is where the air is supplied from blower to the air duct components and also diffuser not optimal anywhere blower the existing one cannot accommodate the total amount of air wind in each part of the air duct components. Therefore, it can be seen that the developed model needs to be improved to make it and ABBM that can work well. Next, all experts agree that the model work in terms of the air duct installation process. In addition, all experts agree that air duct model works to measure the CFM airflow reading value correctly. However, there is an expert commenting on this item where the CFM reading taken on each part may be too small, so it is necessary to improve the position blower and fitting to avoid energy loss. Finally, all the experts agreed that the ABBM model works in terms of student's understanding of the identification of air duct components such as polyurethane duct, flexible duct and fabric duct.

In conclusion, the data collected has answered the third research question by the researcher related to the functionality of the air duct model as a teaching aid (ABBM). Although there was one expert who answered 'no' to one of the five question items, there were comments given for improvement.

3.5 Analysis Of Recommendations And Views From Experts

The analysis in Section E is related to recommendations and views from experts. In this section, it is intended for the researcher to know for the improvement and refinement of the air duct model. Among the comments received as a result of the distribution of expert verification forms are as follows:

- 1) Installation blower can fixed again.
- 2) Shape products can be packed again.

- 3) Students need to improvements in terms of method learning that can be learned from ABBM.
- 4) It's just focus to installation and also air flow readings (CFM).
- 5) Air supplied from blower to the air duct component and also diffuser not optimal.
- 6) Readings is possible too small, necessary improvements of position blower and fitting for avoid loss of energy.

4. Discussion

The research reveal that the air duct model as ABBM has met its objectives and can answer research questions. The model aims to provide students with real-life exposure to installation air ducts, enhancing learning through real material sources. The model also aims to make practical tasks easier for students, fostering confidence and understanding. According to Nor (1994), ABBM helps students learn new skills and abilities, while Mok (2003) suggests it aids lecturers in delivering lesson content more efficiently and effectively, making the teaching and learning process (PdP) easier and more understandable for students.

There are several processes carried out during the development phase of this model to produce an ABBM that is able to achieve the objectives of the study. This model requires three months for the researcher to develop this ABBM model. All planning before starting the work has been carried out carefully to avoid problems and facilitate the development of ABBM. After going through several processes, finally this model was successfully produced and can function as an ABBM well.

During this study period, the researcher used the ADDIE model to design a air duct model as a teaching aid (ABBM). The study on constructing an air duct model as an ABBM identifies five items. The first item is emphasises the necessity of a safe and appropriate model for use, assuring safety and longevity. The second item is emphasises the model's easy-to-see parts which promotes successful learning. The third item that focuses on visual appeal such as appearance, form and colour, ensuring that the model's design corresponds to the actual materials used in industry. These characteristics help to ensure the model's long-term viability. Abu Bakar (1980), that the use of colour in ABBM preparation has a major impact on students' understanding since it adds another dimension to their knowledge. The design size is regarded ideal for ABBM because it is portable and user-friendly (Mok, 2002). However, the final thing is the design of a portable model. The model's properties are appropriate for ABBM and this is supported by Zainal Abidin & Suhaimi (2013) as active learning applications with student participation improve the PdP process.

The researcher evaluated a questionnaire from three HVAC experts, revealing five items. The highest agreement was found in item which is experts agreed that the materials used in the air duct models resemble real ones. This is supported by Alsagoff (2000) stating that teaching aids need to emphasize unique ideas and own designs that are able to attract attention. The process of assembling the model materials was also considered practical. The ABBM model was designed to enhance students' knowledge without confusion, and a manual was prepared for use and it supported by Mok (2002). The study focuses on the installation of materials on a strong model. The Air Conditioning System and HVAC Diagnosis and Analysis System are developed using ABBM, which is practical and solid. The sir duct model is labeled and has an operating manual. This supports Azhari Azman et al.'s (2015) claim that interesting ABBM can influence students' learning styles.

The air duct model as ABBM was tested using a questionnaire filled by three experts in HVAC field. The model was found to be flexible and effective in air duct installation. The model also provided students with hands-on experience in opening and reassembling components. 3D models, as mentioned by Chin (2009), attract interest and provide students with practical experience in real work situations. The ABBM model is effective in measuring CFM airflow reading values. However, it may be too small, requiring improvement in ranking blower and fitting to prevent excessive air loss. The model also helps students understand air duct components, such as polyurethane, flexible, and fabric ducts. ABBM is designed to enhance students' understanding of lesson content.

The ABBM model is designed with interesting functions to aid students' understanding. However, one expert disagrees with the built model, citing insufficient air supply from the motorblower and inadequate air mains system design. This could lead to confusion and energy loss due to the model's insufficient air supply. The air duct model is suitable for practical classes, providing students with hands-on experience and accurate measurement of CFM airflow reading values, but requires improvements based on expert feedback.

5. Conclusion

Thoroughly, according to the analysis that has been done on three experts on the air network model as ABBM that has been built by the researcher was successfully produced based on the objectives that have been set. Through the instruments that have been given by the researcher during the evaluation and confirmation from the experts, it was found that the response given was positive but requires improvement in future studies. Not only that, the results of the findings provided real initial exposure to students on how to install air duct components according to the correct procedure based on the user operation manual that has been prepared.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

*The authors confirm contribution to the paper as follows: **study conception and design:** Noor Farahanis Zaima **data collection:** Noor Farahanis Zaima; **analysis and interpretation of results:** Noor Farahanis Zaima , Faizal Amin Nur Yunus; **draft manuscript preparation:** Noor Farahanis Zaima. All authors reviewed the results and approved the final version of the manuscript.*

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