

## Functionality of R290 Flammable Refrigerant Module

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DOI: <https://doi.org/10.30880/ritvet.2024.04.01.003>

### Article Info

Received: 10th March 2024

Accepted: 10th June 2024

Available online: 30 June 2024

### Keywords

Teaching and learning, flammable,  
VAK, ADDIE model, ABBM

### Abstract

Less interactive modules can make the learning and teaching process (PdP) have no impact on students. Therefore, the use of teaching aids is an important matter in the learning and teaching process (PdP). Effective ABBM has a good impact where it can launch more learning and teaching sessions in the classroom between teachers and students. The researcher has developed a learning module based on the ADDIE Model. This flammable refrigerant module was developed to reduce student dependence on teachers in delivering learning while in class. The module that has been developed by the researcher is to use a storyboard as a guide in developing this module. Then, the R290 combustible refrigerant module was designed using the Canva website where this module emphasizes aspects of the visual, auditory, and kinesthetic (VAK) learning style. The results of the study found that the developed module is suitable and able to function as an ABBM in the classroom. All three experts agreed that this module is functional with a percentage of 100%.

## 1. Introduction

Education plays an important role in improving the quality of human resources to ensure the continuity of national development (Mallaherang, Arsyad, & Darwis, 2018). Therefore, the learning process should be given attention in various aspects in order to support its success (Andayani, 2017). The learning process should be considered according to the different characteristics of students, so these differences can be accommodated through the selection of appropriate media and learning strategies.

One of the competencies that teachers need to implement is the ability to develop teaching materials. The development of teaching materials is important for teachers so that learning is more effective, efficient, and does not deviate from the objectives to be achieved. The use of inappropriate teaching materials is one of the causes that cause the learning input delivered by the teacher to be less understood by the students. The effectiveness of teaching materials cannot be achieved if their use is not consistent with the content of the learning objectives that have been formulated, and the use of teaching materials is not in accordance with the learning objectives. Without teaching materials, it will be difficult for teachers to improve the effectiveness of learning, and for students, without teaching materials, it will be difficult to adapt to learning (Setiawan, 2016).

In the field of education, the use of ABBM cannot be avoided. In the Malaysian education system, the use of ABBM is very necessary to ensure that the learning and teaching process is not boring and less effective. ABBM is divided into two categories, which are electronic and non-electronic. For ABBM, the electronic category

consists of slide projectors, televisions, videos, and computer-aided devices. For ABBM, the non-electronic category consists of modules, flash cards, and pictures related to the lessons taught. According to Hamdan (2010), a module is a teaching aid that aims to achieve effectiveness in education so that the delivery of knowledge to students will be more effective.

For refrigeration and air conditioning (HVAC) courses, a comprehensive understanding of refrigerants is crucial. Utilizing modules is highly effective because their design is user-friendly and easy for both students and teachers to comprehend. Modules can be tailored to individual learning needs, making them versatile educational tools. Visual communication is particularly effective in conveying information quickly (Eichstaedt & Silva, 2003). Hence, developing high-quality modules can significantly enhance the teaching and learning process. Modules that meet the specific needs of students and teachers can greatly improve classroom learning, positively impacting students by enriching their educational content.

## 1.1 Background of problem

The use of ABBM during the teaching and learning session is important because it can attract students' interest, motivate students, and make the learning session easier (Abbas, 2006). Therefore, ABBM can be seen as a very important role and can contribute various facilities. Furthermore, ABBM also helps teachers in technical and vocational schools as well as higher education institutions, where it can create an effective and quality teaching and learning environment. Therefore, effectiveness in imparting knowledge and skills as a stimulus for learning is very necessary so that the learning process between teachers and students is at its maximum level.

A module is a written ABBM that is organized systematically, containing learning materials, methods, learning objectives based on basic competence or indicators for the achievement of competence, and self-learning activities that can give students the opportunity to test themselves through the exercises found in the module (Wigati, Maharta, & Suyatna, 2015). Modules are one of the teaching materials created to help learning become more effective and quality. Apart from making learning fun, modules also play an important role for instructors. A module that contains all the teaching information can help teachers teach more effectively, and it is usually called a teaching module (Alsagoff 1984).

Each student receives learning in various ways based on their own ways of receiving, such as seeing and listening, reflecting and doing, thinking logically, memorizing, and describing learning. In general, each individual will get information by using their senses. The way to concentrate, learning style, memory, mind development, and intelligence of each student are different (Degeng & Marthen 2002). Learning style is the way a person receives information and adapts to the information that has been received. According to DePorter & Hernacki (2002), learning style is a combination of the processes of receiving, organizing, and processing information. The dominant types of learning styles are visual (seeing), auditory (listening), and kinesthetic (moving and touching) learning styles. The existing module is found to be less interactive, and it will cause difficulty for students to understand a topic or content found in the module. Visual, auditory, and kinesthetic learning styles (VAK) are not emphasized much in the existing modules. There are students who only have one learning style, but there are also students who have a learning style that combines VAK learning styles (Hj. Reduzan, 2012). Therefore, the module that has VAK elements is able to attract students' interest in using it according to their respective learning styles.

Printed modules are still relevant today, despite the existence of electronic modules that can be found in internet sources. Modules that are printed and have aspects of visual, auditory, and kinesthetic learning styles (VAK) are modules that can help the teaching and learning process become more effective. Based on the observations made, the existing module related to the combustible refrigerant R290 has less attraction and is not organized. This can make it more difficult for students to use it as a reference and increase their understanding. Therefore, the development of modules that are organized, have complete and interesting content, and have an emphasis on VAK is necessary to overcome this problem so that learning can be carried out effectively. In addition, the module can be used as a reference not only for students, but it can also be used as a reference for teaching staff in any institution as an additional reference. In relation to that, in order to produce a more effective module, it should be developed based on the appropriate module development theory (Omar & Arsat, 2010).

## 1.2 Problem of Statement

As a result of the problem research, it was found that there are several problems that occur. Printed modules that are not organized and do not have a medium capable of attracting students' interest in learning can cause difficulties for students to understand the learning as well as make it difficult to achieve the learning objectives. The lack of references for students also has an impact on students' understanding of a subject. Existing modules on the market are less interactive because the learning content found in the modules does not have the aspect of

learning style which is the aspect (VAK). Therefore, to solve this problem, ABBM, which is a module that has clear, compact, orderly, and systematic teaching content, should be developed to help improve the effectiveness of teaching and learning.

### 1.3 Objective of Study

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

- i) Designing the R290 flammable refrigerant module.
- ii) Development of the R290 flammable refrigerant module.
- iii) Testing the functionality of the R290 flammable refrigerant module.

## 2. Methodology

The methodology of this study discusses the methods and design used in this study. The purpose is to collect and analyze the data obtained to ensure that the objectives of the study can be achieved. According to Siti Sarah (2015), methodology is a method and technique of designing, collecting, and analyzing data to produce evidence that can support a study. The methodology and strategy that will be used to gather information must be planned as best as possible by the researcher so that the research conducted will be more organized.

### 2.1 Research Design

In this study, the researcher elaborated on the detailed procedure for conducting the research, aiming to collect information through specific methods. The research design employed is product development, focusing on module creation. The researcher used the ADDIE model for development, chosen for its organized steps and ease in designing modules. The ADDIE model consists of five phases: analysis, design, development, implementation, and evaluation.

#### 2.1.1 Analyse Phase

Based on this study, the researcher analysed the problems encountered in developing the module. The main issue identified was the lack of a visual, auditory, and kinaesthetic (VAK) learning style approach in the existing module. To address this, the researcher decided to develop the R290 combustible refrigerant module with a focus on the VAK learning style approach. The researcher conducted extensive studies and reviewed numerous references from previous research to gather information useful for developing this new module.

#### 2.1.2 Design phase

After the researcher obtains relevant information and data about R290 refrigerant, the researcher wants to develop a printed form module. At the design stage, each design process must be made comprehensive with relevant parts. Module design is based on learning objectives, according to content suitability, and developing modules using the VAK approach. This module will focus on important information and the safety of this refrigerant. Therefore, the researcher has already drawn up a story board to develop this module.

#### 2.1.3 Development phase

In developing this module, the researcher used the Canva platform due to its various functions that effectively convey information about the R290 refrigerant in an engaging and easy-to-understand manner. Canva offers a wide range of features that support the VAK learning method within the module. The researcher designed the learning content with various colors, mind maps, and flow charts to attract students who prefer visual learning styles. Additionally, videos related to the learning content were included for auditory learners, and a variety of questions were incorporated to assist kinesthetic learners in better understanding the material.

#### 2.1.4 Implementation Phase

The implementation phase involves developing the R290 combustible refrigerant module under real conditions, as planned during the development phase. This phase requires creating a module with content and design that

emphasizes the VAK learning style, ensuring that the study's objectives are met. Once the module is developed, all designed features are reviewed to confirm that they align with the initial plan. These elements are evaluated to ensure suitability and quality for use as an ABBM. Any errors will be corrected, and improvements will be made based on additional suggestions.

### 2.1.5 Evaluation Phase

At this stage, the researcher needs to get feedback on the quality of the modules built, such as the language style, instructions, suitability of the content used, and the activities used. A total of three experts in the field of refrigeration and air conditioning at the Faculty of Technical and Vocational Education at Tun Hussein Onn University will test the effectiveness of the modules that have been developed.

### 2.1.5 Research Instrument

The purpose of the validity of the questionnaire is to test the evidence for different data. The researcher uses this instrument to ensure that the set objectives can be achieved. This validation will be done by three experts who have extensive knowledge and are skilled in terms of language, sentence structure and format where they consist of lecturers from the Faculty of Technical and Vocational Education (FPTV).

## 3. Results

The findings of this study are to answer the third research question which is functionality by going through two phases which are the implementation phase and the evaluation phase. After this module was successfully developed, the researcher made a review with the supervisor first to make corrections if there are errors from various aspects, especially the arrangement and style of module development according to the syllabus. Next, the researcher gives the module and the questionnaire to the selected experts for evaluation and verification.

### 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 gender, age, education level, and period of work experience. 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. Based on table 1 shows the number of experts according to gender involved in this study. The experts involved in this study consisted of two male experts (66.7%) and one female expert (33.3%). In addition, two experts are between the ages of 30 and 39 years (66.7%) while one expert is between the ages of 40 and 49 (33.3%). The level of education of experts, all the experts are a Doctor of Philosophy (100%). Lastly for the data on part A is the period of work experience. The three experts have experience between 11 to 20 years of work experience (100%). Lastly for part A is the three expert has field of specialization in HVAC (100%).

**Table 1** Demographic of Sample

Demographics		Frequency	Percent (%)
Gender	Male	2	66.7
	Female	1	33.3
Age	30 to 39	2	66.7
	40 to 49	1	33.3
	50 above	0	0
Educational status	Diploma	0	0
	Degree	0	0
	Master	1	33.3
	PhD	2	66.7

Period of work experience	5 to 10	0	0
	11 to 20	3	100
	21 to 30	0	0
	31 above	0	0
Field of specialization	HVAC	3	100
	Others	0	0

### 3.2 Analysis of module content

The analysis in Part B is related to the delivery of module content. In part B, there are eight constructs that must have been answered by the experts. The first construct has six items. For each item statement, the expert is asked to mark one answer option based on two (2) options i.e., yes or no.

**Table 2** *Analysis of Module Content*

No	Question	Frequency	
		Yes	Nope
1.	Clear content.	3	0
2.	Accurate facts.	3	0
3.	The learning content is in accordance with theoretical learning.	3	0
4.	The learning content is in accordance with practical learning.	3	0
5.	Description that corresponds to the illustration.	3	0
6.	The objective of the module is clear with each topic.	3	0
<b>Average percentage</b>		<b>100</b>	<b>0</b>

Based on table 2, the three experts agree that this module has clear content. All the experts also agree that the module uses accurate facts. The learning contents in this module are in accordance with theoretical learning and practical learning, based on what all of the experts have been addressing. The three experts also agree that this module has a description that corresponds to the illustration, and the objective of the module is clear for each topic. In conclusion, all the module contents are suitable to use because the average percentage for this construct is 100%.

### 3.3 Analysis of module designs

The analysis in Part B in the second constructs is related to the use of module design. This section has six items. For each item statement, the expert is asked to mark one answer option based on two (2) options i.e., yes or no.

**Table 3** *Analysis of Module Design*

No	Question	Frequency	
		Yes	Nope
1.	Attractive front page.	3	0
2.	The form of presentation of interesting content.	3	0
3.	The module size is easy to carry anywhere.	3	0
4.	Use of appropriate colors.	3	0
5.	Organized text layout.	3	0
6.	Clear graphic layout.	3	0

<b>Average percentage</b>	<b>100</b>	<b>0</b>
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Based on table 3, there are six items on this second construct. This construct is about the module design, which is consist attractive front page, the form of presentation of interesting content, the module size is easy to carry everywhere, use of appropriate colors, organized text layout, and clear graphic layout. All these six items, the three experts have agreed that designs of this module are suitable to be used and has its functionality. The score of this construct is 100%.

### 3.4 Analysis of module pictures

The analysis in Part B is related to module pictures. This section has three items. For each item statement, the expert is asked to mark one answer option based on two (2) options i.e., yes or no.

**Table 4** Analysis of Module Pictures

No	Question	Frequency	
		Yes	Nope
1.	The picture used is clear.	3	0
2.	Arranged pictures.	3	0
3.	Use of recent images.	3	0
<b>Average percentage</b>		<b>100</b>	<b>0</b>

Based on the table above, the data collected shows that all experts agree that the pictures used are clear. The experts also agree that the pictures used are arranged in the module. Lastly, for the last item, which is images in the module, there is also a recent image. In conclusion, the three experts agree that this module is suitable based on the pictures that have been used.

### 3.5 Analysis of module writing

The analysis in Part B is related to module writing. This section has four items. For each item statement, the expert is asked to mark one answer option based on two (2) options i.e., yes or no.

**Table 5** Analysis of Module Writing

No	Question	Frequency	
		Yes	Nope
1.	Using the appropriate type of writing (Arial writing)	3	0
2.	Use appropriate text colors.	3	0
3.	Have the correct sentence structure.	3	0
4.	Have the appropriate writing size.	3	0
<b>Average percentage</b>		<b>100</b>	<b>0</b>

Based on the table above, all the items which are appropriate type of writing, appropriate text colors, correct sentence structure and appropriate writing size are all suitable to be used based on the verification. In conclusion, the average percentage for this construct is 100%.

### 3.6 Analysis of module VAK elements

The analysis in Part B is related to module VAK elements. This section has six items. For each item statement, the expert is asked to mark one answer option based on two (2) options i.e., yes or no.

**Table 6** Analysis of Module VAK Elements

No	Question	Frequency	
		Yes	Nope
1.	Content in the form of pictures can attract interest (Visual).	3	0
2.	The content in the form of pictures is very clear and appropriate to the learning topic (Visual).	3	0
3.	The audio in the video is easy to listen to (Auditory).	3	0
4.	The audio in the video is very clear to hear (Auditory).	3	0
5.	The activities provided can help practical implementation more easily (Kinesthetic).	3	0
6.	The activities provided can help self-learning (Kinesthetic).	3	0
<b>Average percentage</b>		<b>100</b>	<b>0</b>

Based on table above, the data obtained shows that for visual elements, the three experts agree that the content in the form of pictures can attract interest (100%). Other than that, the content in the form of pictures is very clear and appropriate to the learning topic (100%). For the auditory elements. The three experts agree (100%) that the audio in the video is easy and clear to listen to. Lastly for the kinesthetic elements, activities provided can help practical implementations and help self-learning (100%).

### 3.7 Analysis of module additional information

The analysis in Part B is related to module additional information. This section has 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.

**Table 7** Analysis of Module Additional Information

No	Question	Frequency	
		Yes	Nope
1.	Appropriate to the topic.	3	0
2.	Selection of the appropriate QR code.	3	0
3.	Easy to read position.	3	0
4.	Presented in an attractive form.	3	0
5.	Additional disclosure of the latest info.	3	0
<b>Average percentage</b>		<b>100</b>	<b>0</b>

Based on the table, it shows that all the items are suitable to be used based on what the experts has been verified. Based on the expects, the agree that additional info are appropriate to the topic (100%), QR code are appropriate (100%), the additional information are in position that easy to read (100%), its presented in attractive form (100%) and its disclosure to the latest info.

### 3.8 Analysis of module activities

The analysis in Part B is related to module activities. This section has two items. For each item statement, the expert is asked to mark one answer option based on two (2) options i.e., yes or no.

**Table 8** Analysis of Module Activites



No	Question	Frequency	
		Yes	Nope
1.	Have clear instructions.	3	0
2.	Encourages self-directed learning.	3	0
<b>Average percentage</b>		<b>100</b>	<b>0</b>

Based on the table above, the data obtained show that the module activities have clear instructions based on what the experts have been agreeing (100%). The three experts also agree that the module activities also encourage self-directed learning (100%).

### 3.9 Analysis of module summary

The analysis in Part B is related to module summary. This section has three items. For each item statement, the expert is asked to mark one answer option based on two (2) options i.e., yes or no.

**Table 9** Analysis of Module Summary

No	Question	Frequency	
		Yes	Nope
1.	Briefly by topic.	3	0
2.	Topic overview.	3	0
3.	Consistent with the content of the topic.	3	0
<b>Average percentage</b>		<b>100</b>	<b>0</b>

Based on table 9, the three experts agreed that the module summary are briefly about the topic (100%), its topic overview (100%), and the summary are consistent with the content of the topic (100%). In conclusion, the module summary is suitable to be used.

### 3.10 Analysis of recommendations and views from experts

The analysis in this section is related to module comments and suggestions. In this section, it is intended for the researcher to know for the improvement and refinement of the module. Among the comments received because of the distribution of expert verification forms are as follows:

- i) Reduce the use of colors that are too bright. This is because too many colors (more than 6 colors that has been use in that module. Somewhat disrupts the reader's focus.
- ii) Diversify activities to make them more. Diversifying activities involves incorporating different types of tasks, exercises, or events to enhance the overall experience. By adding variety, it can cater to different interests and learning styles, keep participants engaged, and prevent monotony. For example, in an educational setting, this could mean mixing lectures with hands-on projects, group discussions, and interactive multimedia presentations. The goal is to create a more stimulating and comprehensive experience that can maintain interest and improve outcomes."

This approach can apply to various contexts such as education, work environments, recreational programs, and personal development plans.



## 4. Discussion

Based on the analysis done by the researcher, the R290 combustible refrigerant module that has been developed meets the characteristics of a good learning module. However, some improvements need to be made to further improve the quality and quality of the module and to improve the effectiveness of the module. This R290 combustible refrigerant module has been developed according to the research objectives set at the beginning of the study.

Designing is a very important process that needs to be planned by the researcher. Therefore, each component in the module needs to be designed properly to ensure that the module developed is of high quality. Therefore, the components in this module have been designed using Canva software. Researchers believe that well-designed components can attract the interest of module users. Design that emphasizes VAK learning (visual, auditory, and kinesthetic) is the focus of the researcher in developing this learning module. For visual elements, researchers design content that has interesting pictures, colors, writing and arrangement. Then, for the auditory element, the researcher designed a video that has clear audio to further improve the user's understanding of the topic being studied. Activities that have elements of PAK21 and individual activities are also designed in the module for users with a kinesthetic learning style. QR code is a component that is in line with the development of technology in education and is also applied in the module. This is intended for users to access information online provided using the QR code component. A good teaching aid is a module that has an interesting design (Mahidi, 2011). Therefore, the design of this module is an important matter for researchers. This is to ensure that the developed module can attract users and it is effective.

In developing this module, an important step taken by the researcher is to design the content of the module simply so that it is not too complex. Modules that emphasize VAK learning must conform to the VAK learning style, therefore simple and compact learning content with diverse visuals is able to attract the attention of users. According to Deporter & Hernacki (2014), learning style is a combination of the process of receiving, organizing, and processing information. Therefore, the three main dominant learning styles are visual, auditory, and kinesthetic. Apart from the simple and compact content, additional info and activities are also placed in this module. All components in the module have been developed with an emphasis on the VAK learning style. This is intended so that users can use the module according to their respective learning styles.

Based on the evaluation made, there are eight constructs that need to be answered by experts to test the functionality of the module. Through the views and comments given by the experts, the three experts agreed that this learning module is suitable for use. However, there are some improvements that need to be made by the researcher to increase the quality and quality of the module that has been developed. Through the results of the research that has been analyzed by the researcher, the module that has been developed, which is the R290 combustible refrigerant module, has good functionality to be used as an ABBM. According to the results of the analysis, the combustible refrigerant module has 100% suitability which has been agreed by all experts. According to the research that has been done through the existing module, which is the water treatment problem module in HVAC that also applies the VAK approach. Nevertheless, as many as 66.67% agreed that writing in the VAK form of the module is suitable for use. This shows that the module developed by the researcher is more suitable for use in terms of VAK. According to Norma Nawaf (2017), through her research in the most used learning styles, students have a higher tendency to use visual, auditory, and kinesthetic learning styles. Therefore, this has shown that the module developed by this researcher has a suitable VAK approach to use.

## 5. Conclusion

Overall, the development of the R290 combustible refrigerant module has been successfully developed by researchers based on the ADDIE Model. The learning module that has been developed has undergone a verification and evaluation process by three experts in the field of air conditioning and refrigeration from Tun Hussein Onn University (UTHM). The development of this module is an effort to further diversify teaching aids. This ABBM can be used by students and teachers where it can help in the teaching and learning process. Through the results of the study, all experts agree that the module that has been developed, which is the R290 combustible refrigerant module, is suitable for use and that it can be used as an ABBM that has an emphasis on visual, auditory, and kinesthetic learning styles

## Acknowledgement

This research had done by Faculty of Technical and Vocational collaboration with industry Dr Pakar Aircond Sdn. Bhd.

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