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THE DEVELOPMENT OF ELECTRONIC TOPIC MODULE WITH INTEGRATED 2D SIMULATION AND AUGMENTED REALITY APPLICATION: MODULE VALIDITY

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Abstract:

The evolution of education has significantly transformed Teaching and Learning (T&L) sessions through the integration of technologies and digital tools, offering students new learning opportunities. This shift has led to changes in Malaysia's educational curriculum, particularly in technical and vocational subjects. Design and Technology (D&T), a new subject introduced to replace Integrated Life Skills. Research shows that the electronics topic in D&T is particularly challenging, making it difficult for students to achieve their highest mastery levels as outlined in the Curriculum Standard and Assessment Documentation (DSKP). Both teachers and students often struggle with completing electronic projects due to limited technical skills and students' poor visualization abilities. This study aims to validate the module validity in electronic topic module. The research adopts a quantitative research design with Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model approach, emphasizing the implementation phase. The module validity will be evaluated by nine experts in D&T and Technical and

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Vocational field. The study of the data will be analyzed by using the Content Validity Index (CVI). The results show that some items have a minimum CVI value of 0.78, and the S-CVI value is also 0.983, indicating the module validity is valid and acceptable. This demonstrates that the module is ready for pilot and actual studies to assess its usability and effectiveness. In conclusion, the module has been validated by experts, improving its quality and helping to identify areas for future research, particularly in evaluating its usability and effectiveness.

Keywords:

Design and Technology, Electronic Topic, Module Validity, Augmented Reality, Flipped Classroom, Multisensory Learning, Cognitive Theory of Multimedia Learning

Introduction

The evolution of education has significantly transformed Teaching and Learning (T&L) sessions through the integration of technologies and digital tools, offering students new and engaging learning experiences. Numerous studies have explored T&L sessions in this modern educational era, leveraging 2-Dimensional (2D) Simulation Artificial Intelligence (AI), Augmented Reality (AR), Virtual Reality (VR), and Holograms. According to Khalid et al. (2024), interactive and immersive digital learning methods, such as digital simulations, virtual laboratories, and interactive multimedia resources, can enrich students' knowledge, improve their competencies, and boost motivation.

This paper aims to validate an electronic topic module for the Electronics topic in the Design and Technology (D&T) subject. As noted by Arshad et al. (2023), D&T is a relatively new subject introduced in 2017 to replace Integrated Life Skills. Oliva (2005) highlighted that curriculum changes are inevitable, driven by evolving societal needs and technological advancements. In Malaysia, these curriculum changes aim to equip younger generations with creativity, innovation, and critical-thinking skills aligned with the demands of Industry Revolution (IR) 4.0.

D&T is designed for primary and secondary school students to develop their potential for creating innovative and knowledge-based products. Despite its potential to foster critical thinking and product development skills, several challenges have been identified during T&L sessions. For example, Sahaat and Nasri (2020) reported that teachers find insufficient time to complete projects on the Electronics topic. Additionally, Idris et al. (2022) noted a lack of technical skills among teachers, while Jafini et al. (2024) observed that many struggle with visualizing electronic components and microcontroller interconnections, making project development difficult. This need for visualization is supported by Othman et al. (2024) and Liono et al. (2021), who emphasize its importance for electronic project development. A needs analysis from multiple studies (Arshad et al., 2023; Sahaat and Nasri, 2020; Jafini et al., 2024; Othman et al., 2024; Liono et al., 2024; Idris and Che' Rus, 2023; Ali et al., 2019; Ajit et al., 2022; Masingan and Sharif, 2019; Ting et al., 2024; Idris et al., 2023) highlights challenges and requirements from both teachers' and students' perspectives.

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Although various studies have addressed the Electronics topic in D&T, the application of visualization through Flipped Classroom, Multisensory Learning, and Mayer's Cognitive Theory of Multimedia Learning (CTML) remains unexplored. This study, therefore, focuses on the validation of electronic topic module before conducting pilot and actual studies. Research gaps persist regarding module validity. For instance, there are studies from Arshad et al. (2023), Othman et al. (2024), and Ting et al. (2024) had discovered the needs of electronic topic but have not yet to discover the requirements or result of module validity. Accordingly, this study addresses these gaps by validating the electronic topic module through expert review to ensure its accuracy and relevancy for users in future research.

Literature Review

The theoretical framework for this study is grounded in three key theories which are Flipped Classroom, Multisensory Learning and Mayer's Cognitive Theory of Multimedia Learning (CTML). These theories are applied during the design and development phases to create an interactive module aimed at enhancing students' engagement and enjoyment during T&L sessions. Figure 1 illustrates the theoretical framework used to guide the development of the module.

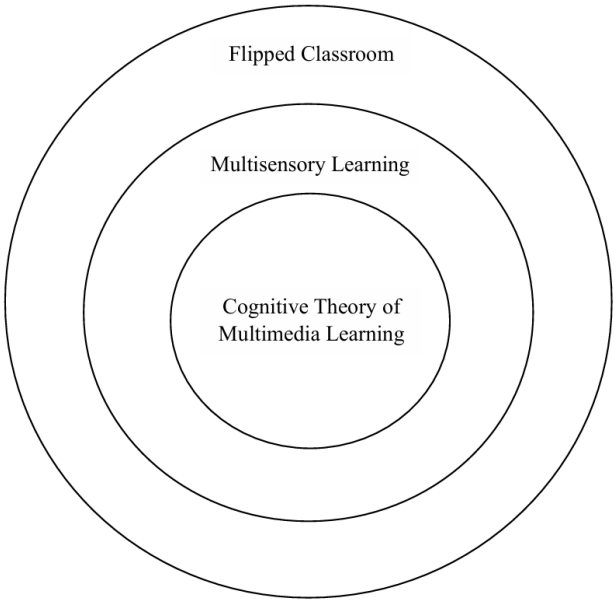

Figure 1: The Theoretical Framework

Flipped Classroom

There are a lot of studies discovered that Flipped Classroom is one of the efficient instructional strategies to increase students' competencies and academic achievements. According to Mandasari and Wahyudin (2021), the implementation of Flipped Classroom helps the students achieve their learning objectives and easily understand the content of the subject. A quasi-experimental study from Gondal et al. (2024) shows that the mean score after Flipped Classroom is increasingly significant towards students' academic achievement. Majority of the students who participated in the study agreed that the flipped classroom strategy improved their learning as well as enhanced their interest in the course (Joseph et al., 2021). Therefore, the implementation of Flipped Classroom is suitable to be used in the module which could enhance the students' engagement and academic achievement during T&L sessions.

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Multisensory Learning

Multisensory Learning encompasses three primary types of learning—auditory, visual, and kinesthetic—enabling students to better understand concepts during T&L sessions. Baberwal et al. (2024) highlighted the role of imagination, specifically Motor Imagery (MI), which enhances a person's ability to visualize and perform tasks. Their study also demonstrated how virtual reality can strengthen MI through the integration of audio and visual stimuli. Similarly, Muda et al. (2024) discovered that an interactive Arduino-based learning tool can support students in improving their kinesthetic learning during T&L sessions. Siagan and Syahril (2024) emphasized that visualization significantly engages students during T&L sessions, with learners relying on 75% visual, 13% auditory, and 12% tactile or other sensory inputs. These findings underline the importance of integrating auditory, visual, and kinesthetic learning approaches to motivate students and enhance their understanding of the Electronics topic in the D&T subject. This study emphasizes the use of Multisensory Learning, supported by AR technology, to capture students' interest and engagement during T&L sessions.

Mayer's Cognitive Theory of Multimedia Learning

Numerous studies have explored the integration of CTML with multisensory elements during T&L sessions. Spaccarotella et al. (2024) demonstrated that CTML can enhance the presentation of visual and auditory information, reducing cognitive load, as shown in their study where food preparation steps were accessed via QR codes. Similarly, Karim and Karim (2024) highlighted the effectiveness of using CTML in AR to improve students' understanding of the Gravitation topic, showing positive impacts through test results. Their findings emphasized that implementing CTML with AR provided students with meaningful learning experiences during T&L sessions. Kuba et al. (2021) suggested that CTML is well-suited for practical implementation in learning and instructional environments, as it helps users acquire valuable knowledge while reducing cognitive load, consistent with Mayer's principles. This study focuses on leveraging CTML with AR technology to create interactive and engaging learning experiences for students during T&L sessions.

Methodology

Research Design

This study employed a quantitative research design using the ADDIE Model approach, as outlined by Hashim et al. (2024), with a primary focus on the Design, Development, and Implementation phases. Fajarini and Rahayu (2020) highlighted that quantitative research designs often utilize questionnaires to validate the reliability and validity of instruments. Similarly, Aithal and Aithal (2020) emphasized the widespread use of questionnaires in social sciences to collect quantitative data from participants within relevant fields. Nashir et al. (2015) demonstrated that sets of questions on module validity were validated by nine experts. Consequently, this study validates its module validity by using questionnaires. Figure 2 illustrates the ADDIE Model phases applied in this research.

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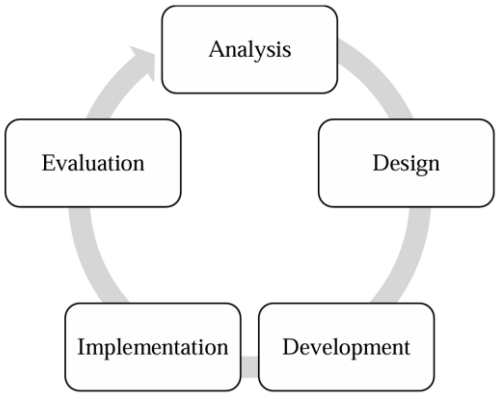

Figure 1: The ADDIE Model

The triangulation in this study involves document analysis, interviews, and a questionnaire to validate module validity. According to Bans-Akutey and Tiimub (2021), triangulation enhances the credibility and validity of a study by incorporating multiple approaches to gather information. During the analysis phase, Jafini et al. (2024) conducted document analysis and interviews, identifying the challenges and needs related to the Electronics topic. Their findings highlighted several resources required to address these challenges effectively.

Sample

The validation sample for the module development was selected using a purposive sampling technique. Susantini et al. (2024) demonstrated this approach by involving three experts in validating an Android-based higher-order thinking skill assessment. Similarly, Matore and Khairani (2015) selected experts with over three years of experience in their respective fields for validation purposes. Based on these studies, three experts with more than three years of experience were chosen to validate the module validity. The selected experts specialize in Information Technology, Computer Science, or Technology, enabling them to provide informed insights and expertise on module validity. As noted by Saaty and Ödzemir (2014), selecting experts from relevant fields with programming experience ensures accuracy and minimizes potential weaknesses in validation results. Table 1 presents the background information of the selected experts.

Table 1: Experts Profile of Module Validity

Experts	Profile and Experience			
	Major	Minor	Experience	Teaching D&T
Expert 1	Living Skills	Technical and Vocational	Drafting UASA (State level)	8 years
Expert 2	Living Skills	Entrepreneurship	Drafting UASA (State level)	8 years
Expert 3	Agricultural Science	Living Skills	Drafting UASA (State level)	8 years
Expert 4	Business	Entrepreneurship	Drafting UASA (District level)	8 years
Expert 5	Fine Art and Design	Design and Technology	Drafting UASA (District level)	5 years
Expert 6	Living Skills	Malay Language	Innovation Competition	8 years

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Experts	Profile and Experience			
	Major	Minor	Experience	Teaching D&T
Expert 7	Home Science	Living Skills	Innovation Competition	8 years
Expert 8	Agricultural Science	Design and Technology	Innovation Competition	4 years
Expert 9	Civil Engineering	Living Skills	Innovation Competition	5 years

Module Validity

There are sets of questionnaire serves as a validation tool for experts to valid the module validity. It is adapted from Noad and Ahmad (2005), where the instruments were created based on the its accuracy and relevancy of needs in the module before giving the questionnaires to the experts. Each item was validated by using five-point Likert Scale, where "1" represents strongly disagree, "2" represents disagree, "3" represents uncertain, "4" represents agree, and "5" represents strongly agree. There are three types of module validity which were validated by experts which are face validity, content validity, and steps and its objectives validity.

Face Validity

The face validity refers to a measurement on how valid the face of the module which can be seen by the user at first glance. According to Taherdoost (2016), the face validity refers to the extent of measurement seems to be associated with a particular construct, such as test instrument, and questionnaires instrument. These statements shows that the face of the module needed to be validated by experts to see the accuracy and relevancy of its feasibility, readability and consistency. Table 2 displays the items of face validity instrument.

Table 2: The Items of Face Validity

Items	The items of face validity
Item 1	Format that matcher the skills being measured.
Item 2	The language used is easy to understand.
Item 3	The font size is appropriate and easy to read.
Item 4	Free from spelling errors.
Item 5	The answer space is suitable for the expected response.

Content Validity

The content validity is a measurement tool that encompassed the content of a specific field whether it is suitable to be represented. According to Taherdoost (2016), the content validity refers to the evaluation of new instrument which covers essential items while excluding undesirable items which relates with the study and knowledge. These statement shows that content of the module needed to be validated by experts to see the suitability of content to deliver based on the needs of the study which is electronic topic. Table 3 displays the items of content validity instrument.

Table 3: The Items of Content Validity

Items	The items of content validity
Item 1	The module contents are suitable for students and teachers.
Item 2	The module contents use appropriate graphic design based on the DSKP.
Item 3	The module contents align with T&L period based on the DSKP.

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Items	The items of content validity
Item 4	The module contents can be effectively implemented during T&L process.
Item 5	The module contents enhance students' and teachers' understanding of electronic.
Item 6	The module objectives can be achieved by using module's teaching strategies.
Item 7	The exercises are appropriate with module contents.

Steps and Objectives Validity

The steps and its objectives validity is a measurement on how valid the steps or activities of the module to achieve the objectives of the module. According to Nawi et al. (2015), a set of questionnaires which is align based on steps and objectives to get the reliability of the module. Noah and Ahmad (2005) emphasized the questionnaires needed to be validated first before conducting module reliability. Therefore, these statements prove that a set of questionnaires of module steps and its objectives needed to be validated before conducting module reliability to see the suitability of accuracy of steps and its objectives.

Data Analysis

The data was analyzed using the Content Validity Index (CVI), following the guidelines adapted from Yusoff (2019) rule of thumb. Table 4 outlines the number of experts involved and the corresponding acceptable cut-off value for CVI, serving as a benchmark for assessing the validity of the module.

Table 4: The number of experts and its implication on the acceptable cut-off score of CVI

Number of experts	Acceptable CVI values	Sources
Two experts	At least 0.80	Davis (1992)
Three experts	At least 1.00	Polit *et al. (2007)*
At least six experts	At least 0.83	Polit *et al. (2007)*
Six to eight experts	At least 0.83	Lynn (1986)
At least nine experts	At least 0.78	Lynn (1986)

Source: Yusoff (2019)

The validation data were converted into binary values, with the 1–3 Likert scale ratings coded as "0" (disagree) and the 4–5 Likert scale ratings coded as "1" (agree). The CVI and S-CVI values were calculated using the following formulas:

$$\text{CVI} = \frac{\text{The expert in agreement}}{\text{The number of experts}}$$

$$\text{S} - \text{CVI} = \frac{\text{The average of CVI scores across all items}}{\text{Total of items}}$$

The CVI values are used to assess the validity and strength of the electronic topic module as evaluated by the three experts. According to the adaptation from Lynn (1986), a minimum CVI value of 0.78 must be achieved in this study before proceeding with the pilot and actual studies.

Result and Discussion

The face validity data were collected and analyzed using the CVI, with a required minimum CVI value of 0.78 and an S-CVI value of at least 0.80. The results revealed that all nine experts

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unanimously agreed on 5 items, each items achieving a CVI score of 1.00, indicating the validity can be accepted as recommended by Lynn (1986). The S-CVI value of 1.00 further confirmed that all items are acceptable and valid for use in the pilot and actual studies. Table 5 shows the module face validity results among experts.

Table 5: The Face Validity Of The Module Results

Items	Experts									CVI	Interpretation	S-CVI
	1	2	3	4	5	6	7	8	9			
Item 1	1	1	1	1	1	1	1	1	1	1.00	Acceptable	1.00
Item 2	1	1	1	1	1	1	1	1	1	1.00	Acceptable	
Item 3	1	1	1	1	1	1	1	1	1	1.00	Acceptable	
Item 4	1	1	1	1	1	1	1	1	1	1.00	Acceptable	
Item 5	1	1	1	1	1	1	1	1	1	1.00	Acceptable	

The content validity data were collected and analyzed using the CVI, with a required minimum CVI value of 0.78 and an S-CVI value of at least 0.80. The results revealed that all nine experts unanimously agreed on 5 items, some items achieve minimum a CVI score of 0.89, indicating the validity can be accepted as recommended by Lynn (1986). The S-CVI value of 0.984 further confirmed that all items are acceptable and valid for use in the pilot and actual studies. Table 6 shows the module content validity results among experts.

Table 6: The Content Validity Of The Module Results

Items	Experts									CVI	Interpretation	S-CVI
	1	2	3	4	5	6	7	8	9			
Item 1	1	1	1	1	1	1	1	1	1	0.89	Acceptable	0.984
Item 2	1	1	1	1	1	1	1	1	1	1.00	Acceptable	
Item 3	1	1	1	1	1	1	1	1	1	1.00	Acceptable	
Item 4	1	1	1	1	1	1	1	1	1	1.00	Acceptable	
Item 5	1	1	1	1	1	1	1	1	1	1.00	Acceptable	
Item 6	1	1	1	1	1	1	1	1	1	1.00	Acceptable	
Item 7	1	1	1	1	1	1	1	1	1	1.00	Acceptable	

The content validity data were collected and analyzed using the CVI, with a required minimum CVI value of 0.78 and an S-CVI value of at least 0.80. The results revealed that all nine experts unanimously agreed on 5 items, some items achieve minimum a CVI score of 0.78, indicating the validity can be accepted as recommended by Lynn (1986). The S-CVI value of 0.983 further confirmed that all items are acceptable and valid for use in the pilot and actual studies. Table 7 shows the module content validity results among experts.

Table 7: The Steps And Its Objectives Validity

Total Items	Total Experts	Interpretation	S-CVI
146 Items	9 Experts	Acceptable	0.983

Limitation and Future Studies

Although the module had been validated by experts but there are some limitations in this study. The purpose of this paper is to validate the validity of module to find the gaps of study in electronic topic. The study consists of nine experts to validate module validity which requires

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the CVI value of 0.78. The researcher suggests to validate the module more than ten experts which shows a valuable strength of module validity. The sample of using Fuzzy Delphi method of analysis needed to acquire the number of experts between 10 until 50 sample (Kadir et al., 2023; Abdullah and Othman, 2023; Yusoff et al., 2021). This would give more accuracy in validation and various kind of comments and opinions to enhance the quality of the module. This module is limited which focuses on electronic topic in D&T subject to enhance the use of sensory effects such as audiology, visualisation and kinaesthetic of students during T&L session. Therefore, the researcher suggested that the module can be used by other user as well which have relation to electronic, microcontroller and programming language. Other than that, the reliability of the module has not yet to be discovered by researcher as well as its impact, usability and effectiveness. Thus, the module needed to find the module reliability, impact, usability, and effectiveness in future studies.

Conclusion

The conclusion of this study is to examine the module validity which integrated the use of 2D simulation and AR in electronic topic. The module is designed and developed with three theories which are Flipped Classroom, Multisensory, and CTML. This would reduce the cognitive loads of students which could increase their sensory effects such as audiology, visualisation and kinaesthetic of students during T&L session. The steps of module validity were conducted with the guidance from Noah and Ahmad (2005) which helps the researcher to validate the face, content, and steps and its objectives module validity. This would enhance the quality of the module that helps students to understand with interactive and enjoyable module environment. Research findings indicate the module validity for students and teachers is to find out whether it is suitable for students and teachers during T&L sessions. All of the items are validated and accepted by nine experts with a minimum value of CVI, 0.78 and S-CVI, 0.983. Thus, the items are acceptable and valid to be used in the study, Therefore, the objective of the study which is to validate the module had been achieved. In future studies, the researcher can find the reliability, usability, impact and effectiveness such as motivation, and interests of the module among students or teachers.

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