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Maisarah Abdul Rahman
Universiti Kebangsaan Malaysia, Malaysia

Mohamad Shanudin Zakaria
Universiti Kebangsaan Malaysia, Malaysia

Rosseni Din
Universiti Kebangsaan Malaysia, Malaysia

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Design Learning Module Fundamental of Computer Science: Evaluation of Content Validity

Maisarah Abdul Rahman, Mohamad Shanudin Zakaria, Rosseni Din

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Abstract

The visualization concept and multimedia is commonly used in designing various learning methods in education. However, less study was conducted for Fundamental of Computer Science (FCS) subjects especially in STEM education approach. Therefore, this study aims to evaluate the content of design learning module for the subject of secondary two-topic Algorithms. The study uses a qualitative approach by interviewing five experts with related educational background to validate the content of the module. The findings show positive responses from those experts regarding applied visualization and multimedia suggesting some modifications be done for teaching and learning environment in the future. In conclusion, this study conclusively improvises design learning module for FCS subject by enhancing STEM education aligned with the Malaysia Education Blueprint 2013-2025.

Introduction

Our world today is based on technology and information. Thus, the rapid development of technology and information required substantial knowledge and skill workforce in the field of STEM. Therefore, subjects like Technology Design (TD) and Fundamental of Computer Science (FCS) are adapting STEM education skills formally (UMP, 2019). Computer science subject has long been introduced at the university level as a technology field subject. Thus, the Ministry of Education (MOE) Malaysia has introduced FCS for its secondary school level as first step to form the younger generation literacy. This initiative is expected to create a generation with excellent information technology knowledge and contribute to the progress of the country (Helyawati et. al, 2018). This initiative tends to expose students to digital technology skills such as coding, algorithms, and problem solving that replaced the previous ICT Literacy (ICTL) subject. Subsequently, the action cultivates students' interest and facilitates them in learning computer science courses at the university level.

Literature Review

STEM education is well-known discipline in most countries (Brigid et. al, 2019). In Malaysia, Ministry of Education (MOE), Ministry of Higher Educational (MOHE), and Ministry of Science, Technology and Innovation (MOSTI) are three main collaborative government agencies that work together in improvise STEM

education. The collaboration of these agencies created a sustainable transformation of the country's education system and produced an action plan known as Malaysia Education Blueprint 2013 – 2025. This strategic education planning was drafted by the Ministry of Education in 2013 as guidelines of enhancing education quality in Malaysia. STEM education was identified as one of the important agendas in determining Malaysia's future education.

The term STEM education refers to teaching and learning in the fields of science, technology, engineering, and mathematics (CRS, 2018). Meanwhile Moore et. al (2014) defined integrated STEM education as "an effort to combine some or all four disciplines of science, technology, engineering, and mathematics into one class, unit, or lesson that is based on connections between the subjects and real-world problems". The Ministry of education (MOE) also has designed a special teaching and learning strategy known as the STEM approach for these subjects. STEM approach also refers to teaching and learning strategy that involving the application of knowledge, skills, and values of Science, Technology, Engineering, and Mathematics integrated in manner to solve problems regards to context of daily life, community, and environment (Edy Hafizan et. al, 2017). The integration of these fields make it possible to practice the learning of STEM skills such as science exploration, analyst mathematics, and innovation of engineering with technology use (Maisarah et. al, 2020).

The innovation requires expertise and skills within the STEM advocators to deal with the demand of the Industrial Revolution 4.0. Consequently, students must be able to adapt significant proficiency skills for 21stcentury learning process. Therefore, MOE suggests a study to increase students' interest through new learning methods and techniques while improving the quality of the curriculum. The emphasis is on high-level thinking will further attract students to get involved in STEM curriculum. However, there is a widespread concern that STEM has not been a popular choice amongst secondary and tertiary level students. We are seeing a steady decline in student's engagement in STEM each year. This is due to the ineffective and unattractive learning tools (ICT), teaching and learning (T&L), and learning strategies adopted. Based on previous studies and ongoing research, the usage of visualization concepts and multimedia could help in improvising an education learning and teaching process (Mastura et al. (2017). The concept symbolizes an idea that may be described in certain terms or word in developing a new structure of ideas. Meanwhile, visualization is a type of mental picture that helps a person to understanding and generating communication ideas more efficiently. Thus, visualization works based on how humans think and process the information they gained.

Souad (2018) in his study stated that visualization is related to memorability, which makes easier to remember and meaningful. Meanwhile, Elif et al. (2018) suggested three objectives related to visualization for education which includes (i) teachers need to know the main features related to the concepts found in visualization and how to draw students attention to the matter; (ii) teachers need to know how to attract meaningful integration between students' knowledge and their efforts with appropriate strategies; and (iii) teachers need to know how to assess students understanding of conceptual targets and find out what is lacking regarding what knowledge students can learn. Based on the literature review, many researchers believe that applying visualization can increase interest and facilitate students to learn more on problem-solving. Therefore, by applying visualization concepts in design learning module, it may improvise the learning process in a fascinating way to understand the

concept. As claimed by Mike Stief (2019), visualization effectively changes the way teaching and learning processes are taught and improves the quality of teaching. Nevertheless, visualization can also improve problem-solving skills whereby students showing an effective change through applying visualization. Students experience positive changes and efficiency using visualization methods in understanding problems. Besides, this method successfully helps students create and explain the concepts more systematically (Fuchsova et al., 2019; Kyvete et al., 2017). This method also helps generate creativity and critical thinking skills among students based on problem-solving question with ease (Gavita, 2016). Furthermore, a study by Maslinah (2016) concluded that the use of visualization improves student comprehension by increasing the problem-solving ability by simplifying the understanding of the subjects taught. A sample of applying visualization concepts in the module study is shown in Figure 1 below.

Figure 1. Application of Visualization Concepts in Module

The advancement in multimedia technology is currently used as mechanism to interpret the visual design concept of the STEM subject module. Multimedia derived from the combination words of "multi" and "media". "Multi" means many, while "media" means source or place to deliver the information. The definition of multimedia in computer context is a combination of multiple media such as text, sound, image, video, and animation by using tools that allow them to create, interact, and communicate (Hofstekter, 2012). The use of multimedia technology is well received by many people and is widely used in many areas, particularly in education. Halah & Patrick (2015) claimed that multimedia tools are the best way to increase student performance and motivation to learn by encouraging discussion, collaboration, problem-solving, and innovation, promoting cognitive processes, and constructing knowledge. Both researchers urged to consider the implications of multimedia for preparing teachers in the proper ways to embed 21st-century skills in their lessons and integrated multimedia tools. In 1997, Richard E. Mayer had created a new design learning module using multimedia which is known as Mayer's Cognitive Theory Multimedia Learning. Figure 2 shows a conceptual model of this theory.

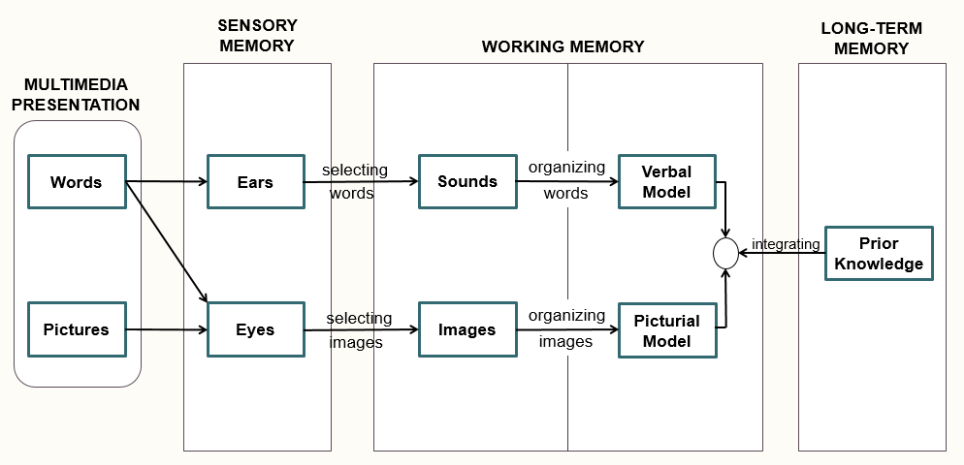

Figure 2. Mayer's Cognitive Theory of Multimedia Learning

By referring to the theory flow, this conceptual model is using multimedia presentation in designing the learning module . With the combination of media, the module becomes more attractive cognitively for learning purposes. A sample illustration of using of multimedia in design learning module is further describe in details as shown in Figure 3.

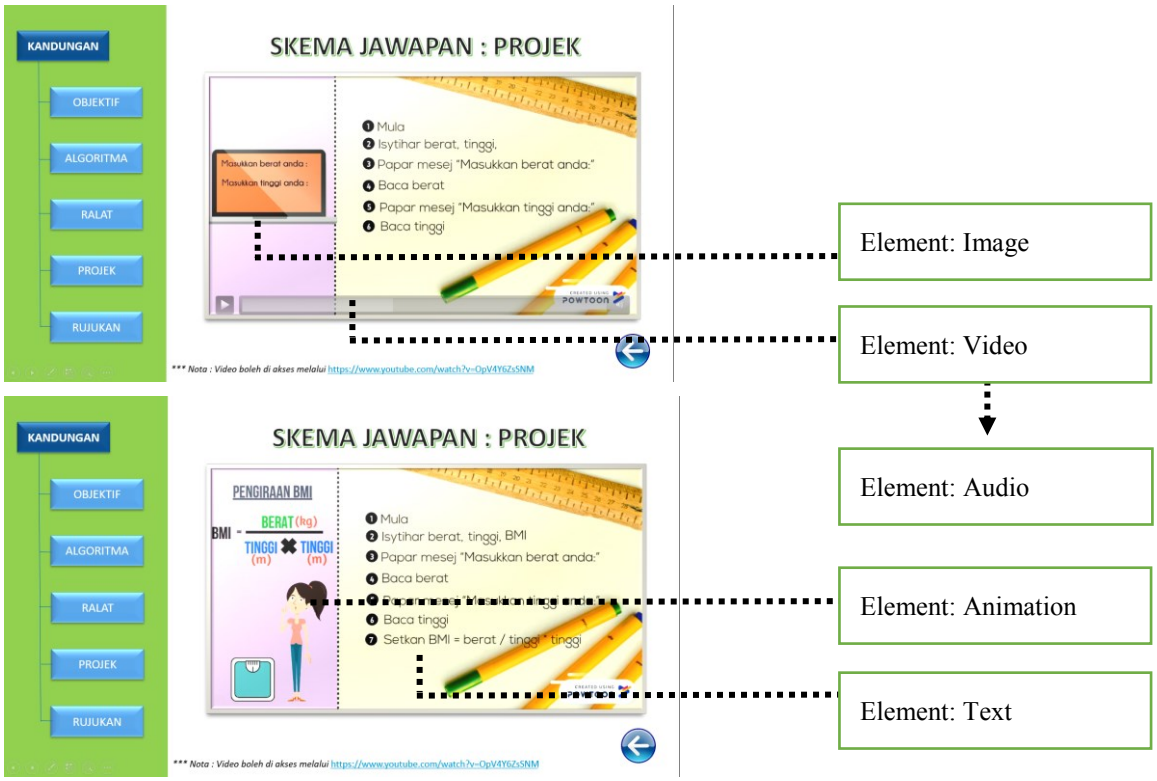

Figure 3. The Use of Multimedia

Therefore, the research was conducted to create a new design learning module by applying visualization concepts using multimedia as a new technique of learning to gain student's attention during the teaching and learning process. This module was able to gain students' attention and comprehension of a concept. This make it relatively ease and attractive enough to make them continuing learning the subject. The outcome of this study

can provide a basis for the development and improvement of other STEM subjects'. Nevertheless, a new design learning module subjects using the STEM approach must meet the the Ministry of Education (MOE) requirements and objectives. This study also draws the importance of STEM engagement in enhancing the quality of education and supporting knowledge economy.

Fundamental of Computer Science (FCS) subject

The importance of the FCS subject as main driver of the country's digital economy as computational thinking and computer science are closely related to the era of the digital economy (MStar, 2017). The goal of this subject is to provide students with computational thinking knowledge and skills (Dokumen Standard Kurikulum dan Pentaksiran, 2016). These skills can embed students with the basic knowledge and skills of computer science. The skills include programming and algorithms to produce students who are creative, innovative, dynamic, and practicing ethical in Information and Communication Technology (ICT).

Computational thinking is defined as the ability to understand and apply the basic principles of computer science. Subsequently, problem-solving methods are translated into forms that can be implemented effectively using computer-based solutions. In computational-thinking producing, students are competent in problem solving, design systems, and understand human behavior. There are several objectives of FCS subject namely (i) organize, analyze and present data or ideas logically and systematically; (ii) use, detect, and correct algorithm and program errors using computational logic and thinking; (iii) solve complex problems through computational thinking using computer-based solutions; and (iv) apply computer knowledge and skills ethically, prudently and responsibly. The algorithm is one of the topics in FCS secondary two subjects and becoming subjected material in designing FCS learning modules.

According to Dokumen Standard Kurikulum dan Pentaksiran (2016), there are three learning objectives for this topic (i) students can write pseudocode and draw a flow chart using a repeat control structure (for, do-while) and nested option control structure in problem-solving; (ii) students can detect and correct errors from pseudocode and flow chart in problem-solving, and (iii) solve problems using sequences and flow charts by combining various control structures. There are many design learning modules used for other STEM education. However, lower numbers of research for FCS subject identified following the standard implementing of STEM approach. To conclude, this study is meant to propose a new design learning method applied to the teaching and learning process for school students.

Method Research Design

This research study utilized a qualitative approach. Findings from previous studies found each of the multimedia modules quality needs to be evaluated and verified. Mohd (2004) suggested measuring the content validity of an instrument or a module, and experts' views. The most important process in determining the validity of a module is before execution stage in which feedback or responses of the module users may be observed. The main goal of conducting content validity for this research is to gain an expert's opinion regarding the FCS module to meet

a quality standard of STEM approach and to improvise the module. This research is not suitable to be evaluated based on usability and reliability. It only focuses on the suggestion of a prototype product design learning module based on the contents of the module. A well-structured question for interview was prepared to meet the objective of the research. There are six items to be evaluated for this learning module which includes

(1) use of visualization concept,
(2) use of multimedia,
(3) STEM approach,
(4) subject content,
(5) relevance, and
(6) suggestion and improvement.

Participants

Five respondents were selected to evaluate the validity of this learning module. Evaluating the content of the design learning module for subject Fundamental of Computer Science requires an expert within computer educational background. The respondents involved in this study were an educator with more than 10 years of teaching experiences and knowledgeable in computer science subjects. All respondents workplace was located in Selangor region. Thus, the information of each expert can be viewed in Table 1. The Table 1 below shows the total numbers of experts involved in this study

Table 1. Expert's Profile

Expert Code	Position	Expertise	Experience (Year)	Working Place
E1	Teacher	Fundamental of Computer Science	10	*SMK Bandar Tasik Kesuma, Selangor*
E2	Teacher	Fundamental of Computer Science	11	*SMK Bandar Rinching, Selangor*
E3	Lecturer	Computer Science	13	*KPM Beranang, Selangor*
E4	Lecturer	Computer Science	16	*KPM Beranang, Selangor*
E5	Teacher	Fundamental of Computer Science	20	*SMK Engku Husain, Selangor*

Data Collection and Analysis

The research was conducted in Selangor state of Malaysia. There are five experts involved in this study and six questions have been asked to each respondent. Data collected from each expert's give valuable feedback based on the sample dialogue provided on results and discussion. Before carrying an interview session with each expert, a researcher has provided an interview questions related to the study. During an interview session, all the

input data was written down and recorded using the researcher's headphone. Once the interview is done, a researcher will reconfirm the feedback given by experts to ensure the credibility and validity of the data.

The content analysis is used to analyze the outcome of collected data. This method is most suitable for text data. When data analysis process began with the researcher transcribing the interview recordings and sorting the data by category based on the data acquisition. Next, the coding process is performed. Coding is the process of organizing the text data before making it meaningful or segment of information (Rossman & Rallis, 1998). Thus, the data obtained are classified into code segmentation based on keywords, word, or a statement that have the specific meaning.

Results and Discussion

The findings from the interviews have been recorded and documented. Figure 4 shows a sample of design learning module for FCS subject

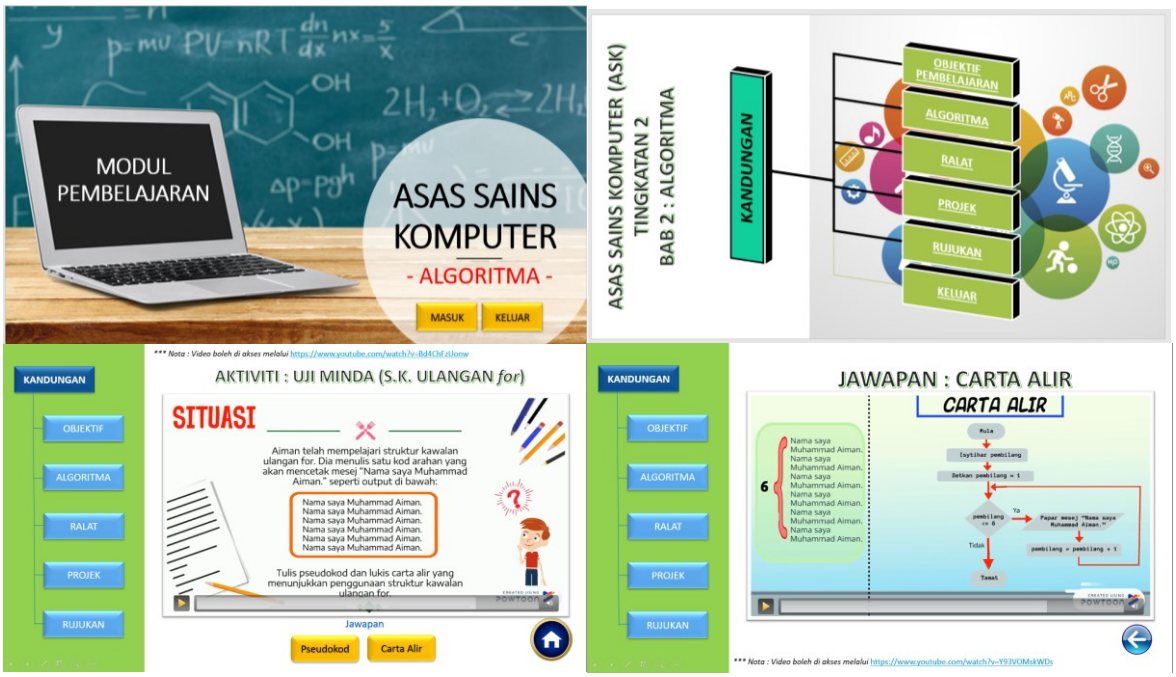

Figure 4. Sample of Learning Module

In this part of study, each question was classified into categories in order to analyze the expert's opinion regarding design learning module development. Based on the results, some experts have agreed in responses regarding the module. However, some experts have their own concepts and concerns regarding the module. The details of expert's opinions can be viewed on research findings.

Views about the Visualization Concepts

The first question is about an opinion of the use of visualization concepts in this module. Based on discussion with experts, most of them agreed on design learning module should be applied and used visualization concepts.

This can be seen clearly where experts are impressed with the use of visualization concepts from the experts view below:

> The visualization concept is suitable for students because it helps in providing a meaningful understanding. [E1]
>
> Ok…it's relevant and attractive. [E2]
>
> Ok. It's good. The concept helps in ease students to do a flow chart and pseudocode. Meet the objective of the FCS subject. [E3]
>
> Interesting…and it's great to use this kind of concept. More reliable for a student to understand and memorize. [E4]

Beside implemented visualization concepts in design learning module, the experts also shows an enthusiastic expression when they have seen the use of visualization concepts applied in design learning module to help improve student understanding. The comments from the experts can be seen as positive gestures when the experts used the words 'attractive' and 'interesting'.

Views about the Use of Multimedia

The second question regarding the expert's opinion about the use of multimedia in the module. All of the experts agreed that usage of multimedia in the module was appropriate. Additional suggestion is given that it can be improvise in the future to be more user-friendly for end-user. Some samples regarding expert's opinions about the use of multimedia include:

> It's appropriate with video features which give convenience and attractive. [E1]
>
> The content follows the topic. However, the flow chart and pseudocode need to be split so that the students can view and do a comparison. [E2]
>
> The use of multimedia in this module is satisfied. [E3]
>
> Based on the use of multimedia it's really attractive….it's great with the features of animation, video….so the students won't easily get bored during learning. [E4]
>
> The use of multimedia in the learning process nowadays is common. From what I see, all those elements of multimedia have been used in moderation and need an improvement that can suit the topic….and I guess the students will have difficulties understanding the slide if you're not showing the flow. [E5]

Based on experts' view regarding the use of multimedia, this element can to be improved in the future in order to make the module more outstanding and attractive. This finding concluded based on experts' comment that the use of multimedia in this design learning module in moderate level and can be improvise.

Views about the Following Guideline of STEM Approach

The third question is about expert opinion regarding the module following the STEM approach. This question was asked to make sure this module meets the expectation and guidelines based on MOE standards. Most experts agreed this module followed a STEM approach:

All these points are there. [E1]

Yes, based on the exercise given. [E2]

Yeah, it's there. All these activities meet the STEM approach. [E3]

I'm not an expert in this part…yet when I go through from the flow… those points follow the STEM approach and related to all activities provided. [E4]

Regarding for this question, experts have checked and verified the content of this module do followed STEM approach. They agreed the content is relevant and exercise provided follows standard of STEM approach.

Views about the Content Following a Standard of Topic

The fourth question is regarding the content of the module based on the standard of the topic. To checked whether the contents of this module are appropriate and following the topic, a researcher had asked questions on content complying to this study. All of the experts agreed the content is relevant to the research module topic:

It does comply with the requirements. [E1]

The content is right. [E2]

So far the contents followed the topics. [E3]

For me, it's ok. It's followed the standard for the student school. [E4]

Yes…but please check back the objectives of learning and ensure to follow the syllabus standard for this topic. [E5]

From this feedback, most of the expert's was satisfied with the contents based on the response using such as words 'yes , 'ok', and 'right'. Based on the content provided in the module, they agreed that contents do follow the standard. However, additional comments given by experts E5 need to be noted by the researcher. This is to assure and checked the content follow the syllabus standard to avoid any irrelevant contents.

Views about the Element Been Used is Helpful

The fifth question is regarding the elements used in this module and its helpful in terms of easy to understand and interesting. This question is seeking expert's opinion on whether this module could attract student to focus during the teaching and learning process. Most experts gave good feedback regarding this question based on their respective opinions:

It's appropriate to use this concept because it interesting and attractive. [E1]

Acceptable and attractive. [E2]

Yes. I agree with this. [E3]

It's convenient and interesting. [E4]

It's really helpful in meaningful understanding for the student and can attract student attention….yet in my opinion need a lot of improvement to make this module more interesting especially for the content parts. [E5]

For this question, the expression of each expert's is capture based on observation of their body language. This is quite convincing by looking on expert's feedback regarding the question. The expert's impression of excitement and delightful are seen while they viewing the module. It can be concluded that experts were satisfied with the use of visualization concept and multimedia in the learning module. The experts also stated the words 'interesting', 'attractive', 'helpful', and '…can attract student attention...'.

Views about the Suggestion for Improvement

The last question is seeking requests an opinion or suggestion for improvement of design learning module. This question is to ask for any improvement that can be done to improvise this design learning module. Here are some suggestions for future study of this research topic:

> It will be helpful to provide an introduction note as a revision before doing an exercise… [E1]
>
> As I told before, I do prefer if you can refer to the DSKP book rather than the textbook because the content is more informative. [E2]
>
> I suggest providing an exercise that can relate the use of the algorithm in real life. For example….maybe a simple calculator exercise [E3]
>
> For the content, I do prefer if the activities made using analogies…which mean, you can try to use 11 other condition rather than following the textbook. [E4]
>
> Those activities you have done are good so far by following the real topic standard…. As I mentioned before, you can refer to DSKP state the details and terms that been uses for FCS subjects… [E5]

Based on comment and suggestion from experts, it can be concluded that expert 1 (E1), expert 3 (E3), and expert 4 (E4) opinions focus on revision and emphasis more on learning exercise module. Expert 1 suggests adding an introduction or review note before started the exercise as a mechanism of revision for students. Expert 3 and expert 4 have same opinion on content of exercise be related to daily life rather than referring solely to textbook. For experts 2 (E2) and expert 5 (E5) opinions are more focusing on following guideline from Dokumen Standard Kurikulum dan Pentaksiran (DSKP) to meet the Ministry of Education (MOE) standard. Overall, most of the experts agreed that application of visualization concepts and multimedia in the module have attracted students to study and enhanced learning in a fun environment.

To summarize, experts' views and opinions are very helpful in producing a quality module, standardized content, and learning standards set by MOE. As the progress of developing a new design learning module is concerned, three main criteria are to be considered. They are

(1) the learning module must be relevant with educational standard,

(2) the content must be validated by experts in order to produce an acceptable module and

(3) the module meet the requirement for learning and teaching environment.

In conclusion, this study proven it is important that every module construction needs to be taken seriously and developed based on the standards set in educational standard, following proper guidelines, and not just producing module without additional values for the contents.

Conclusion

STEM education is becoming an important field of study in many developing countries. To attract more people to get involved in a STEM education, it's should start with evaluating teaching and learning process in current learning environment. The significance of this study as supporting our vision of enhancing the quality of education, as outlined in the Malaysia Education Blueprint 2013-2025. With innovation ideas, such as applying visualization concepts and multimedia in learning module helps to enhance the quality of STEM education. Consequently, each module must follow the objectives set in learning development process. Therefore, evaluation on module content validity process is required and important to make sure final module produced meets the standard and requirement of learning objectives. The evaluation process is also an important element to determine the validity of the module tested before officially uses by the teachers and students. There a many available learning module for education purposes but only few found complying to the requirement standard especially in meeting learning objectives. In conclusion, the research of design learning module need to improvise in depth details for improving STEM education.

Future Study

A suggestion for future study is needed to further improve the outcome of learning module in education. The evaluation based on content validation has been done with experts to get a better-quality prototype module input. One suggestion by expert is to create the module by using powerful apps software for editing. This could help in enhance the visual capabilities and presentation to attract learning process. Other, improvise with additional of sound narrator can manage this technology in providing a navigation or interaction with audience for clear instruction so that audience would alert. Based on suggestion from expert (E5), learning module need to be revised and ensure the contents is following the topic standard including formatting, codes, numbers and correct terms used in the module. By improving the content based from comments given by the experts, this module can proceed to higher development stage of module where any shortcomings can be upgraded by conducting new research. The findings through this manuscript are based on usability and reliability of the module and become reliable results as shown by strengthening and validating the use of visualization and multimedia concepts in the FCS. Subsequently, reliable learning module meets the needs of students, teachers, and MOE to attract students' attention. In conclusion, the research of design learning module need to improvise in depth details for future of STEM education by enhancing its contents and overall teaching and learning process.

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Author Information

Maisarah Abdul Rahman
https://orcid.org/0000-0001-6500-8060
Faculty of Information Science and Technology
Universiti Kebangsaan Malaysia
Malaysia
Contact e-mail: *p83521@siswa.ukm.edu.my*

Mohamad Shanudin Zakaria
https://orcid.org/0000-0001-6277-9003
Faculty of Information Science and Technology
Universiti Kebangsaan
Malaysia

Rosseni Din
https://orcid.org/0000-0002-0851-9910
STEM Enculturation Centre, Faculty of Education
Universiti Kebangsaan Malaysia
Malaysia