INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 14, Issue 8, (2024) E-ISSN: 2222-6990

Development and Evaluation of Let's Explore Micro: Bit (LEM) Module For Design and Technology Teachers in Primary Schools

Ivy Ting Wei Wei, Aidah Abdul Karim

Faculty of Education, Universiti Kebangsaan Malaysia (UKM), Bangi, Malaysia.

Corresponding Author's Email: eda@ukm.edu.my

To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v14-i8/22426 DOI:10.6007/IJARBSS/v14-i8/22426

Published Date: 10 August 2024

Abstract

Since 2017, programming has been part of the Design and Technology (RBT) curriculum in Malaysian primary schools, yet RBT teachers still lack programming knowledge. This study utilized a Design and Development Research approach to develop and evaluate the Let's Explore micro:bit (LEM) module, aiming to increase Year Five RBT primary teachers' understanding of development programming in microcontrollers. Information Processing Theory and a blended learning approach (Flipped Classroom Model) were applied in the development of the LEM module. The development process involved three experts in the areas of Design and Technology in primary schools, Technical and Vocational Education, and Information and Communication Technology while the evaluation process involved 11 RBT teachers from 9 primary schools in East Malaysia. The experts reviewed aspects such as learning outcome, content, language, application of Information Processing Theory, blended learning approach and multimedia elements. On the other hand, the teachers evaluate the usefulness, ease of use, ease of learning and user satisfaction. Data collected via Likert scale questionnaires was descriptively analyzed. The feedback from the experts indicated high agreement on each aspect evaluated for the LEM module. This study also highlighted its high usability. The finding supports the idea that employing Information Processing Theory and a blended learning approach, particularly the Flipped Classroom Model, is suitable for developing the LEM module to enhance development programming in the microcontroller knowledge of RBT teachers. It is recommended to conduct a study to assess the knowledge improvement using the LEM module.

Keywords: Module, Design and Technology (RBT), Information Processing Theory, Blended Learning Approach (Flipped Classroom Model), Experts' Review and Usability

Introduction

Design and Technology, or known as Reka Bentuk dan Teknologi (RBT) in Malay, is a mandatory subject for students in Year 4, Year 5, and Year 6 at the primary school level,

regardless of National Primary Schools (SK), Chinese National Primary Schools (SJKC), or Tamil National Primary Schools (SJKT). With the rapid evolution of technology, the revision of the Standard Primary School Curriculum (KSSR) to 2017 review (KSSR semakan 2017) aims to prepare students for future challenges and equip them with skills needed for Industry Revolution 4.0 (IR 4.0). Consequently, Design and Technology (RBT) subjects in Malaysia are being enhanced to include advanced skills such as computer programming, robotics, and Artificial Intelligence (AI) starting from Year Four onwards (Rajaendram, 2019). Upper primary students will learn about algorithms and learn to create programming projects using tools like micro:bit through the RBT subject. Ismail et al. (2022) also stress that the creation of projects within RBT lessons requires not only knowledge and skills but also a systematic step.

Despite the KSSR RBT being revised in 2017, RBT teachers continue to encounter challenges due to inadequate knowledge and skills, especially in teaching with microcontroller boards, as many are still new to this technology (Muhammad Noor & Saibon, 2023). In the same study, teachers also demonstrate limited interest in using microcontrollers during RBT instruction due to difficulties in understanding microcontrollers and software-based programming. Ajit et al. (2022) further supports this statement, stating that even with comprehensive DSKP and teaching guides provided during training sessions, teachers still lack fundamental knowledge, particularly in areas like programming. Relying solely on textbooks is not recommended for RBT teachers who have limited knowledge of programming topics. Instead, teachers require additional support such as extra modules, courses, and training sessions to enhance their understanding (Sahaat & Mohamad Nasri, 2020). Therefore, this study aimed to develop and evaluate the LEM module to increase development programming in microcontroller knowledge among Year Five RBT teachers.

Literature Review

This section explores the foundational learning theory, approach, and usability model that guided the development and evaluation of the Let's Explore micro:bit module.

Information Processing Theory

Information Processing Theory, introduced by Richard Atkinson and Richard Shiffrin in 1968, provides valuable insights into human cognition and learning, signifying a renewed interest in cognitive perspectives within the study of learning processes (Sucharitha et al., 2020). This theory is also known as the multi-store model of memory consisting of three distinct stages: sensory memory, short-term memory, and long-term memory (Atkinson & Shiffrin, 1968). Initially, sensory memory briefly processes incoming environmental stimuli (Bhinnety, 2015), typically lasting only a few seconds. If attention is given to the learning content, this information transitions into short-term memory, where it is temporarily retained for approximately one minute; otherwise, the information may decay. Repetition or rehearsal allows information to be encoded into long-term memory, facilitating retrieval later.

In educational contexts, techniques like rehearsal, visual aids, chunking, and mnemonics are employed to encode the information (Roblyer & Doering, 2013; Schunk, 2016). Rehearsal involves consciously repeating information to strengthen retention, while visuals, chunking, and mnemonics make information more accessible and easier to recall. Displacement may occur if the information is not adequately processed. Ultimately, information stored in long-term memory can persist indefinitely if retrieval occurs. To prevent loss, exercises are often provided to retrieve stored information (Richey et al., 2011). These strategies reflect the

stages of memory processing outlined in the Information Processing Theory, emphasizing the importance of attention, encoding, and retrieval mechanisms in promoting effective learning.

Blended Learning Approach

Blended learning is defined as a methodology that combines traditional face-to-face learning with online learning (Sharma, 2010). In other words, there will be an integration of the classical educational environment with another part through an online environment. The tools and technologies used in the blended approach fall into five categories: in-class technology, virtual communication tools, social networking software, e-learning systems, and mobile learning (Allan, 2007). The commonly used tools or appliances for blended learning include Telegram, WhatsApp, email, recorded audio, PowerPoint, Google Meet, Microsoft Teams, Facebook, YouTube, blog, Moodle, and Virtual Learning Environment (VLE), as well as Zoom. The usage of online learning applications proved helpful in addressing issues related to time constraints often encountered in face-to-face learning environments (Hussin & Abdul Karim, 2022). Daskan and Yildiz (2020) explained that the advantage of blended learning is that learners can customize their learning experience using technology-driven tools. Additionally, slow learners will receive hints and tasks to assist them in improving their understanding of specific topics.

Albatti (2023) adds that blended learning is famous for being flexible because you can learn wherever and whenever you want. At the same time, learning progress can also be monitored. The blended learning approach has been discovered to boost learners' skills, enthusiasm, and motivation across different subjects, such as English and Physics (Albatti, 2023; Radulović et al., 2023). Blended learning encompasses various models such as rotation model, flex model, self-blend and enriched-virtual model (Staker & Horn, 2012). Within the rotation model, there are four types: station-rotation model, lab-rotation model, flipped classroom model, and individual rotation model. The flipped classroom model requires learners to rotate according to a fixed schedule between face-to-face classes or accessing teaching materials sent online asynchronously outside the classroom (Stapa, 2018).

Usability Model

Usability evaluation is usually used in Design and Development Research (DDR) phase 3, implementation and evaluation. The usability evaluation framework by Ching Sing and Der-Thanq (2004) offers a clear guideline for categorizing the types of usability evaluation based on the involvement of three parties in the evaluation process. The three parties are: (1) the system under evaluation could be the released product, prototype, or even design document; (2) the user, who is the reason behind the product's production and (3) the evaluators who will conduct the evaluation. In other words, the roles of the three parties determine the types of evaluation methods used, namely usability test, usability observation, user retrospective and evaluator retrospective. Alias and Siraj (2013) explained that usability tests and usability observation are employed when the system is present while the user retrospective and evaluator retrospective are utilized when the system is not present.

There are lots of usability testing methods such as remote usability evaluation, co-discovering learning, performance measurement, retrospective testing, question-asking protocol, shadowing method, teaching method, rapid interactive testing and evaluation, rapid interactive testing and evaluation, field observation, questionnaires, logging actual use and interviews (Jain & Kaur, 2018). Several studies (Abd Razak, 2021; Asnawi, 2018) utilize Arnold Lund's usability model to conduct usability tests. Lund's model emphasizes a particular user's

ability in a specific context to achieve defined goals using a product or design effectively and satisfactorily. Consequently, the USE questionnaire by Arnold Lund (2001) was created, focusing on Usefulness, Satisfaction, and Ease of Use (Lund, 2001). However, the Ease of Use items are further divided into two factors: Ease of Learning and Ease of Use.

Methodology

Study Design

This study applies Design and Development Research (DDR) (Richey & Klein, 2007), which includes three stages: (1) need analysis; (2) design and development, and (3) implementation and evaluation. DDR is used in this study because this approach has a systematic procedure for developing products or tools. However, this study, only focusing the development and evaluation stage of the LEM module.

Participants

The samples involved in the development and evaluation stages are different. For the development stage, three experts are selected based on their expertise and the criteria required. The first expert is an RBT master trainer from a primary school in East Malaysia, with expertise in primary school RBT subjects. She is selected as one of the experts as she has 11 years of teaches teaching experience in the RBT subject since KSSR at Chinese National Primary School as well as her sumptuous experiences dealing with RBT teachers. Next, the lecturer from one of the Teacher Education Institutes in West Malaysia was chosen. His expertise is in Technical and Vocational Education which are closely related to RBT subjects. Recently, he has been a lecturer with a Ph.D. qualification from a public university, specializing in Curriculum Information Development (CID) for the Design and Technology Program. Additionally, he is well-versed in Technical and Vocational Education and Training (TVET) expert references. He has actively engaged in curriculum design or training module development for over 10 years and has contributed to curriculum module development within the range of 3-5 years. Finally, a lecturer from a public university is chosen because of its expertise in Information and Communication Technology. This lecturer has a connection with micro:bit Malaysia and recently actively promoted micro:bit to educators and school students. Now, she is a lecturer with a Ph.D. qualification from a public university, specializing in Software Engineering and Software Verification for 6 years.

Furthermore, the usability participants for the LEM module comprise 11 RBT teachers who actively engaged in implementing the module. They were specifically chosen from the need analysis phase due to their identified lack of understanding of the development programming in microcontrollers for Year 5 RBT. These teachers possess a Bachelor's Degree academic qualification and are teaching Year Five RBT in SJKC from one of the districts in East Malaysia in the current study.

Instruments

Two instruments were utilized in this study, one for the three experts selected and another one for 11 RBT teachers. Both instruments underwent review by content and language experts before implementation. The questionnaire for experts, comprising a total of 34 items, was adapted from previous studies conducted by Abdul Kadir (2017); Jenal (2022); Shamsuddin (2021); Subramaniam & Mahamod (2017). It encompasses six aspects: (1) learning outcome; (2) content; (3) language; (4) application of Information Processing Theory; (5) application of blended learning approach and (6) application of multimedia elements.

Conversely, the usability questionnaire for teachers, totaling 20 items, was adapted from Lund (2001), covering aspects such as usefulness, ease of use, ease of learning, and user satisfaction. A Likert 5-point scale ranging from 1 to 5 (1 - strongly disagree, 2 - disagree, 3 - somewhat agree, 4 - agree, 5 - strongly agree) was utilized in both questionnaires.

Data Analysis

The data collected from both the distribution to experts during the development stage and to teachers during the evaluation stage were analyzed using descriptive statistics. Items in the questionnaire were analyzed descriptively, calculating the percentage and mean score. The mean score was calculated using the Statistical Package for the Social Sciences (SPSS) version 27. The analysis aimed to determine the percentage for each aspect evaluated by experts in the development stage while the mean score and percentage are used to identify usability of the LEM module in the evaluation stage. This analysis was conducted to address the objectives of the study.

Results

Development of LEM module

The LEM module is developed based on the design stage which includes the findings from need analysis, content analysis of Standard Curriculum and Assessment Document RBT Year Five and textbook RBT Year Five. This led to the creation of a learning module integrating Information Processing Theory (Atkinson & Shiffrin, 1968) and a blended learning approach to enhance the development programming in microcontroller knowledge of RBT Year Five teachers. After developing the module prototype, it was evaluated by three experts in the field, considering aspects of learning outcome, content, language, application of Information Processing Theory, application of blended learning approach and application of multimedia elements.

(A) Learning outcome of Module LEM

The experts' feedback indicates that the development of the learning outcomes in the LEM Module is clear and appropriate for RBT teachers, aligning with the learning outcomes in the KSSR Review 2017. As indicated in Table 1, the percentage agreement among experts for the learning outcomes aspect of the LEM module is 100 per cent, which means it is highly agreed upon by all three experts. Figure 1 illustrates examples of one of the learning outcomes for the LEM Module.

Table 1
Learning Outcome of Module LEM

No.	Items	Percentage of expert agreement for each Likert scale					Expert Evaluation
		Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree	
1	The learning outcomes provided in each module are clearly explained.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
2	The learning outcomes stated align with the appropriateness of the module.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
3	The scope of learning for each module follows the RBT Year Five subject curriculum (KSSR Review 2017).	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
Average percentage		**0%**	**0%**	**0%**	**0%**	**100%**	Accepted

Figure 1. Example of a learning outcome in the LEM Module

(B) Content of Module LEM

The experts' consensus on the content of the developed LEM module is high as shown in Table 2. All the experts agree that the module's content aligns with Year Five RBT textbooks and is suitable for RBT teachers to master the knowledge of programming development in microcontrollers. The information presented in the LEM module is systematic, progressing from easy to difficult, easy to follow, and clear.

Table 2
Content of Module Lem

No.	Items	Percentage of expert agreement for each Likert scale					Expert Evaluation
		Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree	
1	The content of the module is based on the Year Five RBT textbooks.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
2	The information presented in the module is accurate regarding the topic of programming development in microcontrollers.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
3	The information is organized in a systematic and orderly manner.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
4	The information is structured from easy to difficult.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
5	This module is suitable for users to easily understand the concepts of programming development in microcontrollers.	0 (0%)	0 (0%)	0 (0%)	1 (33.3%)	2 (66.7%)	Accepted

6	The utilization of this module aids teachers in mastering the knowledge of programming development in microcontrollers.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
7	The content is easy to follow.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
8	The content of this module is clear.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
Average percentage		**0%**	**0%**	**0%**	**4.2%**	**95.8%**	Accepted

(C) Language of Module LEM

In terms of language, the terminology and language used in the module LEM are highly accepted by all experts. The agreement on language among experts is shown in Table 3.

Table 3
Language of Module Lem

No.	**Items**	**Percentage of expert agreement for each Likert scale**					**Expert Evaluation**
		Strongly Disagree	**Disagree**	**Somewhat Agree**	**Agree**	**Strongly Agree**	
1	The terminology used is correct.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
2	Consistent use of terminology.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
3	The use of easily understandable terminology.	0 (0%)	0 (0%)	0 (0%)	1 (33.3%)	2 (66.7%)	Accepted
4	The use of terminology appropriate for programming learning.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
5	Clear language usage.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
6	Appropriate language tone.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
Average percentage		**0%**	**0%**	**0%**	**5.5%**	**94.5%**	Accepted

(D) Application of Information Processing Theory for Module LEM

Regarding the application of Information Processing Theory, it is evident that the integration of this theory in the LEM module receives high agreement from all experts. The percentage of agreement is shown in the Table 4.

Table 4
Application of Information Processing Theory for module LEM

No.	Items	Percentage of expert agreement for each Likert scale					Expert Evaluation
		Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree	
1	The questions asked in the module can engage the mind. (Attention)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
2	The learning materials used in the module can capture attention. (Attention)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
3	Using mnemonics to facilitate information retention. (Encode)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
4	Systematically combining multiple pieces of information into larger units, known as Chunking technique. (Encode)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
5	The emphasis on information in the module is linked to existing knowledge. (Encode)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted

6	Utilizing multimedia elements to explain abstract information. (Encode)	0 (0%)	0 (0%)	0 (0%)	1 (33.3%)	2 (66.7%)	Accepted
7	The quizzes provided help reinforce the learned knowledge. (Retrieval)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
8	Hands-on exercises in the module aid in enhancing knowledge related to the topics learned. (Retrieval)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
Average percentage		**0%**	**0%**	**0%**	**4.2%**	**95.8%**	Accepted

LEM module's development is grounded in three principles from Information Processing Theory: attention, encoding, and retrieval. This module LEM consisted of three modules, namely Module 1, Module 2, and Module 3. In sensory memory, questions, images, and text are utilized to captivate the attention of the learners. Upon reaching working memory, techniques such as relational strategies, mnemonics, and chunking are employed to facilitate the transfer of information into long-term memory. Finally, exercises such as quizzes and hands-on activities enable retrieval to occur, thereby enhancing knowledge for the development programming in microcontrollers among RBT teachers. Table 5 provides an example from Module 1 that demonstrates the application of key principles from Information Processing Theory, including attention, encoding, and retrieval.

Table 5
Application of Information Processing Theory in Module 1 of LEM Module

Principles of Information Processing Theory	**Example**	**Description**
Attention		Questioning and the use of multimedia elements such as images and text are employed at the beginning of Module 1.
Encode		An example of emphasizing MakeCode software by relating it to Scratch software.
		The Chunking technique is used to transform data into easily remembered units.
Retrieval		Some quiz given through Edpuzzle application in Module 1.

(E) Application of blended learning approach (Flipped Classroom Model)

All experts unanimously agreed that the blended learning approach, specifically the flipped classroom model, has been successfully integrated into the LEM module. The perfect percentage for the application of the blended learning approach (Flipped Classroom Model) is illustrated in Table 6.

Table 6
Application of Blended Learning Approach for module LEM

No.	Items	Percentage of expert agreement for each Likert scale					Expert Evaluation
		Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree	
1	The technology tools used are appropriate for the content of the module.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
2	Sharing the developed module through the link Google Drive and Telegram application is appropriate.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
3	The developed module is suitable for a learning process that integrates both face-to-face and online methods.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
4	The online module through Edpuzzle application allows for the learning of microcontroller programming knowledge to be studied beforehand.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
5	The face-to-face module	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted

	enables practice to be conducted under the guidance of the main trainer.						
Average percentage		**0%**	**0%**	**0%**	**0%**	**100%**	Accepted

In this study, the flipped classroom model was chosen to develop the LEM module. Programming learning among the study participants lasted approximately three weeks, with the first and second weeks conducted online and the third week conducted face-to-face. Before the sessions resumed, the module link was shared via Google Drive through Telegram. Participants learned theory related to features of MakeCode software and hardware programming components online using Edpuzzle. During the third week, face-to-face sessions incorporated the use of PowerPoint slides to demonstrate hands-on activities involving MakeCode software and Microbit. Telegram will be utilized throughout the three weeks period to facilitate communication and resource sharing among participants. Figure 2 and Figure 3 show how the flipped classroom model is used in module LEM.

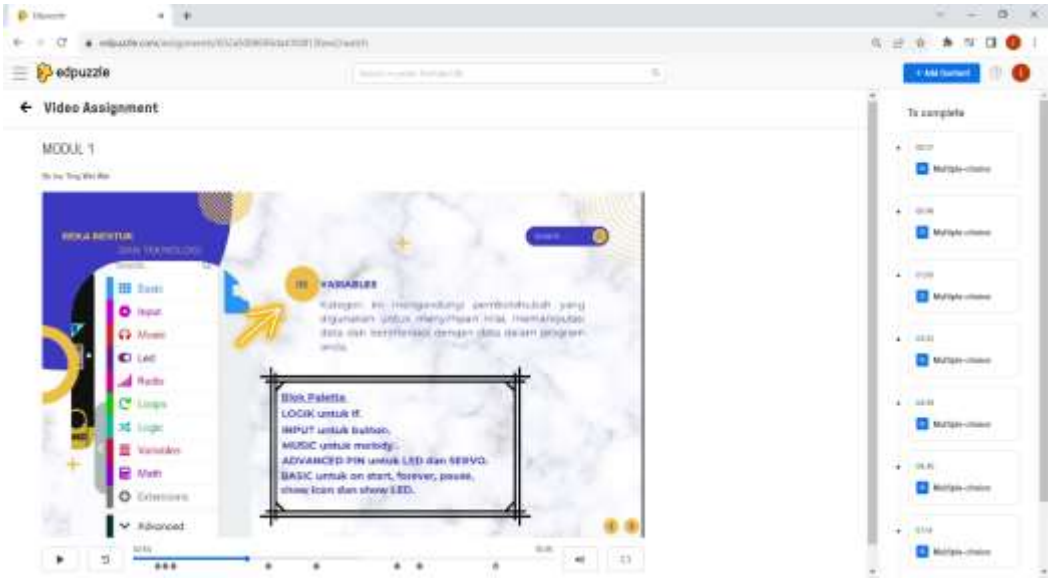

Figure 2. Learning online through Edpuzzle

Figure 3. Face-to-face learning through workshops using PowerPoint slides

(F) Application of multimedia elements

The development of the LEM module involves the utilization of multimedia applications such as Canva and PowerPoint. The consensus among experts, reflected supports the use of these multimedia elements such as images, audio, video, and text in the LEM module as shown in Table 7.

Table 7
Application of Multimedia Elements For Module Lem

No.	Items	Percentage of expert agreement for each Likert scale					Expert Evaluation
		Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree	
1	Application multimedia such as Canva, and PowerPoint slide have been integrated into the learning materials.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
2	Multimedia-based learning materials are suitable and helpful for the learning process.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
3	The quality of multimedia such as images, audio, video, and text are clear.	0 (0%)	0 (0%)	0 (0%)	1 (33.3%)	2 (66.7%)	Accepted
4	Multimedia elements can facilitate understanding of the lesson content more easily.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	Accepted
Average percentage		**0%**	**0%**	**0%**	**8.3%**	**91.7%**	Accepted

Across all six dimensions mentioned, the module was highly accepted by all the experts. The minimal difference between the minimum and maximum percentage values also suggests that there are no significant discrepancies among the experts' assessments.

Let's explore micro:bit (LEM) Usability

The usability of LEM was carried out using USE instrument (Lund, 2001) covering aspects of usefulness, ease of use, ease of learning, and user satisfaction among end users. The USE instrument has been adapted to suit the context of this study. 11 RBT teachers responded to the questionnaire after completing the module using the flipped classroom model. The aspects of usability and their respective percentage and mean scores are presented in Table 8.

Table 8
Usability of Module Lem

No.	Items	Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree	Mean Score
Usefulness							
1	This module has helped me enhance my knowledge of microcontroller programming development.	0 (0%)	0 (0%)	0 (0%)	4 (36.4%)	7 (63.6%)	4.64
2	This module enables me to apply my knowledge of microcontroller programming development to real-world scenarios.	0 (0%)	0 (0%)	0 (0%)	6 (54.5%)	5 (45.5%)	4.45
3	This module is suitable to use as a reference material for the topic of microcontroller programming development.	0 (0%)	0 (0%)	0 (0%)	4 (36.4%)	7 (63.6%)	4.64
4	This module facilitates self-learning for me about microcontroller	0 (0%)	0 (0%)	0 (0%)	7 (63.6%)	4 (36.4%)	4.36

	programming development.						
5	This module contains audio-visual materials that facilitate my understanding of the topic of microcontroller programming development.	0 (0%)	0 (0%)	0 (0%)	4 (36.4%)	7 (63.6%)	4.64
6	This module saves me time in learning about microcontroller programming development.	0 (0%)	0 (0%)	0 (0%)	4 (36.4%)	7 (63.6%)	4.64
Average		**0%**	**0%**	**0%**	**44.0%**	**56.1%**	**4.56**
Ease of Use							
1	The steps for using this module are easy to follow. (user-friendly)	0 (0%)	0 (0%)	0 (0%)	6 (54.5%)	5 (45.5%)	4.45
2	This module is flexible for use in learning sessions.	0 (0%)	0 (0%)	0 (0%)	5 (45.5%)	6 (54.5%)	4.55
3	I find that the language and terminology used in this module are consistent.	0 (0%)	0 (0%)	0 (0%)	6 (54.5%)	5 (45.5%)	4.45
4	Personally, I like this module.	0 (0%)	0 (0%)	1 (9.1%)	4 (36.4%)	6 (54.5%)	4.45
5	I can use this module throughout the learning session.	0 (0%)	0 (0%)	0 (0%)	6 (54.5%)	5 (45.5%)	4.45
Average		**0%**	**0%**	**1.8%**	**49.1%**	**49.1%**	**4.47**
Ease of Learning							
1	I know how to use this module quickly.	0 (0%)	0 (0%)	1 (9.1%)	6 (54.5%)	4 (36.4%)	4.27

2	The procedures in this module are easy to learn.	0 (0%)	0 (0%)	1 (9.1%)	5 (45.5%)	5 (45.5%)	4.36
3	I am proficient at quickly using this module.	0 (0%)	0 (0%)	1 (9.1%)	8 (72.7%)	2 (18.2%)	4.09
Average		**0%**	**0%**	**9.1%**	**57.6%**	**33.4%**	**4.24**
Satisfaction							
1	I am satisfied with using this module.	0 (0%)	0 (0%)	0 (0%)	3 (27.3%)	8 (72.7%)	4.73
2	I will recommend this module to my friends.	0 (0%)	0 (0%)	0 (0%)	2 (18.2%)	9 (81.8%)	4.82
3	I enjoy using this module.	0 (0%)	0 (0%)	0 (0%)	2 (18.2%)	9 (81.8%)	4.82
4	This module functions as I desire.	0 (0%)	0 (0%)	0 (0%)	3 (27.3%)	8 (72.7%)	4.73
5	I feel that I need to own this module.	0 (0%)	0 (0%)	0 (0%)	4 (36.4%)	7 (63.6%)	4.64
6	The use of this module makes my learning easier.	0 (0%)	0 (0%)	0 (0%)	3 (27.3%)	8 (72.7%)	4.73
Average		**0%**	**0%**	**0%**	**25.8%**	**74.2%**	**4.74**

The overall average usability score for the LEM module is high, at 4.50. Table 8 summarizes the average mean score for usability analysis across the four aspects studied. The usefulness aspect shows a high score of 4.56, followed by ease of use aspect with 4.47, and the ease of learning aspect with a score of 4.24. Furthermore, the satisfaction aspect exhibits the highest average score among all aspects studied, which is 4.74. Therefore, it can be concluded that teachers have achieved high satisfaction with the LEM module.

Discussion

Module development emphasizes the importance of various elements such as learning outcomes, language usage, content and multimedia elements in the learning process. This statement is supported by research from Nursuhud et al. (2019) and Basuki (2022). According to Nursuhud et al. (2019), expert evaluation of the module, including learning objectives, content presentation and language has been shown to enhance learners' motivation. On the other hand, Basuki (2022) also points out that the evaluation of learning materials and assessment applications like interactive questions or quizzes is an essential aspect of education to measure mastery levels at the end of learning activities. Multimedia applications like Canva and PowerPoint (Arya Wirawan et al., 2022) in module development have proved to increase learners learning outcomes. Besides that, the integration of Information Processing Theory and the Blended Learning approach into module development has resulted in positive outcomes in the learning process. Haji (2022) and Syamsi and Suryanda (2023) agreed that learners can engage with each other through the blended learning approach, which also enables access to class materials without limitations of time or location. Besides that, mnemonic techniques in Information Processing Theory enable the effectiveness of practice in handling additional learning tasks (Liu et al., 2020) and aid in knowledge retention (Kakharov & Azizov, 2022). Humphries and Clark (2021) strongly endorse the chunking technique, asserting that it improves learners' attention to tasks, thereby increasing their engagement. Furthermore, Abd Razak (2021) applied the USE instrument by Lund (2001) in the research to evaluate the usability of the module developed focusing on three aspects, usefulness, satisfaction, and ease of use. The GIFTED module in the research demonstrates a medium-high level of usability for the GIFTED module. However, the USE questionnaire used in Asnawi (2018) revealed that the Google Classroom application used for e-learning received a poor usability rating, specifically in the aspects of ease of use, ease of learning and satisfaction.

In short, this study has a significant impact on teachers, schools, and curriculum developers. With this module, the knowledge of RBT teachers for development programming in microcontroller topics can be enhanced. This study also brings attention to school leaders regarding the knowledge deficiency among RBT teachers in programming, prompting them to consider the LEM module as an initiative. Curriculum developers can review the RBT curriculum to align it with the existing knowledge of RBT teachers. For future recommendations, conducting a study to evaluate the effectiveness of the LEM module in increasing development programming in microcontroller knowledge among Year Five RBT teachers would be beneficial. The researcher could focus on assessment and evaluation methods which include formative and summative assessment techniques, as well as the use of rubrics or portfolios to measure teachers' progress and mastery of the learning outcomes outlined in the LEM module.

Conclusion

Previous research indicates that teachers often lack knowledge of programming topics covered in the Year Five syllabus. In response to this gap, the DDR approach is used to develop and evaluate the Let's Explore micro:bit (LEM) module to enhance teachers' understanding of development programming in microcontrollers. The module underwent review by three experts in relevant fields, who expressed high agreement regarding its learning outcome, content, language, application of Information Processing Theory, blended learning approach and multimedia elements. Besides, the results showed that the LEM module received high usability ratings across aspects of usefulness, ease of use, ease of learning, and user satisfaction. These finding reinforces that the application of Information Processing Theory and a blended learning approach, particularly the Flipped Classroom Model is appropriate for the development of the LEM module. Therefore, it can be concluded that this module is suitable for use by RBT teachers seeking to improve their programming knowledge. Undoubtedly, these findings have a direct impact on teachers, especially Year Five RBT teachers, as well as schools and curriculum developers for primary schools.

Corresponding Author
Aidah Abdul Karim
National University of Malaysia
Email: eda@ukm.edu.my
Faculty of Education, National University of Malaysia, Selangor, Malaysia

References

Abd Razak, A. Z. (2021). *Development and Usability of Gifted Physchoeducational Module among gifted and talented students* [PhD]. Faculty of Education, UKM.

Abdul Kadir, K. (2017). *The development and evaluation of science teaching module (E-smart) based on constructivist approach for instilling creative thinking skills in form two students* [PhD]. Faculty of Education, UKM.

Ajit, G., Lucas, T., & Kanyan, R. (2022). Design and Technology in Malaysian Secondary Schools: A Perspective on Challenges. *Malaysian Journal of Social Sciences and Humanities (MJSSH)*, 7(1), 335–351. https://doi.org/10.47405/mjssh.v7i1.1219

Albatti, H. (2023). Blended Learning in English Language Teaching and Learning: A Focused Study on a Reading and Vocabulary Building Course. *World Journal of English Language*, 13(5), 121–130. https://doi.org/10.5430/wjel.v13n5p121

Alias, N., & Siraj, S. (2013). Design and development research: Emergent trends in educational research. In S. Siraj, N. Alisa, D. Dorothy, & Z. Hussin (Eds.), *Design and development research* (pp. 30–31). Pearson Malaysia Sdn. Bhd.

Allan, B. (2007). *Blended learning tools for teaching and training*. Facet Publishing.

Arya Wirawan, I. M. T., Ketut Gading, I., & Wira Bayu, G. (2022). Interactive Powerpoint Learning Media on Science Content for Fifth Grade Elementary School. *Journal for Lesson and Learning Studies*, 5(2), 190–198. https://doi.org/10.23887/jlls.v5i2.48852

Asnawi, N. (2018). Pengukuran Usability Aplikasi Google Classroom Sebagai E-learning Menggunakan USE Questionnaire. *Journal of Computer, Information System, & Technology Management*, 1(2), 17–21.

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds.), *Advances in the psychology of learning and motivation research and theory* (Vol. 2, pp. 89–195). Academic Press.

Basuki, N. (2022). Development of Project-Based ICT and Media E-Modules for Learning During the Covid-19 Pandemic. *Journal of Community Research and Service*, 6(1).

Bhinnety, M. (2015). Struktur dan proses memori. *Buletin Psikologi*, 16(2), 74–88.

Ching Sing, C., & Der-Thanq, V. C. (2004). A review on usability usability methods for instructional multimedia: An analytic framework. *International Journal of Instructional Media*, 31(3).

Daskan, A. & Yildiz, Y., (2020). Blended Learning: A Potential Approach to Promote Learning Outcomes. *International Journal of Social Sciences and Educational Studies*, 7(4), 103–108. https://doi.org/10.23918/ijsses.v7i4p103

Haji, S. A. (2022). Students' use of online learning platforms to support blended Learning at Cameroonian University. *Journal of Educational Technology and Online Learning*, 5(2), 422–431. https://doi.org/10.31681/jetol.1028410

Humphries, B., & Clark, D. (2021). An examination of student preference for traditional didactic or chunking teaching strategies in an online learning environment. *Research in Learning Technology*, 29, 1–12. https://doi.org/10.25304/rlt.v29.2405

Hussin, A., & Abdul Karim, A. (2022). The development and evaluation of Digital Wakelet Module to improve information searching and use among lower Secondary School Students. *International Journal of Academic Research in Progressive Education and Development*, 11(1), 60–71. https://doi.org/10.6007/ijarped/v11-i1/10679

Ismail, R., Zaman, H. B., & Mohammad, U. H. (2022). A Visual-Based Project Production Package for Design and Technology Subject Based on Computational Thinking Skills Across-STEM. *International Journal on Informatics Visualization*, 6(2–2), 445–454.

Jain, L., & Kaur, R. (2018). Usability Evaluation Techniques: A comprehensive review. *Journal of Emerging Technologies and Innovative Research (JETIR)*, 5(12), 483–496. www.jetir.org

Jenal, D. (2022). *The development of a BSV module to improve non-PSV option teachers' mastery: A case study in Kota Bharu, Kelantan* [Master]. Faculty of Art, Computer and Creative Industry, UPSI

Kakharov, K., & Azizov, Y. (2022). Mnemonics Techniques for Teaching English Language. *American Journal of Social and Humanitarian Research*, 3(11), 385–387. https://grnjournals.us/index.php/AJSHR

Liu, Y., Su, Y., Liu, A.-A., Schiele, B., & Sun, Q. (2020). Mnemonics Training: Multi-Class Incremental Learning without Forgetting. *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, 12245–12254.

Lund, A. (2001). Measuring Usability with the USE Questionnaire. *Usability Interface*, 8(2), 3–6. https://www.researchgate.net/publication/230786746

Muhammad Noor, A., & Saibon, J. (2023). The Attitudes of Secondary School Teachers toward the Utilization of Microcontroller in The Classroom. *International Journal of Academic Research in Business and Social Sciences*, 13(3), 1657–1678. https://doi.org/10.6007/ijarbss/v13-i3/16813

Nursuhud, P. I., Oktavia, D. A., Kurniawan, M. A., Wilujeng, I., Jumadi, & Kuswanto, H. (2019). Multimedia Learning Modules Development based on Android Assisted in Light Diffraction Concept. *Journal of Physics: Conference Series*, 1233(1). https://doi.org/10.1088/1742-6596/1233/1/012056

Radulović, B., Dorocki, M., Ninković, S. O., Stojanović, M., & Adamov, J. (2023). The effects of blended learning approach on student motivation for learning physics. *Journal of Baltic Science Education*, 22(1), 73–82. https://doi.org/10.33225/jbse/23.22.73

Rajaendram, R. (2019). Teaching pupils high-tech skills. *The Star*. https://www.thestar.com.my/news/nation/2019/05/19/teaching-pupils-hightech-skills

Richey, R. C., & Klein, J. D. (2007). *Design and Development Research: Methods, Strategies, and Issues*. Lawrence Erlbaum Associates, Inc.

Richey, R. C., Klein, J. D., & Tracey, M. W. (2011). *The instructional design knowledge base: theory, research, and practice*. Routledge.

Roblyer, M. D., & Doering, A. H. (2013). *Integrating educational technology into teaching* (K. V. Canton, M. E. Chuck, & G. Erb, Eds.; Sixth). Pearson Education.

Sahaat, Z., & Mohamad Nasri, N. (2020). Challenges in the implementation of Design and Technology subject in secondary school. *Jurnal Pendidikan Malaysia*, 45(1), 51–59. https://doi.org/10.17576/jpen-2020-45.01si-07

Schunk, D. H. (2016). *Learning theories: An educational perspective* (7th ed.). Pearson.

Shamsuddin, H. (2021). *The development of learning software M-SMAW for Welding Technology Course in Vocational Colleges in Central Zone* [Master]. Faculty of Technical and Vocational, UPSI

Sharma, P. (2010). Blended learning. *ELT Journal*, 64(4), 456–458. https://doi.org/10.1093/elt/ccq043

Staker, H., & Horn, M. B. (2012). *Classifying K-12 Blended learning*.

Stapa, M. A. (2018). *Blended Learning Module effects using Voc-learning applications towards motivation and learning strategies for vocational stream studies* [PhD]. Faculty of Art, Computing and Creative Industry, UPSI.

Subramaniam, S., & Mahamod, Z. (2017). Development of A Module on Learning How-To-Learn Bahasa Melayu Komunikasi. *Jurnal Pendidikan Bahasa Melayu-JPBM (Malay Language Education Journal-MyLEJ*, 7(2), 51–64.

Sucharitha, G., Matta, A., Dwarakamai, K., & Tannmayee, B. (2020). Theory and Implications of Information Processing. In *Emotion and Information Processing* (pp. 39–54). Springer International Publishing. https://doi.org/10.1007/978-3-030-48849-9_14

Syamsi, B., & Suryanda, A. (2023). Literature study: Implementation of Chemistry learning using blended learning model to improve students' HOTS. *Jurnal EduScience*, 10(1), 273–278.