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Development of E-Module Trizminds for Physical Contradiction Topic Using Thunkable Application for RBT Subject

Sufriyadi Suhardi[a], Azizul Qayyum Basri[a*], Awangku Zaini Awang Zainal[a], Mad Helmi Ab. Majid[b], Muhammad Azri Othman[c] & N Nelfiyanti[d]

[a]Engineering Technical Department, Technical and Vocational Faculty, Universiti Pendidikan Sultan Idris, 35900 Tanjong Malim, Perak, Malaysia

[b]Faculty of Computer and Meta-Technology, Universiti Pendidikan Sultan Idris, 35900 Tanjong Malim, Perak, Malaysia.

[c]Department of Mechanical Engineering, Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia, Pagoh Education Hub, 84600 Pagoh, Johor, Malaysia.

[e]Department of Industrial Engineering, Faculty of Engineering, Universitas Muhammadiyah Jakarta, 10510 Jakarta, Indonesia

[*]Corresponding author: qayyumb@ftv.upsi.edu.my

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ABSTRACT

This study aims at the development of TrizMinds teaching aids using Thunkable software for the subtopic of Physical Contradictions in Design and Technology (RBT) Form 2. The main problem is divided into three aspects, namely the inappropriateness of "Chalk and Talk" teaching, the focus of 21st century learning that is student-centered, and technology needs in education according to the Malaysian Education Development Plan. The objectives of the study include the development of an E-Module to identify learning needs based on the Thunkable application in Form 2 RBT. This study uses the design of the E-Module development with the ADDIE model, which involves analysis, design, development, implementation, and evaluation, as well as applying constructivism theory. Semi-structured interviews with three teachers who have taught for 3 years in RBT subjects at SMK Pendamaran Jaya to obtain information on the need for teaching aids to be produced. In connection with that, a second semi-structured interview was conducted with three experts, namely two experienced lecturers in the field of RBT who have served for 10 years and an RBT teacher who has served for 5 years as a validity assessor expert in providing comments on the built module. The results of the interview show that this TrizMinds Learning E-Module can help students understand the topic of physical contradiction for the subtopics of space separation and time separation. Therefore, various suggestions and improvements have been put forward to improve this application in order to achieve the educational goals of the School Transformation Program 2025 (TS25), which is part of the efforts of the Malaysian Ministry of Education towards improving the quality of students and schools in order to be in line with the current needs of education in the country.

Keywords: Physical contradictions; 21st-century learning; education technology; Reka Bentuk dan Teknologi (RBT)

INTRODUCTION

Malaysia is an economically competitive, developing country. According to Noradilah Aziz et al. (2019), the Malaysian education system keeps up with technical breakthroughs in the age of globalization, which causes societal shifts toward modernity. Hence, in 21st-century education (PAK21), encompassing primary schools, secondary schools, and higher education, the utilization of technology and inventive, dynamic, creative, and engaging pedagogical approaches assumes unparalleled significance. Information, communication, the internet, and other facets are among the many areas in which technology assumes a substantial role in the current era of globalization. Regarding this, a paradigm change is required in order to adjust education to the demands of the globalization era and the education of the current generation, which is dependent on digital technology (Qureshi, Khan, Raza, Imran & Ismail 2021). In response to the advancements observed in international education systems, the national education system has experienced numerous changes throughout the 21st-century (Adam et al. 2019). As a consequence of these developments, learning methodologies have undergone modifications. In the past, traditional approaches were employed during teaching and learning sessions (PdP). However, these methods have since been incorporated with media and technology to correspond with contemporary global trends (Qureshi et al. 2021; Sulaiman & Ismail 2020).

The objective of education in Malaysia is to cultivate responsible and intellectually mature individuals who execute their obligations to contribute to the physical, emotional, spiritual, and intellectual progress of the nation (JERI). In terms of JERI, the *Falsafah Pendidikan Kebangsaan* (FPK) embodies the government's aspiration to cultivate individuals with a comprehensive skill set. The FPK establishes the trajectory and goals of the nation's education through the curriculum objectives for primary and secondary schools. In order to assist students' holistic development in terms of JERI and knowledge delivery, the curriculum includes activities in the classroom that incorporate values, cultural features, and beliefs (Akta Pendidikan, 1996). Commencing in 2017, the utilization of the Standard Secondary School Curriculum (KSSM) necessitates a departure from conventional methodologies and toward a fresh emphasis throughout the educational journey. One of the subjects introduced in the KSSM is Design and Technology (RBT) for Stage 3 students (Forms 1 to 3).

The Malaysia Education Development Plan (PPPM) 2013–2025 emphasizes the importance of high-order thinking skills (KBAT) in producing industry-ready students (Hassan, Mustapha, Yusuff, & Mansor 2017). The necessity of KBAT in this educational system is related to teachers' abilities in imparting knowledge and exposing students to important contemporary concerns or technology. This initiative is in accordance with the PPPM 2013–2025 objectives and is in accordance with School Transformation 2025 Program (TS25) implemented by the Malaysian Ministry of Education (KPM) (Sulaiman & Ismain, 2020). Clearly, the government intends for student excellence to commence in schools, where educators provide direction. But in the current situation, teachers find it more difficult to adjust to new approaches than to traditional ones (Rusli, Ibrahim, Raâ, and Nallaluthan, 2021). As a result, educators are unable to effectively instruct students in KBAT pedagogy (Hassan, Mustapha, Yusuff & Mansor 2017). Such instruction also necessitates the use of supplementary tools to aid instructors throughout teaching and learning sessions.

The employment of teaching aids (BBM), particularly in the Design and Technology (RBT) topic in lower secondary schools, is an excellent way to improve the teaching and learning process. Abd Samad, Wan Ahmad, Harun, Amiruddin, Hashim, and Ja'apar (2018) say that BBM is a way to give subject-related information in a way that is clearer and more organized, which makes it easier for students to understand. Additionally, Mookan et al. (2021) assert that BBM assists instructors in delivering lesson material in a more systematic and transparent manner, thereby facilitating student comprehension and assessment. According to earlier research, BBM is a good learning tool or medium for assisting students in understanding the subjects being taught. This figure is consistent with the present demographic distribution, wherein 65% of the population prefers visual learning methods, while 30% prefer kinesthetic learning and 5% prefer auditory learning (Busan 2014). According to research by Lambri and Mahamood (quoted in Mook Soon Sang 2019), the visual system provides 75% of the information that humans acquire. In support of their respective conclusions, Ahmad and Rahman (2022), Mahadi, Husin, and Hassan (2022), Busan (2014), and Vaishnav and Chirayu (2013) have all agreed that visual styles, including videos, graphs, images, and charts, can be utilized in education as simulations or demonstrations of learning topics, particularly those that are costly or difficult to replicate in the real world. Moreover, a study conducted by Rusli, Ibrahim, Raa, and Nallaluthan (2021) defines the incorporation of diverse media as an incentive for students to acquire knowledge through the development of unique methodologies. Researchers conclude, based on these studies, that humans are more receptive to learning through visual representations, whether they are tangible or virtual (virtual products).

The implementation of BBM in Form 2 RBT facilitates students' comprehension of inventive problem-solving in physical contradictions. In contrast, traditional approaches devoid of BBM support are deemed less effective and more challenging for students to grasp. The Teoria Rechenia Izobretatelskih Zadatchi (TRIZ), which is another name for inventive problem-solving, is a frequently used unstructured engineering problem-solving tool in the industrial sphere (Heong, Sharberi, Bakar, Ching, & Mohamad 2020; Kiong, Saien, Yunos, Heong, Mohamad, Azman, & Hanapi 2020). It also requires critical, creative, and innovative thinking in RBT coursework in order to synthesize previous products in order to develop tools that are more straightforward, practical, and uncomplicated. However, certain students face obstacles in that their lack of experience and restricted imagination make it difficult for them to comprehend the lesson material in depth. This assertion is corroborated by Libau and Ling (2020), who assert that students' reactions and reception of the presented material are contingent upon their prior experiences, knowledge, and competencies. To encourage students' enthusiasm for studying, teachers must adapt their methods by utilizing technology and BBM (Sallehin & Ab Halim 2018).

PROBLEM STATEMENT

RBT, which employs a project-based assignment structure to familiarize students with technology, is among the most crucial subjects (Kiong et al. 2020). Since 2017, Malaysian secondary schools have adopted RBT as the curriculum replacement for *Kemahiran Hidup Bersepadu* (KHB) from Form 1 to Form 3 (Isa & Ma'arof 2018; Sahaat & Nasri 2020). Previously, textbooks served as a learning guide for teachers during lessons. The integration of this pedagogical approach is executed progressively and encompasses a number of significant concerns, including the inadequacy of the "chalk and talk" method of instruction, which disregards the PPPM priority for student-centeredness and the technological imperative for learning (Yusof, Baharum, & Hamzah, 2023). Students generally dislike the "chalk and talk" method and textbook use in workshops because it lacks student involvement and does not put the students' needs first. This technique focuses on the teacher since it may handle the needs of a large number of students in a class while also completing the learning curriculum in accordance with the subject teacher's *Rancangan Pengajaran Harian* (RPH). Furthermore, as Rusli, Ibrahim, Raa, and Nallaluthan (2021) assert, the perpetuation of this approach may potentially impede students' cognitive development by failing to incentivize them to explore, master, and expand their understanding of a specific subject matter. This finding is in opposition to the outcomes described by Kiong et al. (2020), who observed that mastery of the RBT subject would yield physical products.

In order to give instruction that is simpler, more interesting, and productive for students, Sidek and Hashim (cited by Huba and Freed, 2016) recommend that PAK21 teachers adapt their pedagogical approaches and make use of technology like computers, projectors, visualizers, compact disk (CDs), the internet, and others. One of the novel approaches to obtaining reading materials that are also interactive and thought-provoking is through the use of e-modules (Azman & Rahman, 2022). According to Sulaiman and Ismail (2020), in order to satisfy the expectations of the industry, educators should incorporate media, technology, and social skills into their lessons, as well as components of critical and creative thinking. As a result, RBT is regarded as a foundational course that emphasizes design in the development of technology-based products and seeks to cultivate students who are imaginative, methodical, and creative. Sallehin and Ab Halim (2018) contend that the national education system is undergoing a paradigm shift in order to capitalize on Information and Communication Technology (ICT), and that the integration of technology into PdP sessions is therefore of critical importance. As anticipated, the integration of interactive applications into the educational setting will enhance students' ability to acquire knowledge, which is in accordance with the progressively complex requirements of the 21st-century.

PURPOSE OF STUDY

The primary objective of this study endeavor is to create BBM pertaining to the subtopic of physical contradictions, specifically temporal and spatial separation. These BBM will be constructed utilizing applications that improve Form 2 students' inventive problem-solving abilities in the domain of RBT subject. All participants were allowed to adapt with the car simulator setup and car seat adjustment before starting the experiment. The experiment was started after five minutes the participant had been in the driving position to allow them to adapt with the seat environment and fabrics. All participants understood and complied with the oral and written instructions provided by researcher for this experiment. Information about the experiment procedure was included. After receiving the complete information on the study, each participant signed an informed consent.

OBJECTIVE STUDY

According to the research purpose, the primary objectives of this study are as follows:

1. To assess the need for a Thunkable-based Learning E-Module for the subject of RBT at Form 2.
2. To develop a Thunkable-based learning E-Module for the topic of physical contradictions in the subject of RBT at Form 2.
3. To evaluate the usability of the Thunkable-based learning E-Module for the topic of physical contradictions in the subject of RBT at Form 2 through expert validation.

METHODS

Research design plays a pivotal role in establishing the methodology and techniques that are most suitable for an investigation. As stated by Isa and Mohd Imam Ma'arof (2018), the objective of the research design is to examine matters through the selection of appropriate data collection methods. In addition to providing guidance, the research design ensures that the intended research objectives are met. In conclusion, the research design comprises the methodologies employed, and the nature of the data acquired and serves as a framework for the study.

In this research, the main objective is to develop TrizMinds E-Module for physical contradictions, specifically spatial and temporal separation, in RBT for Form 2. The objective is to provide students with a better grasp of physical inconsistencies so they can solve creative difficulties in product creation. Simultaneously, it seeks to improve individuals' capacity for innovative problem-solving through refined decision-making abilities. The ADDIE model is used and practiced in this study to produce an e-Module using the Thunkable application (Figure 1).

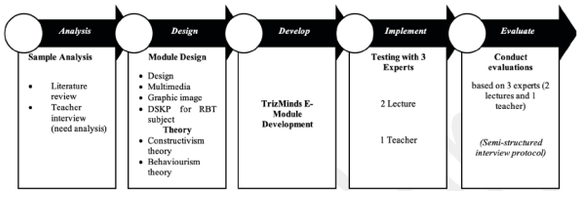


FIGURE 1. Workflow Based on the ADDIE Model

ANALYSIS PHASE

The researcher conducts an initial phase in which they examine the subject matter and subtopics of RBT Form 2 by conducting interviews with instructors and reviewing previous studies in the field. Several difficulties in comprehending and retaining the subtopics of learning pertaining to physical contradictions in the subject of RBT for Form 2 are identified in the researcher's analysis. Consequently, once the research issues have been identified, the researcher proceeds to formulate the research objectives, research questions, and content scope in order to construct an E-Module utilizing the Thunkable application as a BBM for the educational benefit of students as well as teachers in schools.

DESIGN PHASE

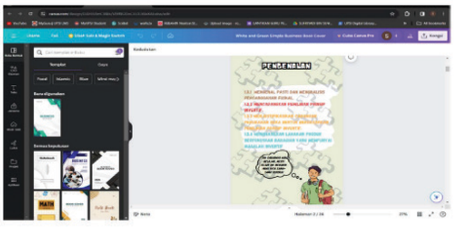
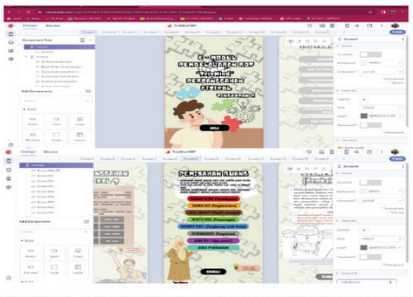
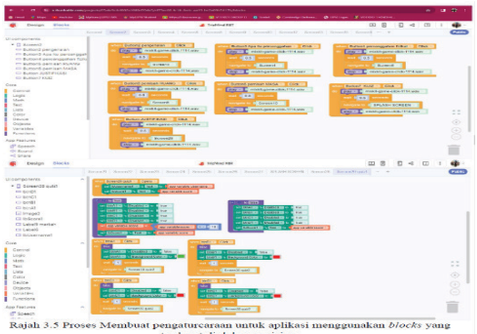
After the requirements assessment process is over, the design phase, which is the second phase, is carried out. According to Moharam, Mokhtar, and Thia (2021), this stage is a result of the analysis phase, which produces an indication or viewpoint on the evolution of the design, structure, method of instruction, theories of learning, media types, and technologies utilized in the product under development. As a result, the researcher devises and implements the structural configuration of the E-Learning Module pertaining to physical contradictions, more precisely temporal and spatial separation, in accordance with the material covered in the textbook. By selecting an appropriate template for the development of the E-Module and methodically organizing each component according to the topics covered in the textbook, the researcher enhances the effectiveness and organization of the designed plan. In addition, the researcher consults the *Dokumen Standard Kurikulum dan Pentaksiran* (DSKP) pertaining to RBT Form 2 as a reference when developing modules.

Additionally, the interconnected constructivism and behaviorism serve as the theoretical underpinnings of this e-module. By enabling and encouraging students to investigate the developed application, the constructivist theory fosters curiosity and interest in individuals. This process also encourages students to think more critically. On the other hand, the behaviorist theory places emphasis on how students develop their behavior and the stimuli they encounter. The use of this e-module will lead to a more stable and constructive understanding in the long run due to repeated actions.

DEVELOPMENT PHASE

Following the completion of the analysis and design phases, this phase is carried out. After thinking and planning, the workflow moves to developing modules based on the earlier design planning. Using applications like Canva and other auxiliary programs like Microsoft PowerPoint, as well as sourcing them from other sources like DSKP, textbooks, and the internet, multimedia elements like text, photos, graphics, audio, video, interaction, and animations are gathered and constructed. Using pertinent software, the development process starts with creating or programming code to add content to the software. The Canva app was selected by the researcher due to its ease of use, wider accessibility than other apps, and eye-catching graphic components. As a result, the Canva application makes it easier for the researcher to change the e-Module (see Table 1).

TABLE 1. Applications used to develop the TrizMinds learning e-Module along with explanations

Application used	Figures	Explanation
Canva	 Rajah 3.2 Proses penghasilan template untuk aplikasi	Canva software is used to generate application templates, backgrounds, and design layouts, allowing the researcher to produce visually appealing templates.
Thunkable	 Rajah 3.3 Proses memasukkan template kedalam perisian Thunkable dan Menyusun pengaturan butang untuk aplikasi berfungsi	Next, incorporate the created templates into the Thunkable program. After that, arrange program pages, add navigation buttons, and add background audio.
Thunkable	 Rajah 3.5 Proses Membuat pengaturcaraan untuk aplikasi menggunakan *blocks* yang terdapat di dalam perisian.	After adding the menu buttons, the next step is to program the computer to ensure the buttons function as intended by adhering to the predetermined instructions.

IMPLEMENTATION PHASE

Once the development phase is concluded, the e-Module learning module TrizMinds, which is built upon the Thunkable application, is thoroughly developed and subjected to content validity testing. Prior to conducting validation, the interview protocol instrument was developed by the researcher and reviewed by three (3) experts who are seasoned lecturers in the qualitative field. After confirming the validity of the research instrument, the investigator proceeded to conduct semi-structured interviews with the three experts. Researchers conducted these interviews to validate the TrizMinds Learning Module against the Thunkable application as a whole, as determined by thematic analysis of the code assignment. Following that, this validation was carried out utilizing the knowledge of three (3) RBT subject matter experts, including one (1) RBT subject teacher and two (2) lecturers

with over ten years of experience each from the Faculty of Technical and Vocational Education (FTV), Sultan Idris Education University (UPSI), in the domain of RBT. The findings from the interviews will subsequently be subjected to thematic analysis.

EVALUATION PHASE

The last phase in the ADDIE model is the evaluation phase. Three expert evaluators—two lecturers and one RBT teacher—are engaged in the evaluation process to provide feedback on the TrizMinds physical contradictions BBM's usability. The evaluation approach entails scheduling visits with respondents to select appropriate days, times, and locations, as well as offering assistance and instructions from the researcher before the teachers evaluate the TrizMinds e-module. Following the assessment, the researcher solicits expert feedback, comments, and recommendations. After analyzing, coding, and formulating the expert responses, the researcher will present the research findings in tabular format.

FINDINGS

NEED ANALYSIS FINDINGS

Interviews with three respondents that teach the RBT subject were used to conduct a requirements analysis for the development of the Triz physical contradictions e-module. The three respondents were chosen at random, with consideration given to attributes including their ability to offer constructive criticism, their tenure as teachers (a minimum of five years), and their expertise in teaching RBT. Following a manual analysis of the collected data, the transcription process will involve listening to the audio recordings of the interviews with the instructors. *"R"* represents *"respondent,"* which will be indicated in each table; for example, *"R1 = Respondent 1"*.

TABLE 2. Coding for Question 1
Is there a problem that has persisted throughout the teaching session with physical contradiction?

No	Item	R1	R2	R3
1	Lack of understanding	/	/	/
2	Less interested	/	/	/
3	Difficult Topic	/	/	
4	High level thinking		/	

TABLE 3. Coding for Question 2
What teaching methods does the teacher use for the topic of physical contradictions?

No	Item	R1	R2	R3
1	Teaching aids (BBM)	/	/	/
2	Adaptation to the environment	/		/
3	Technology	/		

TABLE 4. Coding for Question 3
Does using teaching aids affect students' motivation throughout the teaching and learning process?

No	Item	R1	R2	R3
1	Increase student motivation	/	/	/
2	Two-way communication		/	/
3	Active student	/	/	
4	High level thinking		/	

TABLE 5. Coding for Question 4
What are the constraints faced by teachers during the use of existing teaching aids when teaching the topic of physical contradiction?

No	Item	R1	R2	R3
1	Outdated BBM		/	/
2	Long time allocation	/		/
3	The total BBM is limited			

TABLE 6. Coding for Question 5
Is there a need to develop teaching aids that can be used for teaching the topic of physical contradiction?

No	Item	R1	R2	R3
1	High requirements	/	/	/
2	Less interested	/		
3	Student morale is high			/

TABLE 7. Coding for Question 6
Is there a need to develop teaching aids that can be used for teaching the topic of physical contradiction?

No	Item	R1	R2	R3
1	Time constraints	/	/	/
2	Finance (cost)	/		
3	Pressure			/

TABLE 8. Coding for Question 7
Is there a need to develop teaching aids that can be used for teaching the topic of physical contradiction?

No	Item	R1	R2	R3
1	Improve Understanding	/	/	/
2	Activities	/		
3	Changing perceptions	/	/	/
4	Attract interest	/		/

As indicated by the results of the code determination analysis, instructional aids that assist students in visualizing

and comprehending the subject matter of physical contradictions are necessary. According to the respondents, students perceive this subject as challenging, which consequently results in a lack of interest and comprehension. Additionally, respondents encounter a scarcity of instructional resources to facilitate the instruction of this subject matter, underscoring the critical nature of creating instructional materials that inspire and engage learners. By offering convenient access without the need for internet connectivity, this E-Module presents students with a more accessible alternative.

Due to time constraints, RBT teacher must rely on pre-existing resources provided by the school instead of creating their own teaching aids. The development of E-Modules is regarded as an absolute necessity in order for students to learn about physical contradictions more effectively. While the development of E-Modules is hindered by time constraints, students' comprehension can be enhanced through the use of technology based on BBM's, particularly with regard to the subject of physical contradictions.

ANALYSIS OF STUDY FINDINGS

In order to effectively pursue research objectives in the 21st-century, creative problem-solving and pondering are deemed indispensable. Physical and mental adaptability to the environment, goal setting, curiosity, creativity, risk tolerance, and advanced thinking abilities are all components of inventive thinking. In RBT subjects, which frequently entail project-based assignments, problem-solving is recognized as a crucial skill in both the classroom and learning.

"…the students have a lack of understanding about the topic of physical contradictions, which results in their having less interest in delving deeper into this topic…" (R1:Q1)

"…the topic is somewhat challenging to impart understanding to students and requires high-level thinking from the students themselves." (R2:Q1)

"Students show less interest in learning about this topic... one concept to understand is to differentiate between spatial separation and temporal separation." (R3:Q1)

According to interviews with one RBT teacher and two expert lecturers, time constraints in the classroom make it challenging to get students interested in subjects that call for in-depth thought. As suggested by the outcomes of the interviews conducted with all three authorities, students possess a restricted comprehension of the subjects being instructed. Lack of interest is another factor, according to the experts, that contributes to students' negative reception of the subject and contributes to the perception that it is challenging to learn.

"…these students tend to prefer technology-based materials that can be touched and carried anywhere to enhance their understanding. …" (R2:Q3)

"An interesting BBM can change the perception of students…" (R1:Q7)

"The teacher doesn't have time to allocate for creating instructional materials for students…" (R2: Q6)

Based on the interviews, there is a need to develop BBM to assist instructors in addressing this issue. According to experts, students have a strong affinity for technology-related materials, considering them to be equally captivating as gaming experiences. Thus, by integrating technology into educational resources that can be utilized remotely, instructors have the ability to captivate students' interest. Teachers, on the other hand, have limited time to cultivate BBM, particularly those pertaining to technology, due to time constraints. As a consequence, classroom instruction becomes linear and textbook-based, as research by Yusof, Baharum, & Hamzah (2023); Moharam, Mokhtar, & Thia (2021); and Rusli, Ibrahim, Raâ, & Nallaluthan (2021) has shown. Consequently, the researcher devises a strategy to generate BBM that can alleviate the workload of instructors and learners throughout PdP sessions by constructing TrizMinds learning e-Modules on the Thunkable platform.

Respondent 1 provided favorable feedback regarding the TrizMinds learning e-Modules, which were developed utilizing the Thunkable application. On the other hand, the respondent recommended adding features like dynamic backdrops, films, and artificial intelligence (AI) to make the module more visually appealing. The module's responsibility to captivate students' attention, prevent tedium, and stimulate their intellects underpins these recommendations. This particular aspect is also associated with the research undertaken by Mahadi, Husin, and Hassan (2022), which aimed to develop a stimulating learning environment that personally engages every student's intellect. This BBM can compete with other entertainment applications in a distinctive manner due to the presence of a BBM designed for enjoyment while maintaining its own advantages.

"…the students nowadays are not interested in reading; they prefer apps like TikTok, for example, because it's popular with engaging videos. So, if you want to capture their interest, make sure your app has attractive video and audio elements. Therefore, if possible, develop videos with music, and if feasible, incorporate AI elements into this app." (R1:Q3)

Respondent 2 remarked that this module is excellent and appropriate for helping students grasp the issue of physical contradictions, namely spatial and temporal separation in the RBT subject. Also, Respondent 2 gave excellent feedback regarding the Thunkable application-based TrizMinds learning e-Modules. Moreover, the portability of these e-Modules confers an added benefit, enabling students to access it from any location.

"Okay, so overall, your E-Module can form a good E-Module and overall, in terms of both design and color aspects, everything is good and suitable for use by students... the size of this E-Module is easy to carry anywhere and can be referred to at any time" (R2:Q2)

DISCUSSION

REQUIREMENTS

The study's first goal was to establish the requirements for generating BBM e-Modules for the topic of RBT Form 2. The study assessed the criticality of creating an e-Module for physical discrepancies by conducting semi-structured face-to-face interviews with three (3) randomly selected RBT instructors using the Thunkable application. This necessity stems from concerns, including students' limited comprehension and interest in the subject matter.

In addition, the results suggest that instructional approaches that incorporate effective teaching aid materials can pique students' interest and make learning more engaging. However, employing traditional methods comes with limitations and requires a significant time commitment. By enabling offline access and creating a more flexible and engaging learning environment, the TrizMinds E-Module, which is built upon the Thunkable application, has the potential to enhance students' comprehension.

Overall, the findings from interviews conducted with RBT teacher at SMK Pendamaran Jaya indicate that the TrizMinds E-Module successfully addresses the intended requirements and positively influences students' motivation and comprehension.

USABILITY ASSESSMENT

To accomplish the research objectives, the product design process ought to encompass the following stages: ideation, product design, and post-product development evaluation. The Thunkable application serves as the foundation for the creation of the E-Module, demonstrating an effective and captivating design that enhances understanding of electrical design subjects. The researcher's inquiries were met with favorable responses from RBT specialists during interviews, thereby substantiating the efficacy of the TrizMinds E-Module as an instructional resource.

One emphasized component of the design is its attractiveness and portability, since the e-Module is built as an application that can be installed on smartphones without requiring a data network for access because it is usable offline. With its portability and accessibility, and especially its offline access capability, experts concur that the TrizMinds learning E-Module is appropriate for use as a teaching aid material.

Experts agree that subsequent iterations could improve the design, despite its admiration and appropriateness. Expert feedback further emphasizes the necessity to enhance the E-Module through the incorporation of technological developments, particularly in regard to AI, 3D animation, and more captivating videos for students.

STUDY PROPOSAL

Participants in the interviews provided a wealth of suggestions for improving the TrizMinds Learning E-Module, which is based on the Thunkable application. These experts' recommendations are seen as crucial for improving the product's quality and fixing any module flaws.

First and foremost, respondents recommend that the application's design take into account the latest developments in technology, such as the usage of AI and more engaging technologies. This pertains to the viewpoints expressed by the respondents, who cautioned against neglecting technological advancements in order to maintain the module's appeal and relevance to students.

Moreover, incorporating captivating components like dynamic animated backgrounds is regarded as a constructive progression. The respondents suggest that this may maintain the students' interest in the E-Module for an extended period of time. The idea that static note-based applications garner less attention, while the addition of dynamic graphic features can increase engagement, confirms this viewpoint.

Finally, the respondents suggest supplementing the text with more real-life examples that are relevant to the students' lives and environments. This suggestion seeks to improve students' comprehension of physical contradictions by making connections to actual circumstances. We anticipate further refinement and strengthening of the TrizMinds E-Module, thereby increasing its applicability and efficacy within the domain of physical contradictions education, with these recommendations in mind.

CONCLUSION

In summary, the interview method is essential for gathering detailed information about the use and effectiveness of the developed TrizMinds E-Module. This module has the potential to assist secondary school instructors in their pedagogical endeavors by facilitating the teaching and learning process. The TrizMinds E-Module facilitates the dissemination of explanations to students for the benefit of instructors. Particularly with regard to RBT subject, this module has the potential to broaden students' horizons and foster greater ingenuity through the provision of lucidity and comprehension.

Although this TrizMinds E-Module possesses some strengths, it also possesses some weaknesses. Acknowledging and rectifying these limitations can enhance the module's capacity to foster students' comprehension, particularly in the areas of RBT. With the intention of facilitating seamless teaching and learning for educators and actively involving students in the subject of RBT, this module must undergo meticulous refinement.

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DECLARATION OF COMPETING INTEREST

None.

REFERENCES

Abd Samad, N., Wan Ahmad, W.M.R., Harun, H., Amiruddin, M.H., Hashim, S. & Ja'apar, F. 2018. Bahan bantu mengajar (BBM) dalam pengajaran dan pembelajaran (P&P) di Sekolah Menengah Kebangsaan (SMK) Daerah Pontian. *Online Journal for TVET Practitioners*.

Abdullah, M.F.N.L. & Wei, L.T. 2017. Kesahan dan kebolehpercayaan instrumen penilaian kendiri pembelajaran geometri tingkatan satu. *Malaysian Journal of Learning and Instruction* 14(1): 211–265.

Akta Pendidikan. 1996. *Akta 550 & Peraturan-peraturan Terpilih (Hingga 5 Januari 2013)*. Kuala Lumpur: ILBS.

Ghani, A., Hazni, S.I. & Nordin, M.S. 2019. Kekangan kreativiti guru dalam pengajaran mata pelajaran Reka Bentuk dan Teknologi sekolah menengah. In *Prosiding Seminar Kebangsaan Pendidikan Negara (SKEPEN 2019)*.

Ahmad, N.L., Sho, S.L., Wahid, H.A. & Yusof, R. 2019. Kepentingan amalan pengajaran dan pembelajaran abad ke-21 terhadap pembangunan pelajar. *International Journal of Education, Psychology and Counseling* 4(28): 28–51.

Azman, A.H. & Ab Rahman, A. 2022. Pembangunan e-modul pembelajaran asas NI Multisim. *Research and Innovation in Technical and Vocational Education and Training* 2(2): 86–98.

Buşan, A.M. 2014. Learning styles of medical students: Implications in education. *Current Health Sciences Journal* 40(2): 104.

Hassan, M.N., Mustapha, R., Yusuff, N.A.N. & Mansor, R. 2017. Pembangunan modul kemahiran berfikir aras tinggi di dalam mata pelajaran Sains sekolah rendah: Analisis keperluan guru. *Sains Humanika* 9(1–5).

Heong, Y.M., Sharberi, S.N.M., Bakar, N.A., Ching, K.B. & Mohamad, M.M. 2020. Pembangunan modul TRIZ secara pencantasan untuk pembelajaran berasaskan masalah. *Online Journal for TVET Practitioners* 5(2): 12–19.

Indra Adi Budiman, Yuyun Dwi Haryanti & Aida Azzahrah. 2021. Pentingnya media aplikasi Android menggunakan iSpring Suite 9 pada pembelajaran daring terhadap motivasi belajar siswa. *Prosiding Seminar Nasional Pendidikan* 3(3): 144–150.

Isa, N.S. & Ma'arof, N.N.M.I. 2018. Keberkesanan penggunaan grafik berkomputer sebagai alat bahan bantu mengajar dalam kalangan pelajar Reka Bentuk dan Teknologi. *Sains Humanika* 10(3–3).

Kiong, T.T., Saien, S., Yunos, J.M., Heong, Y.M., Mohamad, M.M., Azman, M.N.A. & Hanapi, Z. 2018. Teori Penyelesaian Masalah Inventif (TRIZ) bagi mata pelajaran Reka Bentuk dan Teknologi. *Online Journal for TVET Practitioners.*

Lambri, A. & Mahamood, Z. 2019. Penggunaan alat bantu mengajar dalam pengajaran Bahasa Melayu menggunakan pendekatan pembelajaran berpusatkan pelajar. *International Journal of Education, Psychology and Counseling* 4(33): 78–94.

Libau, C.M. & Ling, Y.L. 2020. Peranan bahan bantu mengajar dan persekitaran maklum balas dalam meningkatkan kualiti pembelajaran pelajar. In *National Research Innovation Conference (NRICon 2020)*: 20–21.

Mahadi, F., Husin, M.R. & Hassan, N.M. 2022. Gaya pembelajaran: Visual, auditori dan kinestetik. *Journal of Humanities and Social Sciences* 4(1): 29–36.

Moharam, M.M.A.H., Mokhtar, S. & Thia, K. 2021. Pendekatan kaedah interaktif dalam pengajaran dan pembelajaran Pendidikan Islam abad ke-21 di Sekolah Menengah Kebangsaan Kota Kinabalu. *Proceedings ICTLD2021* e-ISBN: 978-967-25529.

Muruganantham, G. 2015. Developing of e-content package by using ADDIE model. *International Journal of Applied Research* 1(3): 52–54.

Qureshi, M.I., Khan, N., Raza, H., Imran, A. & Ismail, F. 2021. Digital technologies in Education 4.0: Does it enhance the effectiveness of learning? A systematic literature review. *International Journal of Interactive Mobile Technologies (iJIM)* 15(4): 31–47. https://doi.org/10.3991/ijim.v15i04.20291

Rusli, N.F.M., Ibrahim, N.F.S.C., Raâ, M. & Nallaluthan, K. 2021. Persepsi pelajar terhadap aplikasi multimedia interaktif dalam proses pengajaran dan pembelajaran abad ke-21. *Online Journal for TVET Practitioners* 6(1): 15–24.

Sahaat, Z. & Nasri, N.M. 2020. Cabaran pelaksanaan mata pelajaran Reka Bentuk dan Teknologi sekolah menengah. *Jurnal Pendidikan Malaysia* 45(1): 51–59.

Sahaat, Z., Nasri, N.M. & Bakar, A.Y.A. 2020. ADDIE model in teaching module design process using modular method: Applied topics in design and technology subjects. In *1st Progress in Social Science, Humanities and Education Research Symposium (PSSHERS 2019)*: 719–724. Atlantis Press.

Sallehin, S.A. & Ab Halim, F. 2018. Penggunaan alat bahan bantu mengajar berasaskan multimedia dalam pengajaran dan pembelajaran di Sekolah Menengah Zon Benut. *Online Journal for TVET Practitioners.*

Sidek, S. & Hashim, M. 2016. Pengajaran berasaskan video dalam pembelajaran berpusatkan pelajar: Analisis dan kajian kritikal. *Journal of ICT in Education* 3: 24–33.

Sulaiman, J. & Ismail, S.N. 2020. Teacher competence and 21st century skills in transformation schools 2025 (TS25). *Universal Journal of Educational Research* 8(8): 3536–3544.

Vaishnav, R.S. & Chirayu, K.C. 2013. Learning style and academic achievement of secondary school students. *Voice of Research* 1(4): 1–4.

Yusof, M.F.H.M., Baharum, H. & Hamzah, N. 2023. Permainan "E-Teka Silang Kata" dalam meningkatkan perkembangan murid dalam pembelajaran gaya bahasa sajak Antologi Kubentang Sehelai Peta. *Asian Pendidikan* 3(2): 9–15.