JPPIPA 11(9) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Development of E-modules Based on Quantum Learning in Projek IPAS for Class X Vocational High School

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Received: June 16, 2025
Revised: August 21, 2025
Accepted: September 25, 2025
Published: September 30, 2025

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DOI: 10.29303/jppipa.v11i9.12179

Abstract: This study aims to develop a Quantum Learning-based e-module for the subject of Natural and Social Science Projects (IPAS) in class X Vocational High School, focusing on Economic Behavior and Social Welfare material. The development employed the ADDIE model (analysis, design, development, implementation, and evaluation). Expert validation results show that the e-module is very valid in material (89.70%) and language (96.70%), and valid in media (78%). Practicality tests indicate the module is practical (79% by teachers) and very practical (82% by students). Effectiveness was assessed through pre-test and post-test with 31 students, analyzed using the t-test. The results show a t-count of 16.17, exceeding the t-table value of 1.697 at a 0.05 significance level, indicating a significant improvement in student learning outcomes after using the module. In conclusion, the Quantum Learning-based e-module meets the criteria of validity, practicality, and effectiveness, and can be used as a quality learning resource to enhance student engagement and achievement.

Keywords: ADDIE model; E-Module development; IPAS project subject; Quantum learning; Vocational High School

Introduction

The Fourth Industrial Revolution is characterised by rapid advances in connectivity, digital systems, artificial intelligence, and virtual technologies, which have blurred the boundaries between humans, machines, and resources. Its impact is evident across multiple sectors, including Indonesia's education system, which is increasingly shaped by the integration of information and communication technologies (Sirimeno, 2022; Widiari et al., 2023).

In this context, education must produce a generation that is creative, innovative, and highly competitive. Technology must be optimised as a tool in the learning process so that educational outcomes can keep pace with or even exceed the demands of the times. Without adaptation, graduates will face difficulties meeting the expectations of the digital labour market.

The demands of 21st-century education emphasise skills relevant to a globally connected society, such as digital literacy, programming, data analysis, and awareness of emerging technologies. Learning should therefore be collaborative, interactive, and student-centred, while curricula and teaching models must adapt to equip learners with these essential skills (Antari et al., 2023); Sholihah et al., 2019).

The Indonesian Merdeka Curriculum responds to this need by promoting the concept of Independent Learning, granting schools, teachers, and students the freedom to innovate and learn creatively. Unlike previous curricula, it prioritises the quality of learning rather than minimum passing grades, aiming to develop Pancasila Student Profiles who are ready to face global challenges with strong character and competence (Ayuningtyas et al., 2023).

How to Cite:
Deviana, B., Zen, Z., Rayendra, J, F. Y., Mirshad, E., & Desky, A. H. A. (2025). Development of E-modules Based on Quantum Learning in Projek IPAS for Class X Vocational High School. *Jurnal Penelitian Pendidikan IPA*, *11*(9), 583–591. https://doi.org/10.29303/jppipa.v11i9.12179

Digital learning media such as e-modules are central to achieving these goals. E-modules are flexible, adaptive, and designed to support self-directed learning, as they can be accessed anytime and anywhere. With self-instructional characteristics, they enable students to construct knowledge independently, in line with the vision of the Merdeka Curriculum (Novitama & Simamora, 2022).

The IPAS Project, an interdisciplinary subject combining Natural and Social Sciences, requires innovative learning media because its materials are often abstract and complex. Without appropriate media, learning objectives become harder to achieve, students' motivation decreases, and opportunities to foster critical and creative thinking are limited. According to Setyawan et al. (2025).

The IPAS Project, an interdisciplinary subject combining Natural and Social Sciences, requires innovative learning media because its materials are often abstract and complex. Without appropriate media, learning objectives become harder to achieve, students' motivation decreases, and opportunities to foster critical and creative thinking are limited (Putri & Hendriyani, 2023).

Furthermore, teachers face challenges such as time constraints, dense curricula, and limited resources, which often result in teacher-centred learning. As a consequence, students remain passive, while higher-order thinking skills—so vital for the 21st century—are not optimally developed (Maulidi, 2022).

Quantum Learning provides an alternative by creating an engaging, enjoyable, and meaningful learning environment. This approach emphasises freedom, comfort, curiosity, and active involvement, thereby enhancing motivation, memory retention, and academic performance (Nurahmi et al., 2024; Maulidi, 2022).

The uniqueness of this study lies in the development of a Quantum Learning-based e-module specifically designed for the IPAS Project in vocational high schools. This dual innovation—combining digital interactive media with a transformative learning model—fills a gap in existing research. The study is important because it addresses pressing educational challenges: low student motivation, limited teacher resources, and the mismatch between graduates' competencies and the demands of the digital economy (Susanti et al., 2025; JH, 2018). Ultimately, this research aims to provide a high-quality learning resource that not only improves learning outcomes but also prepares students with the creativity, independence, and adaptability required in the 21st century.

Method

At the development stage, the research design that had been formulated during the design phase was transformed into a tangible product, namely an E-Module Flipbook based on Quantum Learning for the IPAS Project subject in vocational high schools. This stage is not merely about digitizing learning materials but involves a systematic process of producing interactive, curriculum-based instructional media that can be directly implemented in classroom learning activities (Grasela et al., 2021; Nurahmi et al., 2024).

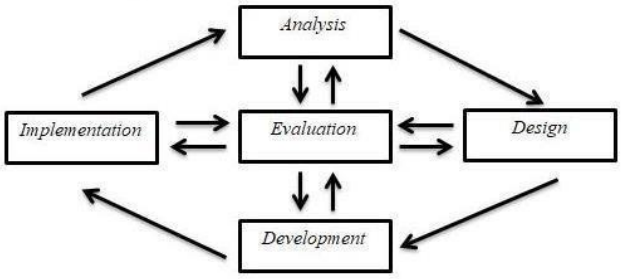

Figure 1. ADDIE model

The first activity in this stage was structuring the content according to the basic competencies, indicators, and learning objectives set in the vocational school curriculum. The material was carefully selected to ensure its relevance to the topic Economic Behaviour and Social Welfare, with a strong emphasis on aligning with students' needs and real-world vocational contexts (Susanti et al., 2025).

After structuring the content, the development proceeded with the design of visual and interactive components. The E-Module was enriched with illustrations, infographics, videos, and hyperlinks, embedded using the Heyzine PDF Flipbook application, to create a learning experience that is engaging and user-friendly. This interactive design aimed to foster multisensory learning, making complex concepts easier to understand (Biroso & Saputro, 2023).

The principles of Quantum Learning were integrated throughout the module, emphasizing AMBAK (Apa Manfaatnya Bagiku / What's in It for Me), joyful learning, and active student participation. By incorporating these strategies, the E-Module encouraged students to learn through multiple senses, stimulated intrinsic motivation, and made the learning process more meaningful.

Following the integration of content and design, a prototype of the E-Module was developed. This prototype represented the initial version of the product, already containing the complete structure, features, and learning materials. However, at this stage, the product

was still subject to refinement and improvement through feedback and trial implementation.

After implementation, the Improvement stage is the prototype was then subjected to a limited trial implementation involving a small group of tenth-grade vocational students. This trial served as a preliminary field test to observe how the E-Module performed in a real learning context. It provided essential insights into usability, practicality, and the extent to which the module supported the intended learning objectives (Taali et al., 2024).

During the trial, data were collected through questionnaires distributed to students and teachers, as well as observation notes. This process aimed to capture factual responses regarding the module's clarity, attractiveness, ease of use, and pedagogical relevance. The feedback obtained served as evidence of both strengths and weaknesses that needed to be addressed.

The Improvement phase, a distinctive feature of the ADIIE model, was then carried out. The feedback from students, teachers, and expert validators was systematically analyzed and used as the basis for revising the E-Module. Adjustments included simplifying complex text, enhancing visual layout, improving navigation, and ensuring all interactive features functioned effectively. This iterative refinement process ensured that the product became more accurate, engaging, and aligned with learner needs (Setyawan et al., 2025).

After undergoing multiple revisions, the final product—an interactive E-Module Flipbook based on Quantum Learning—was produced. This version was ready for broader implementation and subsequent evaluation to measure its effectiveness in improving students' learning outcomes. By combining systematic development, limited trials, and continuous improvement, the research ensured that the final product was not only valid and practical but also effective as a teaching material for vocational high school students (Rachmayani & Setyasto, 2025).

Result and Discussion

Result

Analysis Stage

From observations at SMKN 6 Batam, particularly in the Industrial Electronics and Lighting Technology department where students take the IPAS subject (Economic Behaviour and Social Welfare), it was found that the learning process still relies heavily on PowerPoint slides and printed handouts. The delivery of material is predominantly one-way, with teachers explaining and students merely listening and taking notes. Such an approach results in a monotonous classroom atmosphere and limited student engagement, thereby reducing the effectiveness of learning.

Further field observations revealed that although almost all students in the department possess Android smartphones, these devices are rarely integrated into the learning process. Students tend to use them for social or personal purposes rather than academic support. This indicates a potential to repurpose smartphones as learning media through interactive e-modules, which students can access both in and outside the classroom to support independent learning.

The subject of Economic Behaviour and Social Welfare in IPAS requires students to understand how individual and collective economic decisions affect social well-being, sustainability, and equity. However, students often struggle to connect abstract economic theories with practical, real-life contexts relevant to their daily experiences as vocational learners. This gap highlights the urgent need for learning media that are not only informative but also contextual, engaging, and easily accessible.

To address this issue, the development of a Quantum Learning-based e-module was proposed. Quantum Learning emphasizes active engagement, multisensory experiences, and a learning atmosphere that is joyful and meaningful. This approach is considered suitable because it helps students move beyond passive note-taking and encourages them to actively construct knowledge, collaborate with peers, and apply economic and social concepts in problem-solving activities. In this way, the e-module can transform routine classroom practices into more dynamic learning experiences, directly supporting students in mastering both the cognitive understanding of economic behavior and the affective and social dimensions of welfare-oriented decision-making (Aminah et al., 2025).

Design Stage

(e-module) that integrates the Quantum Learning approach into the teaching of Project IPAS material, specifically focusing on the theme of economic behaviour and social welfare. The target audience for this e-module is students in vocational secondary schools (SMK), where the need for interactive, contextual, and student-centered learning resources is increasingly essential. This e-module is carefully designed to combine informative text, illustrative visuals, and interactive features that facilitate deeper understanding and engagement with the subject matter. By incorporating visual aids and structured content, the module aims to enhance students' cognitive processes, critical thinking skills, and ability to apply theoretical knowledge in practical contexts.

The overarching goal of the e-module is to support classroom instruction by providing a practical, hands-on, and engaging learning experience that aligns with the principles of Quantum Learning. The development process begins with the formulation of a well-organized design framework, which includes several key components: a main menu that serves as the navigation hub, a material menu that provides access to the core learning content, and an evaluation menu that contains a variety of assessment items to measure students' comprehension and mastery of the topics. In addition, project-based assignments are embedded within the module to encourage students to collaborate, reflect, and apply their understanding in real-life scenarios related to economics and social welfare. These components are strategically designed to promote active learning and reinforce key concepts through repeated exposure and application (Tumiran, 2025).

Cover Page of E-module Based on Quantum Learning in the subject of IPAS Projects on economic behaviour and social welfare for 10th grade vocational high school students.

Figure 2. Cover E-modul

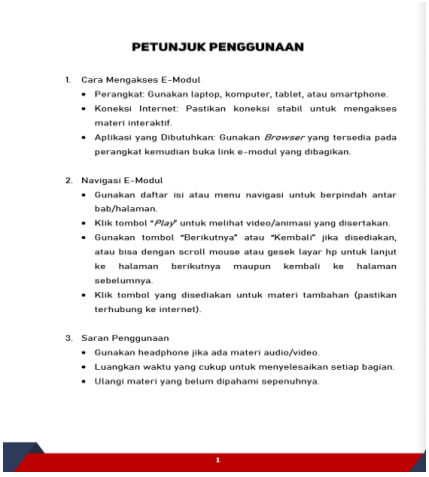

Figure 3. User guide display

The instructions for using the e-module contain information in the form of guidelines for educators and students on how to use the e-module in a more focused, systematic, and optimal manner.

The table of contents contains pages accompanied by information on the page name and page number to make it easier for users to find the desired page. Users can go to the desired page in the e-module by clicking directly on the page listed in the table of contents.

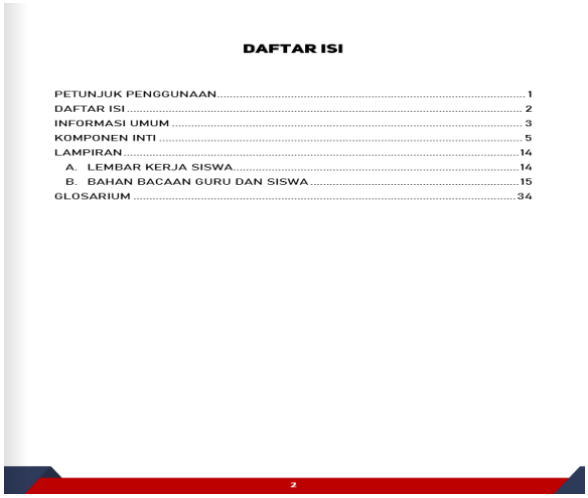

Figure 4. Table of contents display

General learning information in e-modules serves as a foundational component that facilitates the learning process for both educators and students. This section typically includes comprehensive guidance on how to navigate, utilize, and maximize the use of e-modules to support instructional goals. For educators, the information provides clear directions on how to integrate the e-module into lesson plans, align it with learning objectives, and apply it effectively in either face-to-face or online learning environments. It may also offer strategies for assessment, student engagement, and differentiated instruction based on varying learning styles and student needs.

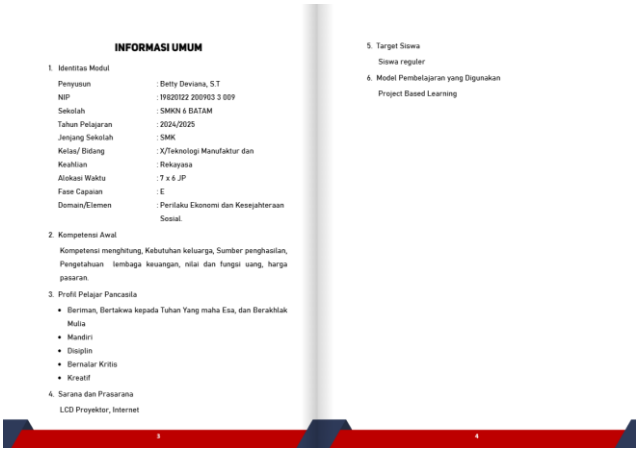

Figure 5. General information

Core Competencies contain learning objectives and attitudinal competencies that students are expected to achieve in the learning process. The core competencies are as follows.

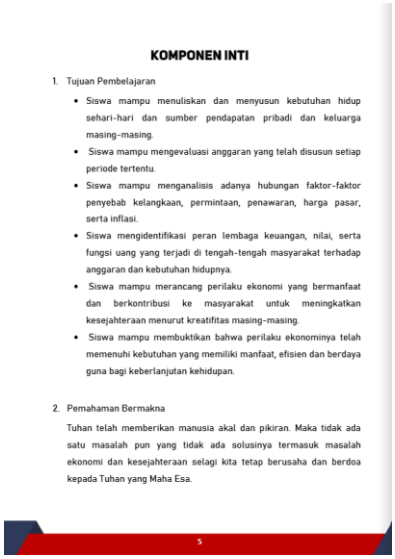

Figure 6. Core competency display

The material in the e-module is organised systematically and written in easy-to-understand language. In addition, the material is supplemented with supporting visualisations to make it easier for users to understand the meaning of the material being studied. The following is a preview of some of the material contained in the e-module.

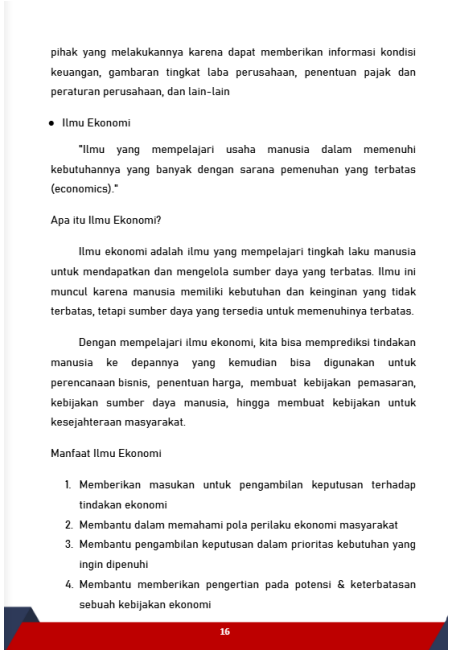

Figure 7. Presentation of material in learning activities

The learning activities contain learning steps using the Quantum Learning model in the e-module, providing guidance or instructions on the Quantum Learning model to be implemented. Learning activities include learning steps using the Quantum Learning Model in electronic modules, which provide guidance or instructions on the Quantum Learning Model to be applied. These independent and group assignments are accompanied by instructions to help students complete each task more easily and in a more focused manner. The assignments vary in nature, including both independent and group tasks. The assignment page is displayed as follows.

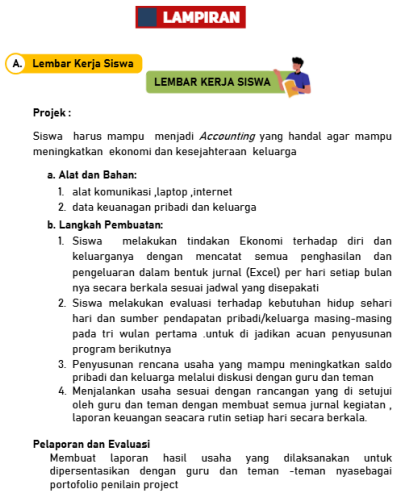

Figure 8. The appearance of the assignment page

The evaluation serves to measure the level of success and understanding of students regarding the material that has been studied. Feedback from the evaluation takes the form of scores from the evaluation results and follow-up with students regarding the scores obtained. Each multiple-choice evaluation consists of 20 questions.

Table 1. Results of Media Expert Validation

Assessment Aspect	Average Validator Value	Categories
Module components	0.988	Valid
Conceptual clarity	0.922	Valid
Presentation of material	0.922	Valid
Writing	0.922	Valid
Readability	0.922	Valid
Evaluation	0.922	Valid
Average	0.910	Valid

A bibliography is a page containing information related to sources or references that used in compiling material for e-modules. A bibliography is also provided to facilitate users who wish to check the validity of the

material contained in the e-module. The following is a list of references. This profile page contains biographical information about the developer of the Quantum Learning-based e-module for the IPAS Project subject on economic behaviour and social welfare for Grade X vocational high school students.

Tabel 2. Results of expert validation of materials results of expert validation of materials

Assessment Aspect	Average Validator Value	Categories
Compliance with language rules	0.911	Valid
Sentence suitability	0.975	Valid
Suitability for students	0.975	Valid
Average	0.960	Valid

Development Stage

The development stage involves creating e-modules using the Heyzine PDF Flipbook application. The products are validated by three experts, namely subject matter experts, media experts, and language experts, using a Likert scale-based validation sheet. Validity is assessed in terms of content, appearance, and language.

The assessment of each aspect of material validation falls within the valid category. The average validity score for material validation reached 0.960, which also falls within the valid category. Considering the assessments of media experts and material experts who acted as validators, this interactive e-module based on quantum learning is deemed suitable and appropriate for use in the learning process, both in a classroom setting and for self-study.

Table 3. Validity level categories

Achievement Level	Categories
0–0.666	Invalid
≥ 0.666	Valid

Effectiveness of Student Learning Outcomes

Gain scores are calculated based on improvements in student learning outcomes after initial and final tests. N-gain values are measured with the aim of evaluating the effectiveness of applying a method or therapy in research using a pretest-posttest group design (experimental design) or with a control group.

Analysis of learning outcomes in the cognitive aspect was conducted using the Gain Score formula. The graph above compares student learning outcomes in the experimental class with those in the control group. The Gain Score analysis shows that the experimental class's learning outcomes were higher than those of the control group. The experimental class's learning outcomes, which achieved an average gain score of 0.82, were classified as moderate. Meanwhile, the control group's average score was 0.61 (Damayanti & Prihatina, 2022).

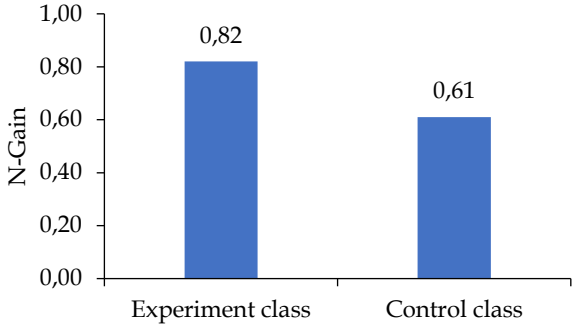

Figure 9. Graph of learning outcomes for the control and experimental classes based on gain scores

The t-test was conducted to determine whether the average learning outcomes differed between the experimental and control groups. The test used the selected t-test formula, and the t-test analysis was considered significant if $t_{count} > t_{table}$ and the sig value (two tails) < 0.05. This was evident from the results of the test calculations using SPSS by comparing the learning outcomes of students in the experimental and control classes.

Table 4. Homogeneity test of experimental class and control class pre-test and post- test

Independent Samples Test				
Levene's Test for Equality of Variances		t- Test for Equality of Means		
	F	Sig.(2-tailed)	T	Df
Equal Variances Assumed	.126	0.00	4.076	61
Equal Variances Assumed		0.00	4.088	60.859

The determination of the average difference in learning outcomes between students in the experimental class and the control class was conducted at the t-test stage. When applying the separate variance t-test formula, the t-test analysis is considered significant if the calculated t-value is greater than the table t-value and the two-tailed sig value is less than 0.05. E-Module Based On Quantum Learning In The Ipas Project Subject In Class X Of Vocational High Schools has been considered beneficial because the t-test results of the post-test scores of the experimental class and control class obtained 0.00 < 0.05.outcomes using SPSS.

Development Stage

After the project-based electronic module (e-module) on Economic Behaviour and Social Welfare at SMKN 6 Batam was successfully designed and proven to be valid, practical, and effective, it can be concluded that the e-module meets the criteria for distribution. The

project-based e-learning module 'Based on Quantum Learning' is now ready to be made available to other classes with similar subjects. The distribution of this e-learning module can be done by providing an application link via WhatsApp messages, allowing educators and students to access the e-learning module through their smartphones (Chairunisa & Zamhari, 2022). Within the distribution framework, students listen to an explanation of how to use the distributed project-based e-learning module 'IPAS.' Based on the study of the distribution results of the project-based e-learning module 'IPAS Project,' it can be concluded that this e-learning module is highly practical for use by educators and students.

Discussion

Teaching materials are a source of learning for both students and teachers that are useful for supporting learning activities. One example of a learning resource that can be used in the learning process is a module. According to Yanto et al. (2024), students have the opportunity to practice learning independently, express learning methods that suit their abilities and interests, and test their own abilities by completing the exercises provided in the module. With the current technological developments, modules are not only made in print form, but also in electronic form, better known as E-Modules. E-modules are electronic modules that can be accessed through electronic devices such as computers, mobile phones, laptops, and so on (Asnur et al., 2025). E-modules have advantages over printed modules, one of which is that they save paper and require less storage space. The development of e-learning modules that can be accessed electronically and owned by students makes it easier for students to understand the learning material (Jannah et al., 2025).

The development of E-Modules based on the Quantum Learning Model in the IPAS Project subject at Junior High Schools (SMK) aims to produce E-Modules that are valid, practical, and effective. This aligns with previous research by Ameriza & Jalinus 2021) which states that E-Modules are used to enhance students' higher-order thinking skills by producing valid, practical, and effective E-Modules for use in elementary schools. According to Hake (1999), in creating a quality product, there are three criteria: validity, practicality, and effectiveness. A product that is valid, practical, and effective can be considered suitable for use in the learning process and assists teachers and students in the learning process.

Conclusion

Based on the results of this research and development, it can be concluded that the Quantum Learning-based e-module for the IPAS Project subject on Economic Behaviour and Social Welfare in grade X at SMK Negeri 6 Batam is valid, practical, and effective. The validity was confirmed by expert assessments, with scores of 75% from media experts, 89.7% from subject matter experts, and 96.7% from language experts, indicating a category of valid to highly valid. In terms of practicality, responses from teachers (79%) and students (82%) showed that the e-module is easy to use, engaging, and supports independent learning. Regarding effectiveness, statistical test results revealed a t-value of 16.17, which is greater than the critical t-value of 1.697 at the 0.05 significance level, demonstrating a significant improvement in learning outcomes after the use of the e-module. Therefore, the developed Quantum Learning-based e-module is suitable to be used as an alternative interactive learning medium that can enhance the quality of IPAS learning while supporting the achievement of 21st-century skills in vocational high schools.

Acknowledgements

Thank you to the Dean of Dean of the Faculty of Education at Padang State University, the Head of the Postgraduate School, lecturers and students of the Educational Technology Study Programme at the Postgraduate School of Padang State University, as well as all parties who have supported the successful implementation of this research.

Authors Contribution

Conceptualization and methodology, writing—original draft preparation, B.D. and Z.Z.; software, validation, formal analysis, and investigation, R. and F.Y.J.; data curation, writing—review and editing, E.M. and A.H.A.D.

Funding

This research received no external funding.

Conflicts of Interest

There is no conflict of interest.

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