

Developing a Differentiated Interactive E-Module to Enhance Elementary Students' Understanding of ASEAN Cooperation

Ratu Meri Agusta¹, Hepsi Nindiasari², Lukman Nulhakim³

¹ Universitas Sultan Ageng Tirtayasa, Banten, Indonesia; ratumeriagusta@gmail.com

² Universitas Sultan Ageng Tirtayasa, Banten, Indonesia; hepsinindiasari@untirta.ac.id

³ Universitas Sultan Ageng Tirtayasa, Banten, Indonesia; lukman.nulhakim@untirta.ac.id

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ABSTRACT

The limited availability of differentiated and adaptive digital learning materials in elementary Social Studies creates challenges in addressing students' diverse readiness levels, interests, and learning profiles. This study aimed to develop and evaluate the feasibility, practicality, and effectiveness of the PETA differentiated interactive e-module for improving Grade VI students' conceptual understanding of ASEAN cooperation. This study employed a Research and Development design using the ADDIE model, consisting of analysis, design, development, implementation, and evaluation stages. The participants were 31 Grade VI students at SDN Cipondoh Makmur. Product validation involved media experts, content experts, and elementary education experts. Data were collected through validation sheets, conceptual understanding tests, questionnaires, observations, and interviews. Quantitative data were analyzed using descriptive statistics, N-Gain, and paired-samples t-tests, while qualitative data were analyzed through reduction, categorization, and interpretation. The developed e-module obtained high feasibility scores from media, content, and pedagogical experts, ranging from 88% to 89%. Students' conceptual understanding improved from a pretest mean score of 49.8 to a posttest mean score of 84.4. The N-Gain score reached 0.70, and the paired-samples t-test showed a significant difference between pretest and posttest scores ($p < 0.001$). Teacher and student responses also indicated high practicality and acceptance. The findings suggest that the differentiated interactive e-module has strong potential to support adaptive, engaging, and student-centered Social Studies learning. However, broader trials using control groups are needed to strengthen evidence of effectiveness and generalizability.

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Corresponding Author:

Ratu Meri Agusta

Universitas Sultan Ageng Tirtayasa, Banten, Indonesia ; ratumeriagusta@gmail.com

1. INTRODUCTION

Elementary education plays a fundamental role in establishing students' cognitive and social foundations. In the context of 21st-century learning, education is expected not only to facilitate the acquisition of factual knowledge but also to promote critical thinking, social literacy, and the ability to understand real-world contexts (Widodo et al., 2020). These competencies are aligned with the global

competence framework, which emphasizes learners' capacity to understand cross-national issues, interact in multicultural environments, and participate responsibly in global communities (OECD, 2019). Conceptually, the development of higher-order thinking skills (HOTS) is grounded in the revised Bloom's Taxonomy, which positions analysis, evaluation, and creation as advanced cognitive processes (Anderson & Krathwohl, 2001).

In this regard, Social Studies learning at the elementary level plays a strategic role in fostering students' understanding of social life across local, national, and global contexts. One essential topic at the Grade VI level is regional cooperation within the Association of Southeast Asian Nations (ASEAN). Beyond its relevance to national curriculum content, ASEAN represents a form of regional collaboration that reflects broader global interactions, making it significant for developing students' global awareness and intercultural understanding. This topic requires learners to comprehend intergovernmental cooperation, Indonesia's role in Southeast Asia, and the interconnected socio-economic and cultural dynamics of the region. Due to its conceptual and spatial characteristics, this content demands analytical and relational thinking rather than rote memorization (Agusta et al., 2025; Widodo et al., 2020).

However, empirical evidence from formative assessments conducted in a Grade VI classroom at SDN Cipondoh Makmur indicates that students' learning outcomes remain suboptimal. The average score was 66.2, below the minimum mastery criterion of 70, with only 32% of students achieving mastery. Students' performance was largely concentrated at lower cognitive levels (C1–C2), while higher-order skills such as analysis (C4) and evaluation (C5) were insufficiently developed (Salsabila & Syaban, 2022; Puspitadewi & Japa, 2022). These findings indicate a discrepancy between curriculum expectations and actual student performance.

To address this issue, the Merdeka Curriculum emphasizes the importance of accommodating student diversity through differentiated instruction. This approach involves adapting content, learning processes, and outputs based on students' readiness, interests, and learning profiles, and has been shown to enhance learning outcomes and classroom inclusivity when supported by digital environments (Purnawanto, 2023; Mumpuniarti et al., 2023). This perspective is consistent with social constructivist theory, particularly the concept of scaffolding within the zone of proximal development (Vygotsky, 1978). In addition, advances in educational technology enable the implementation of differentiation through adaptive digital systems that support individualized learning pathways based on students' readiness levels (Howard et al., 2021; Holmes et al., 2019; Zawacki-Richter et al., 2019).

Previous studies have shown that digital technology integration enhances student engagement and learning achievement, especially when designed using interactive and adaptive multimedia approaches (Nindiasari et al., 2024; Sulysiyah et al., 2024; Winahyu et al., 2024). Adaptive learning systems also contribute to personalized learning experiences and improved learning outcomes (Nulhakim et al., 2025; Bond et al., 2019; Chen et al., 2020). Furthermore, interactive e-modules have been widely reported to increase student motivation and facilitate deeper learning comprehension.

However, prior research has largely focused on product feasibility, media effectiveness, or general multimedia development. Studies that integrate differentiated content, process, and product within a single adaptive e-module based on students' conceptual readiness remain limited, particularly in elementary Social Studies contexts (Kusumawati & Prastiwi, 2025; Tahajudin et al., 2022). This indicates a clear research gap in the development of integrated and adaptive differentiated learning resources.

Accordingly, this study aims to develop and evaluate an interactive e-module that integrates differentiated instruction, conceptual readiness mapping, and adaptive learning pathways. The research is guided by the following questions: (1) How can an adventure-based interactive e-module integrating differentiated content, process, and product be developed based on students' conceptual readiness? (2) How feasible is the developed e-module based on expert validation and limited trials? (3) To what extent does the e-module improve students' conceptual understanding and learning outcomes?

The novelty of this study lies in the integration of differentiated instruction, conceptual readiness mapping, and adaptive digital learning pathways within a single interactive e-module. Theoretically, this study contributes to the advancement of differentiated and adaptive learning in elementary education.

Practically, it provides an innovative digital learning resource that supports the implementation of the Merdeka Curriculum and addresses the demands of 21st-century and globally oriented learning.

2. METHODS

This study employed a Research and Development (R&D) approach aimed at developing an instructional product while empirically evaluating its validity, practicality, and effectiveness in an authentic classroom context (Sugiyono, 2022; Creswell & Creswell, 2018; Plomp, 2013). This approach was selected because it facilitates a systematic development process and produces educational products that are rigorously tested through stages of analysis, design, development, implementation, and evaluation. It is particularly suitable for developing a differentiated interactive e-module tailored to elementary school learners.

The development model adopted in this study was the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) (Branch, 2009). This model was chosen due to its systematic yet flexible structure and its applicability in digital learning media development oriented toward user needs and empirical validation. In addition, the ADDIE model enables the integration of differentiated instruction principles at each stage of development.

The study was conducted at SDN Cipondoh Makmur, Tangerang City, during the 2025/2026 academic year. The participants consisted of 31 Grade VI B students selected using total sampling, as all students in the class were involved in the study. The participants comprised 19 male and 12 female students. In addition, the validation process involved nine experts, including three media experts, three subject matter experts, and three elementary education experts. Ethical approval was obtained from the school, and informed consent was secured prior to data collection.

The analysis phase involved diagnostic assessments, classroom observations, teacher interviews, and curriculum document analysis to identify students' needs, characteristics, and curriculum alignment. The findings indicated that students' understanding of ASEAN cooperation was predominantly limited to lower-order cognitive levels and was not supported by interactive digital learning resources.

The design phase included developing specifications for an adventure-based interactive e-module integrating differentiation in content, process, and product. This phase involved mapping students' conceptual readiness, designing adaptive learning pathways, preparing storyboards, and developing research instruments, including tests, validation sheets, questionnaires, interview guidelines, and observation checklists.

During the development phase, the e-module was produced using Canva Education and integrated with multimedia elements such as infographics, audio, video, and adaptive quizzes. The product was validated by experts to assess content relevance, language clarity, media quality, and pedagogical appropriateness (Nieveen, 2010). Instrument validity was evaluated using Aiken's V , calculated as:

$$V = \frac{\sum s}{n(c - 1)}$$

where $s = r - l_0$, r represents the score assigned by each expert, l_0 is the lowest score, c is the number of rating categories, and n is the number of experts. The validation employed a five-point Likert scale (1–5). The results were interpreted to determine the content validity of the instruments prior to implementation.

The implementation phase involved a limited trial conducted as part of the ADDIE process. To evaluate effectiveness, a one-group pretest–posttest design was employed (Fraenkel et al., 2019). This design was used to measure changes in students' learning outcomes after the use of the developed e-module, while maintaining the primary focus of the study as R&D. Data were collected through tests, questionnaires, observations, and interviews.

The evaluation phase consisted of formative and summative evaluation. Formative evaluation was conducted at each stage to refine the product based on expert feedback and trial results, while summative evaluation was conducted after implementation to assess overall product quality. The study utilized both quantitative and qualitative data. Quantitative data were obtained from validation results, pretest and posttest scores, and questionnaire responses. These data were analyzed using descriptive statistics, Normalized Gain (N-Gain), and paired-samples t-tests (Waruwu, 2024). Prior to conducting the t-test, data normality was tested using the Shapiro–Wilk test to ensure that statistical assumptions were met. N-Gain values were interpreted as low (<0.3), moderate ($0.3\text{--}0.7$), and high (>0.7).

Qualitative data were obtained from interviews, observations, and expert feedback. These data were analyzed through a systematic process consisting of data reduction, coding, categorization, and interpretation to support the quantitative findings.

3. FINDINGS AND DISCUSSION

3.1 Findings

The development of the PETA interactive e-module employed the ADDIE model to produce a valid, practical, and effective learning medium for Grade VI social studies instruction at SDN Cipondoh Makmur. The preliminary needs analysis revealed that classroom instruction remained predominantly dependent on textbooks and atlases despite the availability of digital facilities in schools. Teacher interviews further indicated that students experienced difficulties in understanding spatial and conceptual relationships related to ASEAN cooperation and tended to memorize information without fully comprehending conceptual interconnections. Students also perceived conventional text-based instruction as less engaging and expressed stronger preferences for visual and interactive learning environments. These findings reflect a gap between technological availability and its pedagogical implementation in elementary classrooms (Handayani et al., 2024; Anggraeni et al., 2021; Harsiwi & Arini, 2020).

Curriculum analysis additionally demonstrated that ASEAN-related material within the Merdeka Curriculum requires spatial, relational, and contextual understanding, which aligns with the concrete operational developmental stage of elementary school learners (Ananda & Hayati, 2020; Sanjaya et al., 2024). The diversity of students' readiness levels further highlighted the importance of adaptive and differentiated instructional approaches. Previous studies have reported that interactive digital media may facilitate flexible learning experiences and support differentiated learning implementation in elementary education contexts (Safitri & Dafit, 2025; Fahrozi & Sutikno, 2024; Purnawanto, 2023). Other studies also emphasize the importance of integrating digital learning environments with students' learning profiles and technological accessibility (Azmy & Fanny, 2023; Amini & Usmeldi, 2022; Hasanah et al., 2023). Based on these considerations, a differentiation-based interactive e-module integrating spatial visualization and adaptive learning pathways was developed.

The design phase generated an e-module structure consisting of introductory sections, interactive navigation menus, multimedia-based learning materials, tiered exercises, reflective activities, product-based assignments, and references. Interactive maps, videos, infographics, audio, and reflective prompts were integrated to support differentiated content, learning processes, and product variations according to students' readiness levels and interests. The development stage subsequently produced an interactive prototype equipped with user guidelines, leveled exercises, and differentiated assignments designed to facilitate independent and exploratory learning experiences.

Validation results demonstrated that the e-module achieved highly feasible criteria across media, content, and pedagogical aspects. Media expert validation obtained a mean feasibility score of 89%, content expert validation reached 88.7%, and pedagogical validation achieved 88%.

Table 1. Media Expert Validation Results

Validator	Score	Maximum Score	Percentage (%)	Category
Media Expert 1	48	50	96	Highly Feasible
Media Expert 2	40	50	80	Feasible
Media Expert 3	46	50	92	Highly Feasible
Mean			89	Highly Feasible

The media validation confirmed that the e-module fulfilled essential standards of visual presentation, navigation, typography, and layout consistency in digital instructional media. Minor differences in expert ratings were primarily associated with cross-device accessibility and display optimization across desktop and smartphone platforms (Hasanah et al., 2023; Amini & Usmeldi, 2022).

Table 2. Content Expert Validation Results

Validator	Score	Maximum Score	Percentage (%)	Category
Content Expert 1	45	50	90	Highly Feasible
Content Expert 2	40	50	80	Feasible
Content Expert 3	48	50	96	Highly Feasible
Mean			88.7	Highly Feasible

Content validation further demonstrated strong curriculum alignment, conceptual accuracy, and systematic organization of ASEAN-related materials. The hierarchical arrangement of concepts from foundational to more complex topics supported structured conceptual development appropriate for elementary social studies learning (Widodo et al., 2020; Ananda & Hayati, 2020).

Table 3. Elementary Education Expert Validation Results

Validator	Score	Maximum Score	Percentage (%)	Category
Expert 1	44	50	88	Highly Feasible
Expert 2	40	50	80	Feasible
Expert 3	48	50	96	Highly Feasible
Mean			88	Highly Feasible

The pedagogical assessment additionally indicated that the e-module effectively accommodated the developmental characteristics of elementary learners through contextual visualization, communicative language, and structured learning guidance. Several revisions were implemented following expert recommendations, particularly regarding reflective questions, glossary additions, map visualization refinement, and self-assessment features.

Content validity analysis using Aiken's V produced values ranging from 0.86 to 0.93, exceeding the minimum acceptable threshold of 0.80 and indicating strong inter-expert agreement (Nugraheni et al., 2025).

Table 4. Minimum Acceptable Value of Aiken's V

Number of Validators	Minimum Value
3	0.80

These findings confirm that the evaluation instrument demonstrated adequate representativeness and reliability for assessing product feasibility.

The effectiveness analysis demonstrated substantial improvement in students' conceptual understanding following implementation of the e-module. Instrument testing first confirmed that all test items met validity criteria, while reliability analysis produced a Cronbach's Alpha coefficient of 0.89, indicating very high internal consistency (Wahab et al., 2021; Fraenkel et al., 2019).

Table 5. Item Validity Results

Item	r-value	r-table	Criteria
1	0.763	0.355	Valid
2	0.497	0.355	Valid
3	0.518	0.355	Valid
4	0.815	0.355	Valid
5	0.381	0.355	Valid
6	0.608	0.355	Valid
7	0.381	0.355	Valid
8	0.656	0.355	Valid
9	0.876	0.355	Valid
10	0.903	0.355	Valid

Table 6. Instrument Reliability

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
0.883	0.891	10

The pretest and posttest analyses revealed substantial improvement in students' learning outcomes after the implementation of the e-module.

Table 7. Pretest and Posttest Descriptive Statistics

Statistic	Pretest	Posttest
Minimum	30	71
Maximum	65	100
Mean	49.8	84.4

The normalized gain analysis also indicated substantial improvement in conceptual understanding.

Table 8. N-Gain Category

Mean Pretest	Mean Posttest	N-Gain	Category
49.8	84.4	0.70	High

Inferential analysis using a paired sample t-test additionally confirmed statistically significant improvement following implementation of the e-module.

Table 9. Paired Sample t-Test Results

Statistic	Value
Mean Difference	34.58065
t-value	30.758
Degrees of Freedom (df)	30
Significance (2-tailed)	< 0.001

The increase in learning outcomes indicates that the PETA interactive e-module effectively improved students' conceptual understanding of ASEAN cooperation concepts and facilitated learning improvement across varying initial ability levels (Pangestuti et al., 2024; Nindiasari et al., 2022; Widanti et al., 2023). Similar findings regarding the effectiveness of interactive digital media in elementary learning contexts have also been reported by Widodo et al. (2020) and Pratama et al. (2022).

Practicality and user acceptance analyses likewise demonstrated positive implementation outcomes. Classroom observations revealed that learning implementation reached 87.5% in the very good category, while teacher responses indicated high practicality levels.

Table 10. Teacher Responses to the Practicality of the E-Module

Assessment Aspect	Maximum Score	Obtained Score	Percentage	Category
Learning Implementation	40	35	87.5%	Very Good
Practicality of Use	60	56	93.33%	Very Good

Observation and interview data additionally revealed increased student participation, exploratory interaction, and independent learning behaviors during classroom activities. Teachers also reported that the e-module facilitated differentiated learning implementation through flexible access and varied learning activities aligned with students' readiness and learning pace (Tomlinson, 2014; Husnah et al., 2023).

Table 11. Student Responses to E-Module Acceptance

Indicator	Percentage	Category
Learning Engagement	87.5%	Very Good
Media Attractiveness	94.19%	Very Good
Intention for Continued Use	92.26%	Very Good
Support for Critical Thinking	81.94%	Very Good
Mean	87.80%	Very Good

The high acceptance level indicates that the e-module was positively perceived by students in terms of engagement, media attractiveness, and support for independent learning. Increased interaction with videos, quizzes, and digital maps further demonstrated positive behavioral and cognitive engagement during social studies learning activities (Bond & Bedenlier, 2019; Fredricks et al., 2004; Rahmawati & Yulianti, 2023). Overall, the findings demonstrate that the PETA interactive e-module fulfilled validity, effectiveness, and practicality criteria and supported adaptive, interactive, and differentiated learning experiences in elementary social studies instruction.

3.2 Discussion

The findings demonstrate that the integration of interactive spatial visualization and differentiated instruction may significantly enhance conceptual understanding in elementary social studies learning. Unlike many previous studies that primarily focused on multimedia presentation or general digital learning integration, this study combined interactive digital maps, adaptive learning pathways, and differentiated instructional structures within a single e-module design. The primary novelty of this study therefore lies in the integration of spatial visualization, differentiated instruction, and adaptive digital learning within elementary social studies contexts, particularly in ASEAN cooperation material, which remains relatively underexplored in previous elementary education research. While prior studies generally examined multimedia learning and differentiated instruction separately, the present findings indicate that the simultaneous integration of these components may support conceptual understanding, learner engagement, and adaptive learning experiences more effectively in heterogeneous classrooms (Safitri & Dafit, 2025; Rizaldi et al., 2025; Farmah & Nindiasari, 2025).

The high feasibility results across media, content, and pedagogical aspects indicate that the e-module fulfilled essential digital instructional design standards. Strong evaluations in visual presentation, navigation, and layout consistency suggest that the learning environment successfully reduced unnecessary cognitive complexity and facilitated more accessible learning experiences. This finding is important because elementary learners often experience difficulty processing abstract and spatially complex social studies material through text-dominant instruction alone. Interactive maps, visual navigation, and multimedia integration appear to function not merely as presentation tools but

as cognitive scaffolds that support relational understanding and information organization. This interpretation reinforces multimedia learning theory, which emphasizes that visual and verbal integration facilitates more effective cognitive processing and conceptual retention (Mayer, 2009). Similar patterns have been identified in international studies reporting that structured multimedia environments improve learner engagement and conceptual comprehension through multimodal representation and active interaction (Al-Fraihat et al., 2020; Schindler et al., 2017). National studies likewise reported that interactive multimedia may reduce learning abstraction and improve conceptual understanding among elementary learners (Anggraeni et al., 2021; Harsiwi & Arini, 2020). However, the present findings extend previous research by indicating that spatial visualization in social studies learning may also strengthen contextual and geopolitical understanding rather than merely improving media attractiveness.

Variations in expert assessments, particularly regarding cross-device accessibility, additionally reveal an important issue frequently overlooked in elementary digital learning implementation. Previous studies generally emphasized the effectiveness of digital media without critically addressing disparities in technological accessibility and device compatibility (Hasanah et al., 2023; Amini & Usmeldi, 2022). The present findings suggest that flexibility in digital accessibility constitutes an important component of differentiated instruction because students interact with digital learning environments under diverse technological conditions. This indicates that adaptive digital learning should not only focus on content differentiation but also consider technological inclusivity and accessibility as integral dimensions of equitable learning experiences (Tomlinson, 2014; Fahrozi & Sutikno, 2024).

The strong content feasibility results further indicate that the hierarchical organization of ASEAN-related concepts contributed to gradual conceptual development among elementary learners. This finding is particularly relevant because social studies learning frequently requires students to understand relational, contextual, and spatial connections between social phenomena. The integration of structured conceptual sequencing and interactive spatial visualization appears to facilitate deeper understanding by enabling students to organize information progressively and contextually. Previous studies generally examined conceptual accuracy and multimedia integration independently (Widodo et al., 2020; Ananda & Hayati, 2020), whereas the present findings suggest that conceptual sequencing and spatial representation may work synergistically in supporting social literacy and contextual understanding. This interpretation extends previous elementary social studies research by highlighting the importance of relational visualization in conceptual learning processes.

From a pedagogical perspective, the integration of interactive maps, videos, infographics, reflective activities, and exploratory quizzes supported more meaningful and exploratory learning experiences. The effectiveness of these features may be explained through cognitive load theory and dual coding principles, particularly regarding the role of multimodal representation in facilitating schema construction and reducing extraneous cognitive load (Sweller, 2011; Paas & Sweller, 2014; Mayer, 2009). However, the present findings indicate that multimedia integration alone may not sufficiently support meaningful learning in heterogeneous classrooms. Rather, the combination of visualization, interactivity, differentiated learning pathways, and learner autonomy appears to create more adaptive learning environments that support both conceptual understanding and engagement simultaneously. This finding extends previous applications of multimedia learning theory by emphasizing that cognitive accessibility should be integrated with instructional adaptability in elementary digital learning contexts. Similar findings concerning the effectiveness of interactive multimedia in reducing abstraction and strengthening conceptual understanding have also been reported in previous national studies (Nopiani et al., 2021; Oktafiani et al., 2020; Badri et al., 2019).

The improvement in students' conceptual understanding further confirms the effectiveness of the e-module in supporting meaningful learning experiences. The high N-Gain category and statistically significant results indicate that the intervention contributed not only to statistical improvement but also to substantive conceptual development. These improvements appear to have occurred because

students were provided with opportunities to explore learning materials actively through interactive visualizations, flexible navigation, and differentiated learning pathways rather than passively receiving information through conventional text-based instruction.

International studies have consistently shown that interactive digital learning environments enhance conceptual understanding, learner engagement, and knowledge retention by promoting active cognitive participation and meaningful interaction with learning materials (Scherer et al., 2019; Bond et al., 2020; Martin & Bolliger, 2018). Recent national evidence similarly indicates that adaptive and structured digital visualization contributes positively to conceptual comprehension and exploratory learning processes among elementary students (Muslimah et al., 2025; Holisoh et al., 2023). Previous national studies also reported that interactive media improve conceptual understanding and learning achievement (Nindiasari et al., 2022; Pangestuti et al., 2024; Pratama et al., 2022).

However, the present findings extend previous research by suggesting that differentiated digital learning structures may not only improve conceptual understanding but also reduce learning disparities among students with varying readiness levels and learning profiles. This indicates that the integration of interactive visualization and differentiated learning pathways may function as an adaptive instructional mechanism capable of supporting more equitable and learner-responsive learning experiences in heterogeneous elementary classrooms.

The implementation of differentiated instruction constitutes another important contribution of this study. Although differentiated instruction has been widely discussed theoretically, its integration within interactive digital elementary social studies environments remains relatively limited. Previous studies often implemented differentiation through classroom grouping or task modification without integrating adaptive digital learning pathways (Purnawanto, 2023; Azmy & Fanny, 2023; Husnah et al., 2023). In contrast, the present findings indicate that differentiation in content, process, and product may become more effective when supported by interactive multimedia and flexible digital navigation. This integration enabled students to engage with learning materials according to their readiness levels, interests, and learning preferences. Consequently, differentiated instruction functioned not merely as instructional variation but as a mechanism for supporting equitable and personalized learning experiences in heterogeneous classrooms (Tomlinson, 2014). This finding strengthens previous arguments that digitally supported differentiated instruction may improve learning adaptability and learner responsiveness in elementary classrooms (Nulhakim & Berlian, 2020).

The practicality and user acceptance findings additionally reinforce the pedagogical applicability of the e-module in authentic classroom settings. Observation, interview, and questionnaire data consistently demonstrated increased participation, exploratory interaction, and independent learning behavior during implementation. These findings support engagement theory, which emphasizes behavioral and cognitive participation as essential dimensions of meaningful learning experiences (Bond, 2020; Bond & Bedenlier, 2019; Fredricks et al., 2004). Increased interaction with quizzes, videos, and digital maps also suggests that interactive digital environments may positively influence classroom participation and intrinsic motivation by encouraging exploratory and student-centered learning processes (Ryan & Deci, 2020; Deci & Ryan, 2000). Previous studies similarly reported that adaptive digital learning environments contribute positively to learner autonomy, engagement, and self-directed learning behavior (Zimmerman, 2002; Martin & Bolliger, 2018). The opportunity to explore interactive content and construct understanding independently may also strengthen knowledge transfer and deeper conceptual organization among learners (Bransford et al., 2000).

Another important contribution of this study lies in the contextual integration of interactive digital maps within elementary social studies learning. Previous elementary multimedia studies predominantly focused on science or thematic instruction, whereas interactive spatial visualization in elementary social studies contexts remains relatively underexplored. The present findings indicate that digital map visualization may support not only conceptual understanding but also the development of global literacy, contextual awareness, and relational understanding regarding regional cooperation. This contribution is particularly relevant within contemporary social studies education, which

increasingly emphasizes global citizenship competencies, contextual learning, and digital literacy integration (Khusniawati et al., 2024; Listiyoningsih et al., 2024).

From a theoretical standpoint, the findings reinforce the relevance of multimedia learning theory, cognitive load theory, engagement theory, self-determination theory, and differentiated instruction frameworks within elementary digital learning contexts (Mayer, 2009; Sweller, 2011; Fredricks et al., 2004; Ryan & Deci, 2020; Tomlinson, 2014). Nevertheless, the present findings also extend existing theoretical discussions by indicating that effective elementary digital learning environments require not only multimedia integration but also instructional adaptability, learner autonomy, and contextual visualization simultaneously. This suggests that future digital instructional design frameworks in elementary education should move beyond media-centered approaches toward more adaptive and learner-responsive digital learning ecosystems.

Despite these positive findings, several limitations should be acknowledged. The implementation involved only one class with a relatively limited sample size, which may restrict broader generalization of the findings. In addition, the study primarily focused on short-term conceptual understanding and did not comprehensively examine long-term retention, collaborative interaction, or higher-order analytical skills. Future studies are therefore recommended to investigate longitudinal learning impacts, broader implementation contexts, and comparative effectiveness across different elementary learning environments. Further research may also explore the integration of interactive digital maps with collaborative learning strategies, artificial intelligence-supported personalization, and higher-order thinking skill development in elementary social studies instruction. Future digital learning environments may further benefit from adaptive and intelligent learning systems capable of supporting personalized learning experiences and dynamic learner interaction (Chen et al., 2020; Howard et al., 2021).

4. CONCLUSION

This study concludes that the PETA differentiated interactive e-module is feasible, practical, and effective in enhancing Grade VI students' conceptual understanding of ASEAN cooperation. The integration of differentiated content, learning processes, product-based tasks, interactive spatial visualization, and adaptive learning pathways enabled students to engage with learning materials according to their readiness levels, interests, and learning needs, as reflected in the high expert validation scores, positive teacher and student responses, and improved posttest achievement. However, this study was limited by its small sample size, implementation in a single elementary school, and use of a one-group pretest-posttest design without a control group, which limits the generalizability of the findings and the strength of causal claims. Therefore, future research is recommended to involve larger and more diverse samples, employ experimental or quasi-experimental designs with comparison groups, and examine the long-term effects of differentiated interactive e-modules on students' knowledge retention, higher-order thinking skills, collaborative learning, and digital literacy in broader elementary education contexts.

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