



## The Impact of Interactive E-Modules on Students' Understanding of Basic Map Knowledge in Geography Learning

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**Abstract:** This study examined the effectiveness of interactive e-modules in improving Grade X students' learning outcomes in basic map knowledge at SMAN 2 Tenggara Seberang. The research used a quantitative pre-experimental one-group pretest-posttest design involving 22 students. Data were collected through a 10-item multiple-choice test and analyzed using descriptive statistics, Shapiro-Wilk normality testing, paired sample t-test, and Cohen's d. The mean pretest score was 63.82, while the posttest mean increased to 77.73. The paired sample t-test showed a significant difference between pretest and posttest scores ( $p = 0.006$ ), and the effect size indicated a moderate impact ( $d = 0.657$ ). These findings show that interactive e-modules are effective in supporting student-centered geography learning and improving students' conceptual understanding of map symbols, scale, orientation, and interpretation. The study contributes evidence for developing digital geography instruction that is more interactive, flexible, and conceptually meaningful in secondary education. It also supports wider use of e-modules in visual geography topics strategically.

**Abstrak:** Penelitian ini bertujuan menganalisis efektivitas e-modul interaktif dalam meningkatkan hasil belajar pengetahuan dasar peta pada siswa kelas X SMAN 2 Tenggara Seberang. Penelitian menggunakan pendekatan kuantitatif dengan desain pre-eksperimental one-group pretest-posttest yang melibatkan 22 peserta didik. Data dikumpulkan melalui tes pilihan ganda 10 butir, kemudian dianalisis dengan statistik deskriptif, uji normalitas Shapiro-Wilk, uji paired sample t-test, dan effect size Cohen's d. Rata-rata skor pretest sebesar 63,82 meningkat menjadi 77,73 pada posttest. Hasil uji t menunjukkan perbedaan yang signifikan antara nilai sebelum dan sesudah perlakuan ( $p = 0,006$ ), sedangkan effect size menunjukkan pengaruh sedang ( $d = 0,657$ ). Temuan ini membuktikan bahwa e-modul interaktif efektif mendukung pembelajaran geografi yang berpusat pada siswa serta meningkatkan pemahaman konseptual terhadap simbol, skala, orientasi, dan interpretasi peta. E-modul layak dimanfaatkan sebagai media digital yang praktis dan bermakna. Hasil ini juga memperkuat pentingnya integrasi media digital dalam pembelajaran geografi berbasis konsep spasial di sekolah menengah, terutama untuk materi yang abstrak dan visual.

## A. Introduction

The exponential progression of digital technologies has fundamentally reshaped pedagogical methodologies on a global scale, prompting educators and academic institutions to embrace instructional media that exhibit greater flexibility, interactivity, and alignment with learner-centered paradigms. Within the landscape of modern education, digital resources have transcended their traditional role as merely supplementary aids; they have evolved into indispensable elements that underpin efficacious knowledge acquisition in the contemporary information technology epoch (Suhendra et al., 2025). Such paradigmatic transformation is inextricably connected to the escalating imperative for students to cultivate digital literacy capabilities, autonomous learning proficiencies, and adaptive competencies that correspond with the educational demands characterizing the twenty-first century. As a natural corollary, the incorporation of technology-enhanced learning media has emerged as a central locus of scholarly attention within the broader discourse on educational innovation (FH et al., 2023; Nurhijrah, 2024).

Situated within this broader educational context, the discipline of geography warrants particular scholarly scrutiny by virtue of its engagement with conceptual frameworks that are intrinsically abstract, spatially oriented, and visually demanding in nature. The domain of fundamental cartographic literacy, by way of illustration, necessitates that learners attain comprehension across multiple dimensions encompassing cartographic symbology, scale representation, directional systems, map projections, and interpretive methodologies, all of which presuppose the possession of robust spatial reasoning capacities (Prasetyo et al., 2025). Regrettably, when these multifaceted concepts are conveyed through conventional didactic approaches, learners frequently encounter substantial difficulties in achieving genuine comprehension of the subject matter. Such pedagogical constraints have the potential to engender diminished learner engagement and merely superficial levels of understanding, thereby underscoring the exigency for geography instruction to be supported by instructional media that afford enhanced interactivity and visual scaffolding (Mardiah & Anwar, 2025; Hisan & Mudzakir, 2024).

These pedagogical challenges find concrete manifestation in actual classroom settings, most notably at SMAN 2 Tenggarong Seberang, where the deployment of innovative instructional media for teaching fundamental cartographic concepts remains considerably constrained. The consequence of this technological underutilization is that learners frequently confront significant obstacles in comprehending the subject matter, a predicament that becomes particularly acute when pedagogical delivery depends overwhelmingly on verbal exposition and the use of conventional learning materials. Such circumstances are liable to produce suboptimal academic outcomes and a corresponding attenuation in student participatory engagement. Given that foundational cartographic literacy constitutes a cornerstone competency within the broader architecture of geography education, these identified constraints accentuate the pressing necessity for the development and implementation of learning methodologies that demonstrate both

superior efficacy and heightened capacity for learner engagement (Ardhiansyah et al., 2025; Safira et al., 2025).

In response to these identified pedagogical exigencies, the utilization of interactive electronic modules presents itself as a promising remedial approach. Electronic modules, conceptualized as digitally-based learning resources, are meticulously engineered to disseminate educational content through formats that are systematically organized, visually enriched, and interactively engaging, thereby empowering learners to pursue knowledge acquisition autonomously and according to their individual learning rhythms (Nurbani et al., 2025). Grounded in constructivist epistemology, the process of learning is understood to transpire when learners actively engage in the construction of personal meaning through sustained interaction with educational resources. Complementarily, multimedia learning theory posits that the strategic integration of textual and visual elements serves to augment comprehension while simultaneously alleviating cognitive burden. Collectively, these theoretical orientations furnish robust justification for the incorporation of e-modules within geography instruction, particularly in contexts where visual representation assumes paramount importance in facilitating the apprehension of spatially-oriented concepts (Idayanti & Suleman, 2024).

An expanding corpus of empirical investigation lends credence to this theoretical positioning, with numerous studies substantiating the capacity of digital learning media, including electronic modules, to engender improvements in both academic achievement and learner motivation. Prior research has consistently demonstrated that e-modules promote enhanced comprehension by virtue of their methodically structured, interactively designed, and readily accessible architectural features (Safitri & Dafit, 2025; Sidauruk et al., 2025; Salsabila & Syaban, 2022). Within the specific disciplinary context of geography, digitally-mediated learning instruments have likewise been empirically shown to elevate students' cognitive performance and intensify their engagement with the learning process (Faidah et al., 2025; Ansori et al., 2025; Ady et al., 2025). Additionally, e-modules afford considerable pedagogical flexibility and accommodate student-centered instructional approaches, a characteristic that proves especially advantageous when addressing subject matter that demands both visual apprehension and conceptual depth (Ayuningtyas et al., 2024; Zahra et al., 2025; Fatwa & Agustina, 2025).

Notwithstanding the promising nature of these empirical findings, a critical examination of the existing literature reveals a predominant orientation toward disciplines such as natural sciences, mathematics, or the assessment of general academic outcomes, rather than a concentrated focus on discipline-specific conceptual understanding within geography. Empirical inquiries that specifically scrutinize the pedagogical effectiveness of e-modules in the instruction of fundamental cartographic knowledge remain notably scarce, despite the pivotal status of this subject matter within the geography curriculum (Fachrezi, 2025). Furthermore, extant scholarship has frequently addressed digital media in broad, nonspecific terms, neglecting to elucidate the particular mechanisms through which such technologies facilitate the comprehension of abstract spatial concepts, encompassing

cartographic symbology, scale calibration, directional orientation, and interpretative analysis. This observational pattern unmistakably signals the existence of a substantive lacuna within the current research landscape (Pujiantiningtyas et al., 2022; Wijayanto et al., 2023).

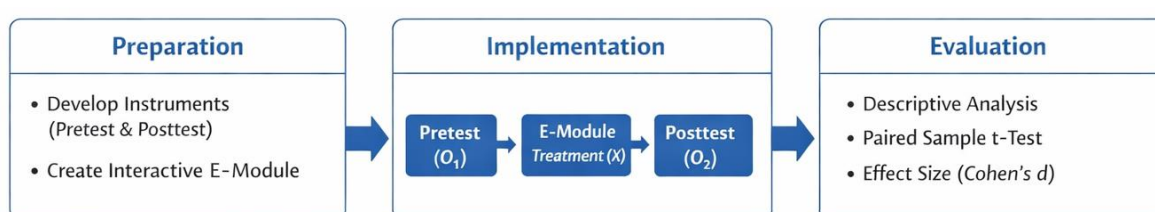
With the explicit objective of addressing this identified scholarly void, the present investigation introduces several distinctive contributions to the existing body of knowledge. Primarily, the study directs its analytical focus toward fundamental cartographic literacy as an essential spatial competency within geography pedagogy. Secondly, it undertakes a systematic examination of interactive e-module utilization, with particular emphasis on their capacity to foster both student-centered and self-directed learning modalities. Tertiarily, the research evaluates intervention effectiveness through a dual analytical framework that encompasses not merely the ascertainment of statistical significance, but additionally the computation of effect size magnitude, an approach that yields a more nuanced and comprehensive appreciation of the intervention's pedagogical impact. Through the integration of these analytical dimensions, the present study establishes itself as a substantive contribution to the ongoing development of digitally-mediated geography instruction (Yenny et al., 2022; Edler et al., 2025).

Synthesizing the foregoing argumentative exposition, the present investigation is oriented toward providing empirical elucidation to the following research inquiry: To what extent does the pedagogical implementation of interactive electronic modules produce significant enhancement in the learning outcomes of Grade X students concerning fundamental cartographic knowledge at SMAN 2 Tenggara Seberang? In consonance with this interrogative framing, the study pursues the objective of rigorously examining the pedagogical efficacy of interactive e-modules in advancing learners' conceptual comprehension of cartographic symbology, scale determination, directional orientation, and map interpretative competencies. From a theoretical vantage point, the anticipated findings are expected to make meaningful contributions to the evolving landscape of digital geography education, specifically through the fortification of constructivist and multimedia-based theoretical frameworks as applied within spatial learning contexts. From a practical standpoint, this investigation furnishes educators with an alternative instructional methodology that demonstrably supports learner-centered pedagogy while concomitantly elevating academic achievement. Moreover, the empirical outcomes of this study are projected to serve as catalyst for the more widespread incorporation of interactive digital media within geography education, with particular relevance for the pedagogical treatment of abstract and visually-intensive concepts at the secondary education level.

## B. Method

The methodological framework of this investigation was anchored in a quantitative research paradigm, specifically utilizing a pre-experimental design characterized by a one-group pretest-posttest structure. This methodological configuration was selected to enable a rigorous assessment of the pedagogical effectiveness of interactive electronic modules in

enhancing student achievement within the domain of fundamental cartographic knowledge. The research design operationalized a sequential measurement protocol denoted as O1-X-O2, wherein O1 corresponds to the baseline pretest assessment, X designates the experimental treatment consisting of e-module-mediated instruction, and O2 signifies the posttest evaluation administered subsequent to the intervention (Wahidah et al., 2022; Rahmawati et al., 2026). The research sample comprised 22 students enrolled in the tenth grade at SMAN 2 Tenggara Seberang, recruited through a total sampling procedure whereby all members of the target class were invited to participate in the investigation. The empirical data collection was executed during the odd semester academic period, spanning from November through December.



**Figure 1.** Research Flow

The procedural execution of this research was organized systematically across three principal phases: preliminary preparation, instructional implementation, and post-intervention evaluation, as depicted diagrammatically in Figure 1. During the preparatory phase, the principal investigator undertook the development of all research instruments, encompassing both pretest and posttest assessment items, alongside the formulation of the interactive e-module that would serve as the primary instructional medium. The assessment instrument was constructed to comprise ten multiple-choice items, each designed to measure student comprehension of fundamental cartographic concepts, specifically including cartographic symbology, scale representation, directional orientation, and map interpretation. To safeguard the psychometric integrity of the instrument, content validity was established through expert panel review, engaging two specialists in geography education and one expert in educational evaluation, whose collective assessment confirmed the substantive validity of all test items. Supplementary to this validity determination, reliability analysis was conducted using Cronbach's Alpha, yielding a coefficient value of 0.78, a result that attests to satisfactory internal consistency of the measurement instrument.

During the implementation phase, participants were initially administered the pretest instrument to ascertain their baseline level of comprehension regarding fundamental cartographic concepts. Subsequent to this baseline assessment, the instructional process was enacted utilizing the interactive e-module across two separate class sessions, during which learners interacted with visually enriched and interactively designed content that had been specifically developed to foster both independent study habits and student-centered learning modalities. Upon the conclusion of these instructional sessions, the posttest instrument was administered to evaluate any measurable alterations in student learning outcomes attributable to the experimental intervention. In order to preserve the internal

validity of the research design, stringent procedural controls were maintained throughout the investigation, including the consistent deployment of the same instructor, uniform instructional time allocation, and unvarying learning objectives across all phases of the study.

In the evaluation phase, the numerical data generated from both the pretest and posttest administrations were subjected to comprehensive statistical analysis employing both descriptive and inferential analytical techniques. Descriptive statistical procedures were utilized to compute the arithmetic mean, standard deviation, and aggregate measures of score improvement across the participant cohort. Preliminary to the execution of hypothesis testing procedures, the distributional properties of the data were examined through the Shapiro-Wilk normality test. The analytical results indicated that the pretest data conformed satisfactorily to the normal distribution assumption ( $p > 0.05$ ), whereas the posttest data evidenced a modest departure from normality ( $p < 0.05$ ). Notwithstanding this minor distributional violation, the paired sample t-test was deemed appropriate for continued application given its established statistical robustness when employed with sample sizes exceeding 20 observations. To provide empirical resolution to the stated research question, the paired sample t-test was implemented to ascertain the existence of statistically significant differences between the pretest and posttest score distributions (Putri et al., 2023). Complementarily, the magnitude of the intervention's impact was quantified through the calculation of effect size using Cohen's d statistic, with the resulting value interpreted according to Cohen's established benchmark criteria.

### C. Result

The empirical findings of this investigation elucidate the pedagogical effectiveness of interactive electronic modules in engendering improvements in student learning outcomes within the domain of fundamental cartographic knowledge. The instructional process was executed across two class sessions, employing a pedagogical approach that foregrounded student-centered learning principles. The sequential structure of the intervention commenced with the administration of a baseline pretest, proceeded through the systematic implementation of the interactive e-module as the instructional medium, and concluded with the administration of a posttest to measure outcome changes.

#### Descriptive Statistics

A comprehensive descriptive statistical analysis was undertaken to investigate the distributional characteristics of student learning outcomes both prior to and following the experimental intervention. The analytical results are systematically presented in Table 1.

**Table 1.** Descriptive Statistics of Pretest and Posttest

| Variable | N  | Mean  | Std. Deviation |
|----------|----|-------|----------------|
| Pretest  | 22 | 63.82 | 19.94          |

| Variable | N  | Mean  | Std. Deviation |
|----------|----|-------|----------------|
| Posttest | 22 | 77.73 | 13.98          |

The analytical results reveal a marked elevation in the mean achievement score, advancing from 63.82 at the pretest phase to 77.73 at the posttest phase, an absolute gain of 13.91 points subsequent to the implementation of the interactive e-module intervention. This observable score differential provides empirical indication of a favorable shift in student learning outcomes.

### Assumption Test

As a prerequisite to the execution of inferential hypothesis testing, an assessment of data normality was conducted utilizing the Shapiro-Wilk statistical procedure. The resultant values are displayed in Table 2.

**Table 2.** Normality Test (Shapiro-Wilk)

|          | Kolmogorov-Smirnov |    | Shapiro-wilk |           |    |      |
|----------|--------------------|----|--------------|-----------|----|------|
|          | Statistic          | df | Sig.         | Statistic | df | Sig. |
| Pretest  | .106               | 22 | .200*        | .956      | 22 | .407 |
| Posttest | .201               | 22 | .021         | .869      | 22 | .005 |

The analytical outcomes demonstrate that the pretest data distribution satisfied the normality assumption ( $p = 0.407$ ), whereas the posttest data manifested a modest deviation from normality ( $p = 0.005$ ). Nevertheless, the application of the paired sample t-test was retained, justified by its recognized statistical robustness in accommodating sample sizes that exceed 20 participants.

### Hypothesis Testing

With the objective of ascertaining whether statistically significant differences existed between the pretest and posttest score distributions, a paired sample t-test analytical procedure was executed. The obtained results are tabulated in Table 3.

**Table 3.** Paired Sample t-Test

| Variable         | Mean Difference | Std. Deviation | t      | df | Sig. (2-tailed) |
|------------------|-----------------|----------------|--------|----|-----------------|
| Pretest-Posttest | -13.91          | 10.24          | -3.084 | 21 | 0.006           |

The inferential statistical analysis confirmed the presence of a statistically significant divergence between pretest and posttest score distributions ( $p = 0.006 < 0.05$ ), providing robust empirical evidence that the pedagogical implementation of the interactive e-module engendered meaningful and measurable advancement in students' academic achievement.

### Effect Size

In order to quantify the practical magnitude of the observed intervention effect, the Cohen's *d* effect size statistic was computed. The resulting value is presented in Table 4.

**Table 4.** Effect Size (Cohen's *d*)

| Effect Size      | Value | Interpretation |
|------------------|-------|----------------|
| Cohen's <i>d</i> | 0.657 | Moderate       |

The computed effect size value of 0.657 falls within the moderate effect category according to Cohen's interpretive framework, signifying that the utilization of the interactive e-module exerts a substantively meaningful influence on students' comprehension of fundamental cartographic concepts.

Synthesizing the empirical evidence derived from both the paired sample *t*-test and the effect size analysis, it can be definitively concluded that the pedagogical implementation of interactive electronic modules yields significant improvements in student learning outcomes within the domain of fundamental cartographic knowledge. Consequently, the posed research question receives affirmative empirical resolution, demonstrating that e-module utilization constitutes an effective pedagogical approach for advancing students' conceptual understanding.

#### **D. Discussion**

The empirical findings emanating from this investigation provide unequivocal elucidation to the research question concerning the efficacy of interactive electronic module implementation in enhancing student learning outcomes within fundamental cartographic knowledge. Grounded in the statistical evidence presented in the preceding section, the deployment of interactive e-modules demonstrably produces significant enhancements in student academic achievement, as substantiated by the observed elevation in mean scores, the statistically significant *t*-test outcomes, and the moderate magnitude of the computed effect size. Accordingly, it is warranted to conclude that interactive e-modules function as pedagogically effective instruments for advancing students' comprehension of foundational cartographic concepts within the context of geography education.

The observable gains in student academic performance documented in this investigation may be ascribed to the distinctive pedagogical characteristics inherent within the interactive e-module employed as the primary instructional medium. In contrast to conventional learning materials, e-modules disseminate curricular content in a methodically structured and systematically organized fashion, seamlessly incorporating textual elements, visual imagery, and interactive components that collectively serve to facilitate deeper conceptual comprehension. Within the specific context of geography instruction, and particularly within the domain of foundational cartographic literacy, learners are required to develop understanding across a range of inherently abstract spatial concepts encompassing cartographic symbology, scale representation, directional orientation, and map interpretation competencies. Such multidimensional conceptual demands frequently

present formidable comprehension challenges when transmitted through conventional lecture-dependent pedagogical approaches. Notwithstanding these inherent difficulties, the deployment of visual and interactive functionalities within the e-module architecture functions as an effective pedagogical mechanism for translating abstract informational content into more tangible, concrete, and meaningfully accessible representational forms. As a direct consequence of this transformation, learners are positioned to more effectively engage with, process, and subsequently internalize the instructional material presented to them.

When examined through a theoretical lens, these empirical findings lend themselves to interpretation via constructivist learning theory, a theoretical framework that posits meaningful learning as occurring when learners actively engage in the construction of personal understanding through sustained interaction with educational resources. The interactive e-module substantively facilitates this constructivist process by providing learners with opportunities for direct engagement with instructional content, autonomous exploration of conceptual material, and repeated revisitation of content as necessitated by individual learning requirements. Such inherent flexibility empowers learners to exercise self-regulation over their own learning tempo, thereby fostering the development of more profound and durable conceptual understanding. Furthermore, the obtained results demonstrate theoretical congruence with multimedia learning theory, which postulates that learning efficacy is augmented when informational content is presented through a synergistic combination of verbal and visual modalities. The deliberate integration of photographic imagery, schematic diagrams, and interactive functional elements within the e-module architecture serves the dual purpose of mitigating extraneous cognitive load while simultaneously enhancing learners' capacity to comprehend and navigate complex spatial relationships that are characteristic of geography education.

The findings emerging from this investigation demonstrate theoretical and empirical alignment with the extant body of scholarship that has documented the pedagogical effectiveness of digital learning media, electronic modules prominently included, in advancing student learning outcomes. The scholarly contributions of [Safitri & Dafit \(2025\)](#) alongside [Sidauruk et al \(2025\)](#) have established that e-modules possess the capacity to enhance both student comprehension and motivational levels by virtue of their inherently interactive architecture and flexible deployment characteristics. In a similar vein, the investigations undertaken by [Faidah et al \(2025\)](#) and [Ansori et al \(2025\)](#) have furnished evidence that digitally-mediated learning instruments can produce measurable improvements in cognitive achievement and meaningful engagement with the learning process. Collectively, these prior studies furnish substantive support for the proposition that digital learning media occupy a position of considerable significance within contemporary educational practice, functioning as catalysts for the creation of more efficacious and pedagogically meaningful learning experiences.

Notwithstanding this alignment with prior scholarship, the present investigation makes a distinctive contribution by concentrating its analytical focus specifically upon

fundamental cartographic literacy as a central disciplinary competency within geography education, a domain that has heretofore received comparatively scant attention in the existing literature. The majority of antecedent research has directed its inquiry toward the evaluation of e-module effectiveness within general academic disciplines such as natural sciences and mathematics, or has examined broad learning outcome indicators without according specific emphasis to conceptual understanding within discrete disciplinary contexts (Sumadi, 2023). In marked contrast, the current study foregrounds the pedagogical function of interactive e-modules in scaffolding the comprehension of spatially-oriented concepts that constitute the foundational bedrock of geography education. Through this targeted analytical focus, the investigation furnishes more granular empirical evidence concerning the manner in which digital learning media can be strategically deployed to confront the distinctive pedagogical challenges inherent to geography instruction, particularly in curricular domains that demand robust visual processing and spatial reasoning competencies.

Additionally, the moderate effect size magnitude documented in this study carries important implications, signaling that the influence of the e-module intervention transcends mere statistical significance to encompass practical pedagogical meaningfulness. This finding suggests that the implementation of interactive electronic modules exerts a tangible and quantifiable impact on student learning outcomes, thereby establishing its credibility as a viable and implementable instructional strategy within geography education. The classification of the effect within the moderate range simultaneously conveys that while the intervention demonstrates demonstrable effectiveness, substantive opportunities for enhancement remain extant. Such improvement trajectories might encompass the refinement and optimization of e-module design features or the strategic integration of the e-module with complementary instructional methodologies with the aim of achieving more pronounced pedagogical impact.

Moreover, the observed improvements in learning outcomes documented in this investigation may be partially attributable to concomitant increases in student engagement and motivational levels throughout the instructional process. Interactive digital media possess an inherent capacity to capture and sustain learner attention while simultaneously promoting active participatory involvement, given that contemporary learners tend to exhibit heightened interest in content that is visually stimulating and interactively engaging when contrasted with traditional printed textbooks. This elevated level of engagement is liable to generate ancillary benefits including enhanced attentional focus, deeper involvement with the learning material, and the ultimate production of superior learning outcomes. Consequently, the pedagogical effectiveness of e-modules should be evaluated not merely through the lens of cognitive achievement indicators, but additionally through their demonstrated capability to cultivate a more engaging, dynamic, and authentically student-centered learning environment.

In summation, the findings of this investigation serve to fortify and reaffirm the critical importance of systematically integrating digital learning media within geography

education, with particular emphasis upon curricular topics that engage abstract conceptual material and spatial reasoning demands. The deployment of interactive e-modules offers educators a pragmatic and actionable solution to the pedagogical challenges traditionally associated with teaching fundamental cartographic literacy, accomplishing this by rendering the learning process more accessible, intrinsically engaging, and conceptually substantive. In this respect, the study makes a noteworthy contribution to the burgeoning scholarly literature on digital pedagogy by providing empirical demonstration that interactive e-modules are not merely efficacious vehicles for improving quantitative learning outcomes, but additionally serve an indispensable function in scaffolding deep conceptual understanding within the discipline of geography.

Accordingly, in direct response to the interrogative that guided this investigation, the study provides empirical confirmation that the pedagogical implementation of interactive electronic modules produces statistically significant improvements in student learning outcomes within the domain of fundamental cartographic knowledge. The obtained results serve to illuminate the considerable potential of e-modules to function as effective instructional media that simultaneously support learner-centered pedagogical approaches, deepen conceptual understanding, and provide viable resolutions to the enduring challenges of teaching abstract spatial concepts within geography education.

## **E. Implication**

The findings of this investigation carry substantial implications that resonate across theoretical, practical, and policy dimensions. From a theoretical standpoint, the results make a meaningful contribution to the ongoing development of digital learning scholarship within geography education by providing empirical reinforcement for constructivist and multimedia learning theoretical frameworks. Specifically, the study demonstrates that interactive e-modules grounded in visual representation can effectively advance students' conceptual comprehension of abstract and spatially-oriented curricular content, with particular efficacy in the domain of fundamental cartographic literacy. From a practical pedagogical perspective, the findings indicate that classroom practitioners can effectively employ e-modules as viable instructional media for the promotion of learner-centered education, thereby empowering students to pursue autonomous learning trajectories, participate more actively with curricular material, and achieve deeper comprehension of complex spatial concepts through the combined affordances of interactive and visual representational modalities. Additionally, e-modules may function as pedagogically sound alternatives to conventional instructional materials, particularly in curricular domains where robust visualization capabilities are prerequisite to effective learning. From a policy vantage point, these findings underscore the imperative for educational institutions to actively support the integration of digital learning media through the provision of adequate technological infrastructure, including reliable access to digital computing devices and internet connectivity, alongside the establishment of comprehensive professional development programs designed to equip teachers with the requisite competencies for

effective e-module design and implementation. Furthermore, educational policymakers are encouraged to consider the formal incorporation of digital learning strategies within curricular frameworks as a means of fostering more innovative, pedagogically flexible, and technology-integrated learning environments that are appropriately responsive to the evolving demands of twenty-first-century education.

## **F. Limitation and Suggestion for Further Research**

Notwithstanding the empirically significant findings that have emerged from this investigation, several methodological limitations warrant careful consideration when interpreting the results. Foremost among these constraints is the employment of a pre-experimental one-group pretest-posttest design that lacked a control group condition, a design feature that constrains the capacity to establish unambiguous causal relationships between the intervention and observed outcomes. Specifically, the documented improvements in learning outcomes may have been partially influenced by extraneous variables such as fluctuations in student motivational states, differential levels of prior subject knowledge, or variations in classroom environmental conditions. A second notable limitation concerns the modest sample size, comprising a single class of 22 students situated within one educational institution, a circumstance that necessarily circumscribes the generalizability of the findings to more expansive and diverse educational contexts. Furthermore, the temporal duration of the study was comparatively brief, raising the possibility that the investigation may not have adequately captured the long-term durability of students' conceptual understanding over extended time periods. An additional limitation pertains to the curricular scope of the investigation, which was confined exclusively to fundamental cartographic literacy, a subject matter domain that is inherently visual in nature and may consequently possess greater suitability for e-module implementation than other geography topics characterized by less visually-dependent content.

In light of these acknowledged limitations, several recommendations are advanced for the guidance of future scholarly inquiry. Primarily, subsequent investigations are encouraged to adopt more methodologically rigorous experimental designs, such as true experimental or quasi-experimental frameworks that incorporate both control and experimental group conditions, thereby yielding more robust empirical evidence capable of supporting causal inferences. Researchers are further encouraged to recruit larger and more demographically diverse sample populations drawn from multiple educational institutions or geographic regions, a strategy that would substantially enhance the external validity and generalizability of the research findings. Additionally, future scholarly endeavors should undertake systematic exploration of e-module application across a broader spectrum of geography curricular topics, including content areas characterized by greater complexity or analytical demand, with the aim of assessing the more comprehensive scope of their pedagogical effectiveness. It is likewise recommended that forthcoming investigations expand the range of outcome variables under examination to encompass supplementary learning indicators such as student motivation, classroom engagement, critical thinking

development, and long-term knowledge retention. The incorporation of more sophisticated statistical analytical techniques would further serve to fortify the methodological rigor of subsequent studies. Through the collective implementation of these recommendations, future research stands positioned to generate a more complete and nuanced understanding of the multifaceted role that e-modules can play in advancing technology-integrated geography education.

## **G. Conclusion**

The present investigation arrives at the definitive conclusion that the pedagogical implementation of interactive electronic modules produces statistically significant improvements in the learning outcomes of Grade X students within the domain of fundamental cartographic knowledge at SMAN 2 Tenggarong Seberang. This conclusion is empirically grounded in three convergent lines of evidence: the documented elevation in mean achievement scores, the statistically significant divergence observed between pretest and posttest measurements, and the moderate effect size magnitude that attests to the practical meaningfulness of the intervention's impact. These findings collectively confirm that electronic modules function not merely as effective digital learning media, but additionally occupy a position of considerable pedagogical importance in scaffolding students' comprehension of abstract spatial concepts encompassing cartographic symbology, scale calibration, directional orientation, and map interpretation. Through their inherent capacity to support both student-centered and self-directed learning modalities, e-modules furnish learners with a more engaging, dynamic, and pedagogically flexible learning environment when compared to conventional instructional approaches. Consequently, this study serves to illuminate the considerable potential of interactive e-modules to function as strategically valuable instructional instruments within geography education, with particular efficacy in curricular domains that demand robust visual processing and deep conceptual comprehension, while simultaneously making a meaningful contribution to the broader enterprise of developing technology-integrated pedagogy at the secondary education level.

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