Integrating Digital Reading Module to Enhance Computational Thinking Skills via Lesson Study for EFL Beginners: Case Study of a Public Senior High School in Indonesia

Silvi Listia Dewi[1], Misnar[2], Abdul Syahid[3], Rahma[4], Alfi Syahrin[5]

[1] Associate Professor, English Education Study Program, Faculty of Teacher Training and Education, Universitas Almuslim, Aceh, Indonesia

[2] Lecturer, English Education Study Program, Faculty of Teacher Training and Education, Universitas Almuslim, Indonesia

[3] Lecturer, English Education Study Program, Faculty of Teacher Training and Education, Institut Agama Islam Negeri Palangka Raya, Palangka Raya, Indonesia

[4] Lecturer, Early Childhood Education Study Program, Faculty of Teacher Training and Education, Universitas Almuslim, Indonesia

[5] Associate Professor, Indonesian Education Study Program, Faculty of Teacher Training and Education, Universitas Almuslim, Indonesia

Correspondence: Silvi Listia Dewi, Associate Professor, English Education Study Program, Faculty of Teacher Training and Education, Universitas Almuslim, Aceh, Indonesia.

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Abstract

Research on the integration of computational thinking skills into English language teaching, especially as a digital module, in the EFL context is limited. Moreover, the adoption of locally based cultural materials in this integration is extremely rare. To address the gaps, this mixed methods sequential explanatory study explores the effectiveness of a digital reading module focused on local female heroes in enhancing computational thinking skills among EFL students in Indonesia. Quantitative data were obtained from a pretest and a posttest administered to 30 secondary school students, determined through power analysis for sample size and recruited using random sampling. The results indicate a significant improvement in students' computational thinking, with an N-Gain score of 71.87% (High). ll participants were interviewed to gain a deeper understanding of the results through a case study analysis The qualitative phase, which utilized thematic analysis, reveals that the digital reading module not only enhanced students' problem-solving abilities and logical reasoning. Furthermore, it demonstrated its effectiveness in helping students apply computational concepts to real-world scenarios. Participants also reported positive experiences with the lesson study approach, highlighting its role in refining the module and aligning it with educational objectives. Qualitative findings thus support quantitative results. This suggests that culturally relevant digital modules, combined with collaborative professional development strategies like lesson study, can effectively improve computational thinking skills in EFL contexts. This study contributes to the broader understanding of how digital tools and pedagogical frameworks can be adapted to meet the needs of diverse educational environments

Keywords: digital reading module, computational thinking, EFL education, lesson study, Indonesia

1. Introduction

1.1 Background

In the modern world, skills in computing are essential for every individual. These skills allow a person to break down a complex problem into simpler parts that can be solved through algorithms. Such skills are applicable in various areas, including language. The ability to think of solving a problem through computation is almost the same with language skills (Berikan & Özdemir, 2020). In the field of linguistics, the application of computational thinking allows learners to perform the systematic deconstruction of systemized languages, language phenomena, and communicational issues (Rottenhofer et al., 2021). For learners of English as a Foreign Language (EFL), the information processing patterns made possible through computational thinking improve their metacognitive strategies and language pattern discernment (Nouri et al., 2020).

The absence of incorporating computational thinking skills in English language instruction is a persistent concern for numerous educators (Dong et al., 2019). One of the issues is the “problem” and its “solution” mismatch in the context of an English teacher, which seems to be a fundamental problem (Q. Li, 2021). That leads to a lack of willingness to use this approach. It also stems from inconsistent and inadequate training and resource allocation (Sherwood et al., 2021), which leads to inappropriately disregarding these skills (Jocius et al., 2020). There's also a stubborn refusal to let go of old-school teaching techniques, which stifles imagination (Li et al., 2023), as well as insufficient resources to measure the incorporation of computational thinking into language classes (Yağcı, 2019).

Therefore, the challenging ability to analyze and solve complex problems is often neglected (Fredagsvik, 2023) while the lesson practice becomes useless, new developments in language teaching are not fostered, and it is exceedingly problematic for teachers to satisfy the need to verify if the use of computational thinking benefits pupils learning a language and their overall reasoning ability.

1.2 Literature Review

To overcome these challenges, using digital modules to develop computational thinking skills is a promising solution. These digital reading modules can help bridge the gap between the traditional language learning approach and the modern digital world. Digital reading modules are new learning devices combining technology and real context in the language learning process (Ramadhan et al, 2020). In this regard, a Digital Reading Module based on narrative texts of the female warriors of Aceh helps learners to cultivate their computational thinking skills alongside language and cultural understanding. This module features inspiring stories of figures such as Putri Ratna Keumala, Putri Syah Alam Bahriansyah, Laksamana Keumalahayati, Sultanah Nurul Alam Nakiyatuddin Syah, Sultanah Kemalat Syah, Pocut Meurah Intan Biheu, Pocut Bahrein, and Laksamana Keumala (Yusuf, 2021).

Using the digital stories of these Acehnese female fighters, learners are not only taught English but are also required to analyze, decompose, recognize and solve problems in comprehension using computational methods. For instance, learners can be requested to deconstruct the plot into parts (decomposition) (McMaster et al., 2019), recognize language patterns around the notions of leadership and courage (pattern recognition) (Martin & Betrus, 2019), or model how the different characters are expected to perform based on information given (abstraction and modeling) (Yang & Chen, 2023). This module not only enhances learners with ethos and cultural knowledge but also fosters computational thinking skills in a practical and relevant approach to language instruction.

For better execution of this digital reading module, the lesson study is suggested as a collaborative design technique. Lesson study is a form of professional development focusing on teachers collaborating to plan, observe and reflect on a lesson's teaching components (Venketsamy et al., 2022). Within the scope of incorporating digital reading modules towards the development of computational thinking skills, lesson study serves as a strategy that is planned and organized (Mumcu et al., 2023). The lesson study strategy consists of three major components (Fujii, 2019a). The first component is the Planning stage, where teachers collaborate to create lesson plans utilizing the digital reading module. The second is the Implementation and Observation stage, during which one teacher instructs according to the lesson plan, while other observe. The third is the Reflection stage, in which the participants analyze their observation and discuss possible improvements for future sessions.

The integration of lesson study offers several advantages. First, it broadens the teachers' understanding of collaborative practices through sharing information and experiences, while incorporating computational thinking into English Language teaching. Second, it allows teachers develop and implement effective digital reading modules and observe students' reactions and outcomes, enabling them to modify the modules and teaching methods as needed. Furthermore, lesson study fosters the creation of a professional learning community around a specific area, which encourage creativity and improves teaching practices. Finally, this method enables participants to evaluate the impact of the module on students' skills in computational thinking and their integration with English language learning.

From the iterative lesson study cycles, teachers could refine the structure and teaching practices of the digital reading modules (Weaver et al., 2021). This process guarantees that the acquisition of computational thinking skills in the English language classroom is done in a relevant and purposeful context. It assists not only in the teachers' professional development but ensure that students receive the full benefits of the educational change.

To measure the impact of this approach, we can examine several indicators as cited by Gibson, Ivancevich, and Donnelly (1989) in Syafii (Syafii et al., 2015). The product indicator assesses the organization's capability to meet the needs of the environment in terms of the quantity and quality of output, which could be reflected in the number and quality of digital reading modules developed. Efficiency can be evaluated by assessing outputs in relation to inputs such as the ratio of student learning achievements to the time and funds used for the lesson study process.

Satisfaction, as a measure of the organization's performance, indicates how well the needs of employees and members of the organization are being met. For example, it can be measured by the feedback from teachers and students regarding the lesson study modules. The adaptability indicator measures the level of an organization's responsiveness to changes, particularly in integrating emerging skills, such as computational thinking, into traditional subjects. Lastly, the development indicator evaluates the organization's accountability towards the enhancement of capacity and potential growth. In this context, it is demonstrated by the ongoing advancement of teaching practices, along with the upskilling of teachers in digital pedagogy and integration of computational thinking. By utilizing this indicators, schools and educational institutions can examine the effectiveness of implementing lesson study focused on integrating a computational thinking approach into English language teaching, ensuring that teachers and students benefit significantly from this method.

Many other studies have previously worked on the possibility of applying computational thinking to language education. In a study by Parsazadeh et al. (2021) on EFL students, those who received a computational thinking approach reported improvement in their verbal and non-verbal linguistic problem-solving skills. The results of this study suggest that skills associated with computational thinking can be applied in the process of learning a foreign language, which is an advantage when teaching EFL. Also, the research done by Afzali & Izadpanah (2021) demonstrated that interactive digital modules enhance students' motivation and participation in learning a foreign language. This study illustrates the role of technology in enhancing the teaching and learning process, particularly for the so-called digital natives (Smith et al., 2020).

1.3 Research Questions

However, most previous studies have focused on the context of English language learning in Western countries. There remains a gap in understanding how these approaches can be effectively applied in different cultural and educational contexts, particularly in Indonesia. Furthermore, integrating local cultural content about Acehnese female warriors into digital modules to enhance computational thinking skills is rarely explored. To investigate the possible potential of integrating digital reading modules to enhance computational thinking skills in EFL students through lesson study, this study poses the following research questions:

1) What are the perceptions and experiences of EFL students in using lesson study to integrate computational thinking skills through digital reading modules?
2) How effective is the implementation of a digital reading module in enhancing computational thinking skills among EFL students through the lesson study approach?

2. Method

2.1 Research Design

This research employed a mixed-method approach with a sequential explanatory design, integrating quantitative and qualitative methods. The first phase involved the collection and analysis of quantitative data, followed by a second phase focused on qualitative data based on the initial quantitative findings. The primary focus was on the quantitative method to gather measurable and descriptive data, while the qualitative method aimed to deepen and broaden the understanding of the quantitative results. The quantitative design used was pre-experimental, using a one-group pre-test-post-test approach. The qualitative design was descriptive, aiming to evaluate the use of digital modules in enhancing students' computational thinking skills through narrative texts about Acehnese female heroes.

2.2 Research Procedures

The first step in this research was the preparation phase, consisting of observations and interviews with fellow colleagues. A pretest was then carried out to assess the changes in student responses towards the integration of a digital reading module on narration of stories related to Aceh female warriors into the lessons. They were later administered a post-test. Finally, computational thinking skills were evaluated through in-depth interviews to obtain information from students to better understand the impact of the teaching module.

2.3 Participants

The participants were 30 eleventh graders of a public secondary school located in Aceh Province, Indonesia. They were selected through purposive sampling to gather and enable efficient data collection and analysis, ensuring that the sample met predefined criteria. The research aims at providing a specific contextual focus within the educational system by uncovering learning outcomes and experiences from specialized second-year students attending this particular school. A comprehensive and multi-faceted understanding of the educational phenomena was achieved using quantitative evaluation in the form of pre-experimental design and qualitative evaluation through interviews with all students.

An a power analysis was performed to calculate the sample size necessary to detect a meaningful difference between pre-test and post-test scores, given the sample size of 30 participants. With significance level of 0.05, and an estimated effect size (Cohen's *d*) of:

$$d = \frac{\bar{x}_1 - \bar{x}_2}{s} = \frac{74.330 - 63.670}{12.994} = 0.820$$

with s indicates the standard deviation from the pretest data, G*Power 3.1.9.4 showed that the test attained minimum sample size of 22 along with actual power of 0.9559051, indicating that the sample size is adequate to detect significant effects.

2.4 Data Collection

This study utilized primary data sources, including detailed interviews, pre-tests, and post-tests. Students participated in interviews as active contributors, working in pairs or groups. Information was exchanged through dialogue and a synthesis was constructed on a given topic of focus. In this case, interviews were held to determine students' reactions to the application of digital reading modules which were enhanced with narratives on female Acehnese heroines.

In this research, the pretest with 20 questions was given prior to the module implementation in order to establish the benchmarking level of students' computational thinking skills. Following the implementation of the module, a post-test with the same 20 questions was conducted to evaluate the effect of the module on students' computational thinking skills. Normality and homogeneity tests were performed on both pre and post-test data as a condition for using parametric statistical test: the independent samples t-test.

From the interviews and the pre-test and post-test assessments, a holistic evaluation of the impact of the module on improving the computational thinking skills of EFL learners through Lesson Study was obtained. This study sought to explore the level to which advanced digital reading modules improved students' computational thinking skills in public senior high schools located in one of the districts of Aceh Province, Indonesia, and how the students perceived the use of the modules within the scope of learning English.

2.5 Data Analysis

The qualitative data collected for this study was analyzed by thematic analysis. Thematic analysis assists researchers to organize the

interview data into the key themes that emerge, which may serve as evidence of patterns within the data, even if such patterns may not be immediately visible to others. This analysis is specific to students' reception towards the application of digital reading modules enhanced with narratives on heroines from Aceh.

The quantitative data from the pretest and posttest were analyzed using the N-Gain formula. This analysis focused on determining the extent of improvement in students' problem-solving capabilities, particularly in computational thinking, following the instruction. As explained by Wahab and Junaedi (2021), the rate of correct responses is calculating by summing the actual scores achieved in all the assessment areas. This total was then compared to the benchmarks set, and the resulting value was multiplied by 100%. The formula for normal N-Gain is as follows.

$$N - gain = \frac{Post\ test - Pre\ test}{Maximum\ Score - Pre\ test}$$

Table 1. Interpretation of N-gain score

N-Gain	Criteria
N-gain > 0.70	High
0.70 ≥ N- gain ≥ 0.30	Medium
N-gain > 0,30	Low

Source: Harjono & Gunawan (2020)

As previously mentioned, several analyses was conducted after data collection, including tests for normality, homogeneity, and paired samples. The homogeneity test determines whether the variance between the groups is consistent whereas normality test confirms if the data adheres to a normal distribution. An independent samples t-test was used to compare the results on the groups before and after the intervention, allowing us to test null hypothesis regarding the difference in the improvement of students' computational thinking skills.

3. Results

3.1 Effectiveness of Student Learning Outcomes

Effectiveness refers to the impact of a specific action. In this study, the focus is on the impact of using a digital reading module on enhancing students' computational thinking skills. The effectiveness test was employed to assess the success level of the learning activities. The digital reading module was designed to improve students' computational thinking, and the results demonstrated a significant increase in students' learning outcomes after using the digital reading module. Before being implemented in the classroom, the digital reading module was reviewed and validated by design experts, media experts, and content experts, all of whom rated it as "very good."

The students' learning outcomes, as examined in this study, included pretest and posttest scores and minimum criteria of mastery learning. The minimum criteria of mastery learning applied for second-grade students at an Indonesian public senior high school is ≥ 80. The students' learning outcomes are detailed in Table 3 and a boxplot showing the differences between pre-test and post-test scores is presented on Figure 1.

Table 3. Summary of improvement and N-Gain

Average Score		Improvement	N Gain	N-Gain Percentage	Maximum		Minimum	
Pretest	Posttest				Pretest	Posttest	Pretest	Posttest
59.00	89.83	30.83	71.87	71.87 %	80	90	40	80

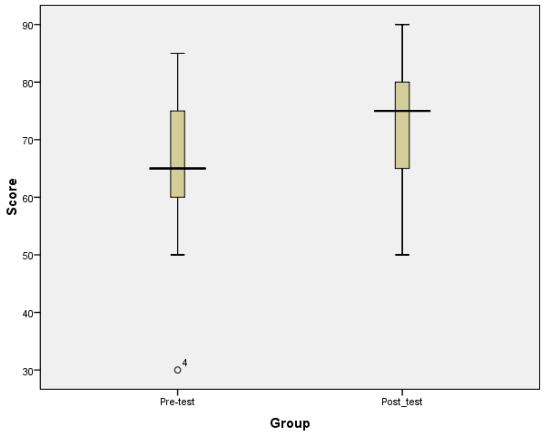

Figure 1. The differences between pre-test and post-test scores

The N-Gain analysis results indicate that the students' score improvement reached 0.7187 or 71.87%, which falls into the "High" category. This suggests that the digital reading module significantly improved the students' learning outcomes. The findings confirm that the application of this digital reading module was successful and highly effective in enhancing students' learning outcomes. The high category of N-Gain score indicates a substantial improvement in students' learning, affirming the success of the digital reading module in enhancing their academic performance.

Table 4. Normality test results

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelas	Statistic	df	Sig.	Statistic	df	Sig.
Student Learning Outcomes	Pre-Test	.122	30	.200*	.955	30	.235
	Post-Test	.146	30	.100	.935	30	.068

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Table 4 presents the normality test results using the Kolmogorov-Smirnov method. It show that the pretest and posttest data for student abilities are normally distributed at the 5% significance level (p=0.200 for pretest and p=0.100 for posttest).

These findings confirm that the normality assumption necessary for using parametric statistics to compare the mean difference between the pretest and posttest results has been satisfied. Consequently, hypothesis testing can proceed using appropriate parametric statistical methods. Meeting the normality assumption strengthens our confidence that the differences between pretest and posttest results are due to the application of the digital reading module, rather than being influenced by a non-normal data distribution.

Table 5. Homogeneity test

		Levene Statistic	df1	df2	Sig.
Student Learning Outcomes	Based on Mean	2.976	1	58	.090
	Based on Median	2.366	1	58	.129
	Based on Median and with adjusted df	2.366	1	52.523	.130
	Based on trimmed mean	2.595	1	58	.113

The results of the homogeneity test using Levene's test in Table 5 indicates the variance between pretest and posttest scores is homogeneous (p=0.090). This suggests that at the 5% significance level, the gain scores from the pretest and posttest learning outcomes are from a homogeneous population.

These findings indicate that the homogeneity of variance assumption has been satisfied, allowing hypothesis testing to proceed using pair samples t-test to determine the mean difference in student learning outcomes before and after applying the digital reading module.

Table 6. Paired samples t-test

Paired Samples Test									
		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Pretest –Posttest	-10.667	17.157	3.132	-17.073	-4.260	-3.405	29	.002

The results of paired samples t-test in Table 6 shows a significant difference between the students' learning outcomes before and after the implementation of the digital reading module (p=0.002). The results underscores the effectiveness of the digital reading module in significantly improving students' learning outcomes. The substantial difference in mean scores between the pretest and posttest further confirms that the digital reading module has had a meaningful impact on students' computational thinking and overall learning achievements.

3.2 Thematic Analysis

The analysis conducted with the students highlighted three key themes in their experiences related to the digital reading module, including: (1) engagement with the digital reading module, (2) impact on computational thinking skills, and (3) educational value perceived by participants in the research. Each theme was subdivided into smaller units of meaning, capturing the granular details of the students' responses.

In the second chapter, titled "engagement with the digital reading module," three subthemes were identified: (a) motivation and interest, (b) challenges and difficulties, and (c) user interface and accessibility. Under the theme "impact on computational thinking skills", additional subthemes were included: (d) problem-solving abilities, (e) logical reasoning and sequencing, and (f) application to real-world scenarios. The third main theme, 'perceived educational value,' comprised (g) relevance to curriculum, (h) long-term benefits, and (i) Comparison with Traditional Learning.

These themes and subthemes capture the multifaceted experiences and perspectives of the students, from the different angles of their satisfaction with the digital reading module and its role in developing their computational thinking skills. The ensuing sections discuss every theme and subtheme in detail, capturing the richness of the experiences including outcomes of learning and engagement from the

students' perspective.

Table 2. Themes and subthemes

T1: Engagement with the Digital Reading Module			Theme 2: Impact on Computational Thinking Skills			Theme 3: Perceived Educational Value		
ST1 Motivation and Interest	ST2 Challenges and Difficulties	ST3 User Interface and Accessibility	ST1 Problem-Solving Abilities	ST2 Logical Reasoning and Sequencing	ST3 Application to Real-World Scenarios	ST1 Relevance to Curriculum	ST2 Long-Term Benefits	ST3 Comparison with Traditional Learning

Theme 1: Engagement with the Digital Reading Module

Every student noted that interacting with the digital reading module was one of the most important aspects of their learning experience. The module's content of Acehnese female heroes and its digital nature impacted students' motivation, interest, and engagement with the learning material. The subsequent subthemes elaborate on the different components that influenced the students' engagement.

Subtheme 1: Motivation and Interest

Most of the students noted that the historical and cultural stories of Acehnese female heroes featured in the digital module greatly enhanced their motivation and interest in learning. The application of cultural heritage and technology made the content more relevant and stimulating. Students articulated that the distinctive emphasis on local heroines not only captured attention but also nurtured a sense of pride about their heritage.

"Learning about these heroines through the module made me appreciate how robust our history is. It motivated me to learn more."

"The digital format makes the material more relatable and easier to engage with, and the stories are inspiring."

Incorporating the historical narratives of Acehnese female heroes into the digital module undoubtedly enhance students' motivation and interest in learning. Students found the emphasis on local cultural heritage distinctive and more appealing when combined with contemporary technology.

Subtheme 2: Challenges and Difficulties

While interacting with the digital module, some students experienced challenges. Concerns such as technical problems, difficulties with internet access, and some activities being overly complicated were mentioned. These challenges sometimes contributed to a lack of motivation to engage completely with the content. Regardless of the issues, the majority of students were still motivated because of the module's relevance and support provided.

"Sometimes the page wouldn't load properly, and I got frustrated, but I kept trying because the stories were really interesting."

"Hearing those in class, I always said the module was a bit difficult, but upon reflection, with a bit of a gentle nudge, I would come to see the rationale."

In spite of some students encountering technical difficulties and challenges with module navigation, they were motivated to continue because of the materials' relevance along with the support provided. These challenges emphasize the necessity of more robust suggestions to support underserved users, along with enhancing the design to be more intuitive and inviting, with less complexity.

Subtheme 3: User Interface and Accessibility

Students critiqued the user interface and experience of the digital reading module. They understood how the design structure features allowed for seamless navigation across content. Nonetheless, some students indicated a need for improvement, such as mobile compatibility, interactivity, and other enhancements to elevate their experience.

"The module was easy to use but I think it will be better if it works well on my phone too."

"I liked how I could easily find the information I needed, but it would be nice if there were more interactive elements."

Students suggested better mobile compatibility and additional interactive features on the digital module to enhance its usability along with improved learning experiences.

Theme 2: Impact on Computational Thinking Skills

All students noticed that the digitally presented modules built around Acehnese heroines increased the students' skill level in computational thinking. The integration of historical stories with the problem-solving activities gave a powerful structure to strengthen logical reasoning, problem-solving, and computational thinking. The following subthemes elaborate on these effects.

Subtheme 1: Problem-solving Abilities

A considerable percentage of students noted enhancements in their problem-solving skills after interacting with the digital module. The tasks given involved analyzing situations, strategizing, and reasoning, which are all aspects of computational thinking processes.

"The activities made me think more critically about how to solve problems. I had to plan my steps carefully."

"It helped me break down problems and solve them step by step, which I think will also be useful in other subjects."

Computational thinking practices include reasoning logically, which is aligned with problem analysis done in the module. Students reported having improved their problem-solving skills in relation to the digital module activities conducted.

Subtheme 2: Logical Reasoning and Sequencing

Students reported that the module improved their understanding of logical processes. As they engaged with the activities in the module, they gain a clearer grasp of how to sequence completable tasks and follow the flow of information, which is an essential aspect of computational thinking.

> "I understood better how to sequence things in my mind, especially in stories or narratives."

> "All of the exercises made it possible for me to structure and systematize multifarious concepts in a sequential manner."

The module assisted students in improving reasoning and task ordering skills, both of which are essential elements of computational thinking. Students demonstrated the ability to organize and relate concepts more systematically.

Subtheme 3: Application to Real-World Scenarios

Students noted that the abilities acquired from the digital module were relevant with the contexts outside the classroom. They spoke of applying problem-solving strategies to other subjects, utilizing complex understanding processes in actual scenarios, and organizing thinking on a day-to-day basis.

> "Computational skills helped me structure my homework and even let me organize my day more resourcefully."

> "Jo's approach to decomposition is something I can apply in decision-making and math."

The interdisciplinary nature of the module was seen as helpful in organizing personal activities and problem-solving in everyday situations.

Theme 3: Perceived Educational Value

Every student shared similar sentiments about the learning outcomes achievable from interacting with the digital reading module concerning its contribution to the curriculum, its long-term benefits, and how it compares to other learning methods. These perceptions are further explored in the following subthemes.

Subtheme 1: Relevance to Curriculum

Most students and teachers agreed that the digital module's content was highly appropriate forthe curriculum. The integration of culture and history with the computational thinking activities was perceived as a valuable addition to the in-class learning process.

> "This goes hand in hand with what we are doing in history and ICT. It's like combining the two subjects into one."

> "The module covers the same topics we discuss in class but adds a new perspective, which makes it more interesting."

The digital module was considered relevant to the existing curriculum, combining historical and cultural narratives with computational thinking exercises as a valuable supplement to classroom learning

Subtheme 2: Long-Term Benefits

Students expressed that the skills and knowledge gained from the digital module would have long-term benefits, particularly in future educational pursuits and potential career opportunities. They believed that the combination of cultural awareness and computational thinking would provide a strong foundation for further learning.

> "I think understanding our history and learning these new skills will help me in the university and even in my future job."

> "The module teaches us about our culture but also provides essential skills for today's world."

Students believe that the knowledge and skills gained from the module will provide long-term benefits, especially in further education and career opportunities, with a combination of cultural awareness and computational thinking.

Subtheme 3: Comparison with Traditional Learning

Some students have observed that the digital reading module is more engaging compared to traditional learning approaches due to its interactivity and opportunity to learn at one's own pace. However, several others expressed a desire for face-to-face interactions and instant feedback that are typical in conventional classroom settings.

> "I enjoyed working through the module at my own pace; however, I sometimes wished there was a teacher available to assist with my questions."

> "The module was more engaging than just reading a textbook, but it was different from having a discussion in the classroom."

Although some students appreciated the freedoms granted by the digital modules, others commented on the lack of social learning components, such as discussions with peers and teachers, which are present in more traditional forms of education.

4. Discussion

These findings align with and extend prior works related to the application of digital learning tools to students' cognitive skills enhancement, particularly to computational thinking. The findings by Parsazadeh et al. (2021), revealing that the application of

computational thinking within the language learning paradigm greatly enhances students' problem-solving skills, supports the claimed improvement in students' computational thinking skills and digital module-assisted academic achievement.

One of the most impressive aspect of this study is the N-Gain score of 71.87%, reflecting a marked improvement in learning outcomes. This finding corresponds Afzali and Izadpanah's (2021) research, which revealed that interactive digital modules greatly benefited students by enhancing their motivation and academic performance. The use of relevant ethnic content was not only made the lesson more interesting but also but also helped students connect better with the material learning. This increased engagement is, as highlighted in previous studies, a crucial factor in effective digital learning(Smith et al., 2020).

Several normality and homogeneity tests have been done, and their results further strengthens the claim of improvement, showing that indeed the impact of the digital reading module is statistically significant, not due to chance or as a consequence of data irregularities. This claim relied on earlier work, for example Afzali and Izadpanah (2021), who stressed the need for well-designed digital modules if substantive educational value is to be realized.

The lesson study approach used in this research also resonates with earlier studies regarding the collaborative professional development of teachers. The iterative steps of lesson study strategies provided ongoing improvement of the digital reading module development. The module was crafted to support and enhance students' learning. This finding agrees with Elliott (2019) who revealed that lesson study is associated with improvement in the sophistication of teaching practices and student learning outcomes.

In addition, this study aims to address the research gaps by examining effectiveness of digital reading modules within a non-Western context. This success of this digital reading module in Indonesian shows that such tools can be effective when designed to meet local educational and cultural considerations. This research contributes to the existing literature, as previous studies have mainly concentrated on Western settings. It also supports Ran's (2021) argument claiming that the use of technology in education must be contextually relevant to be useful.

To assess the impact of the use of the digital reading module and lesson study technique on the integration of computational thinking in teaching English, the criteria provided by Gibson, Ivancevich, and Donnelly (1989) as cited by Pasolong (2019), was used as the basis. The digital reading module that highlights Acehnese female heroes demonstrates the ability to design high quality, educational products that are both relevant and useful in the local context. The effectiveness of the strategy is evient from the N-Gain score of 71.87%, which is considered very high and indicates substantial improvement in learning outcomes. The resources expended to achieve the results obtained were minimal. Additionally, satisfaction is indicative of the increased interest and motivation from students as the relevant material used fostered a more positive attitude toward the content by students and teachers.

The changing needs of modern education is met by the approach's successful integration of computational thinking skills into English language teaching, which underscores its flexibility. The lesson study framework showcased emerging responsiveness to educational needs and technologies through ongoing refinement of the module. Improvement of teaching practices with regard to digital pedagogy, the integration of computational thinking, and the Kager's et al. (2023) framework mark the development indicator. Professional development was sustained through the iterative lesson study approach, which bolstered the capacity and potential for growth within the institution.

Viewing these findings from the perspective of effectiveness indicators, it is clear that the lesson study approachis effective. Adapting digital tools to non-Western contexts has increased student engagement, enhanced computational thinking skills and improved academic performance. The stratified effectiveness indicators further demonstrate the comprehensive success of this approach. By addressing evolving educational needs, these results illustrate the profound benefit to student performance and reveal the potential for organizational transformation.

In this study, we not only corroborate previous research concerning the efficacy of digital learning tools, but we also enhance these findings by demonstrating their use in a different cultural setting. The successful implementation of computational thinking through a culturally responsive digital reading module within a lesson study framework illustrates the potential accomplishments when such methods are developed and applied in other educational systems worldwide. The effectiveness criteria used also substantiates the success of the digital reading module and lesson study in integrating computational thinking into English language teaching. This integration yields benefits, such as cascading value, organizational growth, and transformation, which are often overlooked but certainly are present, in addition to the primary stroke value for students and educational agility markers.

5. Conclusion

This study investigated the effectiveness of a digital reading module featuring Acehnese female heroes in enhancing computational thinking skills among EFL students, while also exploring EFL teachers' experiences with the lesson study approach for integrating these skills. Results show a significant improvement in students' computational skills, indicated by a remarkably high N-Gain score of 71.87%. The module facilitated participation through the development of an engaging classroom model involving problem-solving and logical reasoning for real-life skill application. These finding were supported by normality and homogeneity tests. In their feedback, EFL instructors expressed appreciation for the lesson study approach, highlighting its focus on teamwork, which enriched the module and helped to meet the learning objectives. The relevance of the content to the context, along with a structured implementation process, contributed to improving students' skills and teachers' professional development simultaneously.

The research focuses on integrating culturally relevant digital modules with lesson study frameworks to enhance students' cognitive skill and engagement levels in EFL teaching. This example of success in Indonesia adds to the literature by illustrating the impact of digital reading modules outside the Western context, offering insights applicable for other regions, cultures, and all educational settings. Furthermore, these approaches were effective due to their educational quality, resource efficiency, high student satisfaction and engagement. They also aligns well with contemporary educational standards and improve teaching approaches. Overall, such approaches validate and advance the growing body of research on using digital resources to develop computational thinking skills, demonstrating that they can be adapted and used in different countries around the world.

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Authors' contributions

SLD and M were responsible for the study design and revisions. AS was responsible for data collection and analysis. ASy drafted the manuscript, and R revised it. All authors read and approved the final manuscript. All authors contributed significantly to the study. There were no special agreements concerning authorship, and contributions were distributed based on expertise and research involvement.

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Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

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The Publication Ethics Committee of the Sciedu Press.

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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