EXPLORING STUDENTS' NEEDS FOR STEM-BASED DIGITAL LEARNING MODELS TO ENHANCE ENGLISH ACADEMIC READING IN 21ST CENTURY

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Abstract: Academic reading is an active process that requires engagement with the text. It is a complex skill that demands effort and plays a crucial role in building knowledge and understanding. However, many students struggle with academic reading due to complex sentence structures, abstract concepts, and the need for critical analysis. This study investigates students' needs for a STEM-based digital learning model to enhance academic English reading in the 21st century. Using a quantitative survey approach, data were collected through a questionnaire consisting of 33 statements distributed to students in the English Education Program, Faculty of Teacher Training and Education, Universitas Muhammadiyah Mataram. Descriptive statistics, including frequency and percentage, were used to analyze the data. The findings reveal that most students recognize the importance of STEM in improving academic reading comprehension and motivation. Digital applications, particularly interactive tools and gamification, were perceived as effective in supporting learning. However, challenges such as technical difficulties, low motivation, and the need for training in digital tools were identified. The study highlights the necessity of structured academic reading support and digital learning resources that align with the curriculum. These findings provide valuable insights into the integration of STEM-based approaches in English language education, emphasizing the need for effective instructional strategies to maximize their benefits.

Keywords: *academic reading; digital learning; models; STEM; students' needs.*

INTRODUCTION

The integration of Science, Technology, Engineering and Math (STEM) in English language learning has obtained significant attention in recent years (Le et al., 2023; Zhan & Niu, 2023). As interdisciplinary skills become increasingly important in the 21st century (Fajrina et al., 2020; Fritsche et al., 2021; Koyunlu Ünlü & Dökme, 2022), educators (Kavak, 2023; Li et al., 2020; Takeuchi et al., 2020; Tytler, 2020) and researchers have been exploring innovative ways to improve students' academic competence (Hu & Guo, 2021; Rajasekaran et al., 2024), particularly in reading comprehension (Goudsouzian & Hsu, 2023). STEM-based learning offers a dynamic approach that bridges technical knowledge with language proficiency, fostering critical thinking, creativity and problem-solving skills (Khushk et al., 2023; Megawati, 2024; Meylani, 2024). By incorporating STEM concepts into English education, students engage with real-world applications that deepen their understanding of both disciplines.

Despite the recognized benefits of STEM-based learning, students often face challenges in academic reading, particularly in comprehending complex texts and acquiring specialized vocabulary (Z. Ghafar, 2024; Lan, 2024). Many English learners struggle with technical jargon commonly found in STEM-related academic materials, which can hinder their ability to fully grasp key concepts (Khalid et al., 2024; Salvetti et al., 2023). Furthermore, the advancement of digital technology has introduced new learning modalities that support interactive and engaging education (Alam & Mohanty, 2023; Pramesworo et al., 2023). Digital applications have emerged as powerful tools for facilitating academic reading through gamification, multimedia content, and collaborative learning environments (Herrera Cano et al., 2023; Lampropoulos et al., 2022b; Manaff & Azahari, 2024). However, the effectiveness of these approaches and students' perceptions of their impact remain areas requiring further investigation.

Another crucial factor in STEM-based English learning is the need to develop students' academic reading skills. Research has shown that proficiency in academic reading is fundamental to students' success in higher education, as it enables them to

analyze, interpret, and synthesize information from various sources (Alenezi et al., 2023b; de-la-Peña & Luque-Rojas, 2021; Du et al., 2023; Patiño et al., 2023; Shamida et al., 2023). Yet, many students experience difficulties in reading academic texts due to the complexity of sentence structures, abstract concepts, and the need for critical analysis (Z. N. Ghafar & Mohamedamin, 2022; Imaniah, 2022). To address this issue, structured interventions such as intensive reading practice, summarization techniques, and vocabulary enhancement strategies must be incorporated into English education curricula.

In addition to reading skill development, digital learning applications have been widely recognized as valuable tools for modern education (Alenezi et al., 2023a; Alotaibi, 2022; Kok et al., 2022; Saleem et al., 2022). Digital apps offer interactive features, including STEM simulations, gamified learning, and real-time assessments, which can enhance students' engagement and comprehension (Lampropoulos et al., 2022a; Mystakidis et al., 2022). The use of digital tools not only improves accessibility but also facilitates personalized learning experiences, allowing students to progress at their own pace (Cevikbas & Kaiser, 2022; Gm et al., 2024; Hafezy, 2023; Shireesha & Jeevan, 2024). However, despite these advantages, students often encounter barriers such as technical difficulties, lack of motivation, and time constraints, which can impact their learning outcomes (Forde & OBrien, 2022; Regmi et al., 2020).

Furthermore, STEM-based learning plays a significant role in fostering 21st-century skills, including critical thinking, communication, collaboration, and creativity (Goudsouzian & Hsu, 2023; Khushk et al., 2023; Le et al., 2023; Megawati, 2024; Salvetti et al., 2023). As the global workforce evolves, there is a growing emphasis on equipping students with the ability to apply knowledge across multiple disciplines. STEM education encourages students to engage in problem-solving tasks that require analytical reasoning and teamwork (Bybee, 1997; Onu et al., 2024; Safira et al., 2024). When integrated into English language learning, STEM approaches can enhance students' ability to discuss academic texts, articulate ideas effectively, and develop essential digital literacy skills (Audrin & Audrin, 2022; Chang et al., 2023; Pangrazio et al., 2020).

This study aims to investigate students' needs of STEM-based learning in English education, focusing on its relevance, the need for academic reading skill development, the role of digital applications, and its contribution to 21st-century skills. Additionally, the study explores barriers to digital learning and students' expectations for effective integration of STEM in language education. By analyzing these aspects, this research seeks to provide insights into the potential benefits and challenges of STEM-based English learning and offer recommendations for its implementation in higher education.

METHOD

This study utilized a quantitative research design to examine students' needs for STEM-based learning in English education. A structured survey questionnaire was used to collect data from students in the English Education Program, Faculty of Teacher Training and Education, Universitas Muhammadiyah Mataram. The questionnaire consisted of 33 statements and was divided into six sections, each focusing on a key aspect of STEM-based learning: its necessity, the development of academic reading skills, the role of digital applications, the enhancement of 21st-century skills, barriers to digital learning, and students' expectations. A total of 22 students participated in the study, selected through a convenience sampling method to ensure representation from diverse academic backgrounds and learning experiences.

The survey instrument included Likert-scale questions, with responses ranging from "Strongly Disagree" to "Strongly Agree." The questionnaire was administered online via Google Forms, and responses were gathered over one month. To ensure the reliability of the instrument, Cronbach's alpha was calculated, confirming consistency in participants' responses. Descriptive statistics, including frequencies and percentages, were used to analyze the collected data. The findings were examined to identify students' needs for STEM-based learning. Additionally, relevant literature was referenced to contextualize the results and provide deeper insights into the implications of integrating STEM into English language education.

RESULTS AND DISCUSSION

The findings and discussion of students' needs analysis for STEM-based digital learning models to enhance English academic reading in the 21st century can be categorized into six variables.

The need for STEM-based learning

Table 1. *The need for STEM-based learning*

No	Statements	Strongly Disagree	Disagree	Netral	Agree	Strongly Agree
1	I understand the concept of STEM and its relevance in English language learning.	0 %	0 %	40,9 %	50 %	9.1 %
2	I need a STEM approach to enhance my academic reading skills.	0 %	0 %	18.2 %	68.2 %	13.6 %
3	The STEM approach interests me in understanding academic texts.	0 %	0 %	18.2 %	68.2 %	13.6 %
4	STEM helps connect English language learning with real-world contexts.	0 %	4.5 %	27.3 %	50 %	18.2 %
5	STEM-based learning will increase my learning motivation.	0 %	0 %	31.8 %	54.5 %	13.6 %

Table 1 conveys that a majority of students recognize the relevance of STEM in English language learning, with 50% agreeing and 9.1% strongly agreeing with its importance. Additionally, 68.2% of respondents agree that a STEM-based approach is beneficial for improving academic reading skills, while 13.6% strongly agree. Similarly, the same percentage of students (68.2% agree and 13.6% strongly agree) find STEM engaging in understanding academic texts. Moreover, 50% of students believe that STEM helps relate English learning to real-world applications, while 18.2% strongly agree. Lastly, 54.5% agree that STEM-based learning enhances their motivation, whereas 13.6% strongly agree. These findings highlight the positive reception of the STEM approach in supporting English language learning.

The findings of this study highlight the positive perception of students toward the integration of STEM-based learning in English education. A significant majority of students recognize the value of STEM in enhancing various aspects of language learning, particularly in academic reading and engagement with texts. The fact that 68.2% of respondents agree that STEM improves academic reading skills suggests that interdisciplinary approaches can facilitate comprehension by providing contextually rich and meaningful content. This aligns with previous research emphasizing the role of STEM in promoting analytical thinking and deeper cognitive engagement (Idris et al., 2023).

Moreover, the study indicates that STEM-based learning not only supports reading comprehension but also enhances motivation and real-world application. The acknowledgment by 50% of students that STEM connects English learning to practical contexts demonstrates its potential to make language acquisition more relevant and meaningful. Additionally, the motivational impact of STEM, as indicated by 54.5% of students, suggests that interactive and problem-solving approaches associated with STEM can foster a more engaging learning environment. These results support the growing advocacy for integrating STEM into language education as a means of developing critical thinking, problem-solving, and interdisciplinary skills (Kavak, 2023). However, further research is needed to explore the specific challenges students face in adopting STEM-based learning and to develop strategies that maximize its effectiveness in English language education.

The need for academic reading skill development

Table 2. *The need for academic reading skill development*

No	Statements	Strongly Disagree	Disagree	Netral	Agree	Strongly Agree
6	English academic reading is very important in my studies.	0 %	0 %	13.6 %	54.5 %	31.8 %
7	I have difficulty understanding academic vocabulary in English texts.	0 %	4.5	18.2 %	59,1 %	18,2 %
8	I need learning strategies to understand academic texts effectively.	0 %	0 %	13.6 %	59.1 %	27.3 %
9	I need structured intensive reading practice.	0 %	0 %	22.7 %	50 %	27.3 %

10	I need a guide to summarizing academic texts.	0 %	0 %	13.6 %	63.6 %	22.7 %

The table 2 indicates that a majority of students recognize the importance of academic reading in their studies, with 54.5% agreeing and 31.8% strongly agreeing. Additionally, 59.1% of students agree that they struggle with academic vocabulary, while 18.2% strongly agree. Regarding the need for effective learning strategies, 59.1% agree and 27.3% strongly agree. Similarly, 50% of students acknowledge the need for structured intensive reading practice, with 27.3% strongly agreeing. Lastly, 63.6% of students agree that a guide for summarizing academic texts is necessary, while 22.7% strongly agree. These findings highlight the critical need for targeted strategies and resources to support students in academic reading.

The findings emphasize the significant role of academic reading in students' studies, with the majority (86.3%) recognizing its importance. This suggests that students are aware of the necessity of strong reading skills for academic success. However, the results also reveal key challenges, particularly in vocabulary acquisition, with 77.3% of students struggling with academic terminology. This aligns with prior research indicating that specialized vocabulary is a common barrier in academic reading (Fritsche et al., 2021; Lalit et al., 2020). Addressing this issue requires explicit vocabulary instruction and exposure to discipline-specific texts to enhance students' comprehension and confidence in reading academic materials.

Furthermore, the study highlights the need for effective learning strategies and structured reading practice. The fact that 86.4% of students acknowledge the necessity of learning strategies indicates a strong demand for guidance in developing efficient reading techniques. Similarly, the agreement among 77.3% of students on the need for structured intensive reading practice suggests that systematic and scaffolded approaches could significantly benefit their reading proficiency. Additionally, the high percentage (86.3%) supporting the inclusion of summarization guides reinforces the importance of teaching students how to synthesize information effectively. These findings suggest that implementing targeted interventions, such as explicit strategy instruction, guided reading sessions, and structured summarization techniques, could greatly enhance students' academic reading skills and overall learning outcomes.

The necessity of using digital apps in learning

Table 3. *The necessity of using digital apps in learning*

No	Statements	Strongly Disagree	Disagree	Netral	Agree	Strongly Agree
11	Digital apps are effective to help learn academic reading.	0 %	0 %	9.1 %	68.2 %	22.7 %
12	The interactive features in the app help improve my comprehension.	0 %	0 %	13.6 %	54.5 %	31.8 %
13	I need STEM-based simulation features or videos in digital apps.	0 %	0 %	22.7 %	54.5 %	27.7 %
14	Highly gamified digital apps can increase my learning motivation.	0 %	4.5 %	22.7 %	59.1 %	13.6 %
15	I need app-based quizzes to evaluate my reading skills.	0 %	4.5 %	18.2 %	59.1 %	18.2 %
16	I need progress reports on my learning outcomes through digital apps.	0 %	0 %	18.2 %	59.1 %	22.7 %
17	Digital apps should provide features that support collaborative learning.	0 %	0 %	18.2 %	63.6 %	18.2 %
18	I need app support that can be used offline.	0 %	4.5 %	13.6 %	63.6 %	18.2 %

Table 3. points out that students largely perceive digital applications as effective tools for academic reading, with 68.2% agreeing and 22.7% strongly agreeing. Additionally, 54.5% of respondents agree that interactive features enhance comprehension, while 31.8% strongly agree. A notable 54.5% of students agree on the necessity of STEM-based simulations or videos, with 27.7% strongly agreeing. Regarding motivation, 59.1% of students agree that gamified digital apps can boost

engagement, while 13.6% strongly agree. Similarly, 59.1% agree that app-based quizzes are useful for assessing reading skills, while 18.2% strongly agree. A majority (59.1% agree, 22.7% strongly agree) also express the need for progress reports on their learning outcomes. Furthermore, 63.6% of students agree that collaborative learning features should be included in digital apps, and an equal percentage believe offline access is essential.

The findings suggest that students generally perceive digital applications as valuable tools for academic reading. A significant proportion (68.2%) agree that digital apps enhance reading comprehension, with an additional 22.7% strongly supporting this claim. This indicates that digital platforms provide interactive and engaging learning experiences that facilitate better understanding. The high level of agreement (54.5%) regarding the role of interactive features in improving comprehension, with 31.8% strongly agreeing, further reinforces the importance of incorporating multimedia elements such as animations, videos, and interactive exercises in digital learning environments. These results align with previous studies highlighting the effectiveness of digital applications in supporting active engagement and knowledge retention (Audrin & Audrin, 2022; Chang et al., 2023).

Moreover, the study highlights students' preference for specific digital tools, such as STEM-based simulations and gamified learning. The agreement among 59.1% of respondents that gamified apps increase motivation suggests that integrating game mechanics into educational applications can enhance student engagement and learning outcomes. Additionally, the demand for features like progress reports (81.8% combined agreement) and collaborative learning tools (63.6%) suggests that students value personalized learning experiences and opportunities for peer interaction. The equal percentage (63.6%) supporting offline access further emphasizes the need for flexible learning options that accommodate different technological constraints. These insights indicate that well-designed digital applications incorporating interactive, gamified, and collaborative elements can significantly enhance academic reading experiences in STEM-based English education. Future research should explore the effectiveness of specific digital tools and strategies for optimizing their use in language learning.

Supporting 21st century skills through STEM learning

Table 4. *Supporting 21st century skills through STEM learning*

No	Statements	Strongly Disagree	Disagree	Netral	Agree	Strongly Agree
19	STEM learning can help improve my critical thinking skills.	0 %	0 %	27.3 %	59.1 %	13.6 %
20	STEM encourages creativity in understanding and solving academic problems.	0 %	9.1 %	13.6 %	68.2 %	9.1 %
21	STEM-based apps improve my communication skills in academic text discussions.	0 %	4.5 %	22.7 %	54.5 %	18.2 %
22	STEM approaches are relevant to building my collaboration skills.	0 %	4.5 %	22.7 %	59.1 %	13.6 %
23	Digital-based STEM helps me better understand complex academic texts.	0 %	0 %	18.2 %	63.6 %	18.2 %

Table 4. indicates that students generally perceive STEM-based learning as beneficial for developing critical thinking, with 59.1% agreeing and 13.6% strongly agreeing. Similarly, 68.2% of students agree that STEM fosters creativity in problem-solving, although 9.1% express disagreement. Regarding communication skills, 54.5% of students agree that STEM-based apps enhance their ability to discuss academic texts, while 18.2% strongly agree. Additionally, 59.1% of students agree that STEM approaches are

relevant to developing collaboration skills, with 13.6% strongly agreeing. Finally, a majority of students (63.6%) agree that digital-based STEM tools help them understand complex academic texts, while 18.2% strongly agree. These findings suggest that students recognize the value of STEM in strengthening higher-order thinking skills, communication, and collaboration in academic contexts.

The findings indicate that students generally perceive STEM-based learning as an effective

approach to developing higher-order thinking skills, including critical thinking, creativity, communication, and collaboration. The fact that 72.7% of students agree or strongly agree that STEM fosters critical thinking suggests that interdisciplinary learning encourages analytical reasoning and problem-solving, which are essential for academic success and real-world applications (Lampropoulos et al., 2022b; Zhan & Niu, 2023). Similarly, 68.2% of students recognize STEM's role in enhancing creativity in problem-solving, reinforcing the idea that STEM methodologies promote innovative thinking through hands-on and inquiry-based learning experiences. However, the presence of 9.1% of students who disagree suggests that some learners may struggle with adapting to STEM-based approaches, highlighting the need for supportive

instructional strategies to ensure inclusivity.

Furthermore, the study highlights the impact of STEM-based learning on communication and collaboration skills, with 72.7% of students agreeing that STEM-based apps help them discuss

academic texts more effectively. This finding suggests that integrating STEM in English education can facilitate academic discourse, allowing students to articulate complex ideas with greater clarity. Additionally, 72.7% of students acknowledge that STEM enhances collaboration, emphasizing the importance of teamwork in problem-solving activities. The high level of agreement (81.8%) regarding the usefulness of digital STEM tools in understanding complex academic texts further supports the notion that technology-driven STEM education provides students with interactive and structured learning experiences. These results reinforce the growing emphasis on STEM as a means of preparing students with essential 21st-century skills, while also highlighting the need for further exploration of the challenges students may face in implementing STEM-based learning in English education.

Barriers to digital learning

Table 5. *Barriers to digital learning*

No	Statements	Strongly Disagree	Disagree	Netral	Agree	Strongly Agree
24	I often experience technical difficulties (internet, devices) when learning to use the app.	0 %	9.1 %	27.3 %	50 %	9.1 %
25	I need training to use digital apps effectively.	0 %	0 %	27.3 %	50 %	22.7 %
26	My study schedule is tight, making it difficult to utilize digital learning optimally.	0 %	13.6 %	40.9 %	36.4 %	9.1 %
27	I lack motivation to use learning apps.	0 %	4.5 %	31.8 %	54.5 %	4.5 %
28	I have difficulty understanding academic texts that contain STEM technical terms.	0 %	4.5 %	31.8 %	45.5 %	18.2 %

Table 5 indicates that technical difficulties remain a concern, with 50% of students agreeing and 9.1% strongly agreeing that they face internet or device-related issues. Additionally, 77.3% of students express a need for training to effectively use digital learning apps, highlighting the importance of structured guidance. Regarding time constraints, 36.4% of students agree and 9.1% strongly agree that their tight study schedules limit their ability to utilize digital learning optimally. Moreover, 54.5% of students agree that they struggle with motivation when using learning apps, though only 4.5% strongly agree. Finally, understanding STEM-related academic texts poses a challenge for 45.5% of students who agree and

18.2% who strongly agree, suggesting the need for additional support in navigating technical vocabulary.

The findings highlight several challenges students face in utilizing digital learning applications for STEM-based English education. Technical difficulties, such as internet connectivity issues and device limitations, remain a significant barrier, with 59.1% of students acknowledging these concerns. This aligns with previous research indicating that digital access disparities can hinder the effectiveness of technology-based learning (Le et al., 2023; Zhan & Niu, 2023). Addressing these issues may require institutional support, such as

improved digital infrastructure and offline access options for learning applications.

Additionally, the need for structured training is evident, as 77.3% of students express a desire for guidance in using digital learning tools effectively. This finding underscores the importance of digital literacy training to ensure that students can maximize the benefits of these applications. Time constraints also present a challenge, with 45.5% of students indicating that their study schedules limit their ability to engage with digital learning. To address this, educators could integrate digital learning into structured coursework rather than expecting students to engage with these tools independently. Furthermore, motivation appears to be another obstacle, with over half of the students (59%) struggling to stay engaged when using digital learning apps. This suggests that incorporating gamification, personalized feedback, and interactive elements could enhance student motivation. Lastly, the difficulty in understanding STEM-related academic texts, as reported by 63.7% of students, highlights the need for additional scaffolding, such as glossaries, guided reading strategies, and contextualized explanations of technical terms. These findings suggest that while digital STEM learning has significant potential, its effectiveness depends on addressing technical, instructional, and motivational challenges to ensure successful implementation.

Expectations and Suggestions

Table 6. *Expectations and suggestions*

No	Statements	Strongly Disagree	Disagree	Netral	Agree	Strongly Agree
29	I expect digital apps to have simple and easy-to-use features.	0 %	0 %	9.1 %	59.1 %	31.8 %
30	Digital apps need to offer content that is integrated with my learning materials.	0 %	0 %	22.7 %	54.5 %	22.7 %
31	App-based STEM approaches can be integrated into the regular learning system.	0 %	0 %	13.6 %	63.6 %	22.7 %
32	I need a complete guide on using STEM apps for learning.	0 %	0 %	9.1 %	59.1 %	31.8 %
33	STEM learning should be designed to support long-term learning outcomes.	0 %	0 %	18.2 %	59.1 %	22.7 %

Table 6. reveals that simplicity and ease of use are key expectations, with 59.1% agreeing and 31.8% strongly agreeing that digital apps should have user-friendly features. Additionally, 77.2% of students believe that digital content should be aligned with their learning materials, reinforcing the need for curriculum-integrated digital tools. Regarding integration into regular learning, 63.6% of students agree, and 22.7% strongly agree that app-based STEM approaches can be incorporated into formal education. Moreover, 90.9% of students express a need for a comprehensive guide on using STEM apps, emphasizing the necessity of clear instructions and tutorials. Lastly, long-term learning outcomes are a major consideration, with 59.1% of students agreeing and 22.7% strongly agreeing that STEM-based learning should be designed for sustained academic benefits.

The findings emphasize students' expectations for user-friendly, curriculum-aligned, and structured digital learning applications in STEM-based English education. A significant majority (90.9%) express the need for a comprehensive guide on using STEM apps, underscoring the importance of clear instructions, tutorials, and support materials. This aligns with previous studies highlighting that the usability and accessibility of digital tools play a crucial role in students' learning experiences (Alam & Mohanty, 2023; Herrera Cano et al., 2023). Ensuring intuitive navigation and well-structured learning pathways can enhance engagement and minimize barriers to adoption.

Furthermore, the strong preference (77.2%) for digital content that aligns with existing learning materials suggests that students seek coherence between traditional and digital learning methods. This reinforces the necessity of integrating STEM-based applications into formal curricula to provide a seamless educational experience. Similarly, 63.6% of students believe that digital STEM approaches should be incorporated into structured coursework, highlighting the potential for blended learning models. Additionally, the emphasis on long-term learning outcomes (81.8%) suggests that students value digital learning tools that contribute to sustained academic growth rather than just

short-term engagement. To meet these expectations, educators and developers should design digital learning experiences that not only enhance immediate comprehension but also build lasting skills in academic reading and STEM-related language proficiency.

CONCLUSION

This study highlights the students' need of STEM-based learning in enhancing students' academic reading skills, motivation, and 21st-century competencies in English education. The findings suggest that while STEM-based approaches offer numerous benefits, challenges such as technical difficulties, motivation barriers, and the need for structured guidance must be addressed. Integrating STEM effectively requires curriculum alignment, interactive digital resources, and tailored instructional strategies. Future research should explore long-term impacts and intervention models to maximize the effectiveness of STEM in language education.

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