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Analysis of Ethno-STEM-Integrated PBL E-Module to Enhance Creative Thinking Skills of 8th Grade Junior High School Students

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ABSTRACT

Purpose of the study: This research aims to analyze the needs for developing an Ethno-STEM-integrated Problem-Based Learning (PBL) e-module to enhance the creative thinking skills of 8th-grade junior high school students on the topics of vibrations, waves, and sound.

Methodology: This study employed a mixed method. The instrument used was a questionnaire adapted from previous research. The sample consisted of junior high school science teachers and students in Karanganyar Regency. Data analysis used descriptive statistics.

Main Findings: The findings revealed a significant gap between current science learning practices and the demands of 21st-century education. Teachers reported difficulties in explaining abstract concepts such as vibrations, waves, and sound using conventional methods, compounded by the limited availability of instructional media that integrates local cultural wisdom. Meanwhile, students expressed strong interest in digital and contextual learning resources, yet their creative thinking skills remained low, with an average score of only 49.4%. This indicates the urgent need for innovative, interactive, and culturally relevant learning solutions.

Novelty/Originality of this Study: The development of an Ethno-STEM-based PBL e-module that not only integrates science, technology, engineering, and mathematics with local wisdom but also explicitly targets the four core aspects of creative thinking: fluency, flexibility, originality, and elaboration. Unlike conventional modules, this approach leverages ethnoscience contexts to make abstract concepts more tangible while simultaneously fostering problem-solving and higher-order thinking. Thus, the research provides a strategic foundation for designing learning media that is pedagogically sound, culturally meaningful, and aligned with the competencies required in the global era.

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1. INTRODUCTION

The transformation of education in the era of the Fourth Industrial Revolution requires innovation in the learning process, especially in the field of science, which necessitates mastery of critical, collaborative, and creative thinking skills [1]. Implementing education that aligns with the demands of the times plays a crucial role in accelerating the optimal growth and development of society, especially in responding to the rapid advancements in technology [2]. Innovative and integrated learning approaches have become a primary necessity, and one of the increasingly recognized approaches is the Ethno-STEM approach [3]. This approach combines four disciplines holistically, providing not only an understanding of concepts in isolation but also fostering strong interconnections among fields within real-world contexts [4].

Education in the 21st century requires students not only to master factual knowledge but also to possess higher-order thinking skills, one of which is creative thinking skills [5]. This skill is essential for students to generate innovative, original, and applicable ideas in solving real problems [6]. In the context of science learning, creative thinking becomes an essential aspect for building a strong conceptual understanding and encouraging students' ability to connect science with everyday life [7]. However, studies show that the creative thinking skills of Indonesian students are still considered low [8]. One of the main reasons is the teacher-centered learning approach, which has not stimulated active student engagement in solving contextual problems [9]. Therefore, there is a need for learning innovations that can foster active student involvement and develop their creative thinking potential [10].

Education in Indonesia currently requires students to think creatively. According to the deep learning curriculum, one of the educational goals and necessary skills for students is creative thinking [11]. The main challenge at the junior high school level (SMP/MTs) is the low creative thinking skills of students on the topics of vibrations, waves, and sound, which are often considered abstract and difficult to understand without the appropriate teaching media [12]. Students in the 21st century are expected to be able to compete globally [13]. Along with the rapid advancement of information and communication technology in this 21st century, students are required to master various essential skills to adapt to the changing times [14]. The skills needed in the 21st century are often referred to as higher-order thinking skills, which include critical thinking, creative thinking, communication, and collaboration [15]. Mastery of these four skills is crucial for students to face the challenges and demands of education in the 21st century. One important competency recommended in the education system in Indonesia to meet future challenges is the ability to think creatively [16].

However, the reality on the ground shows that many students in Karanganyar still have low levels of creative thinking skills. This condition is reflected in the evaluation results, where the average test scores of students remain below the minimum competency standards (KKM). In the 2024/2025 academic year, about 70% of students have not succeeded in reaching the established KKM standards. The low creative thinking skills among students can be influenced by various factors, such as a lack of varied teaching methods, minimal use of innovative learning media, and insufficient stimulation to develop higher-order thinking skills [4]. Other research also emphasizes that low achievement of the KKM often indicates the need for improvements in teaching strategies and the development of media that are more adaptive to students' needs [17].

One relevant approach is Problem-Based Learning (PBL) [18]. PBL emphasizes a learning process based on authentic real-world problems, where students are encouraged to explore, identify, and solve problems through a collaborative and reflective process [19]. This model has proven effective in developing higher-order thinking skills, including creative thinking, as it provides space for students to ask questions, design solutions, and evaluate their own ideas [9]. The Problem-Based Learning (PBL) model is known to be effective in enhancing creative thinking skills because it encourages students to solve real problems independently and collaboratively [20]. The integration of PBL with the Ethno-STEM approach, which combines science, technology, engineering, mathematics, and local wisdom, can provide a more contextual and meaningful learning experience [21]. This approach not only strengthens the understanding of science concepts but also fosters appreciation for local culture while enhancing student motivation and creativity [20].

On the other hand, the Ethno-STEM approach emerges as a new strategy that integrates local values and cultural wisdom into the context of learning science, technology, engineering, and mathematics [22]. This approach bridges the gap between modern science and local culture, helping students understand that scientific knowledge is rooted in the traditions of their communities [23]. The implementation of Ethno-STEM in science learning can also enhance cultural identity and learning relevance, ultimately fostering student motivation and creativity [11]. The Ethno-STEM approach is believed to have great potential for improving the quality of learning because it presents material comprehensively and contextually with a focus on local culture [23]. Through the Ethno-STEM approach, students are encouraged to develop motivation and skills in designing, developing, and integrating technology [24]. This enables students to apply knowledge effectively to solve a variety of complex problems that are relevant to their daily lives [25]. Thus, Ethno-STEM not only focuses on mastering content but also on developing practical skills and creative thinking necessary in the modern era, combined with local cultural wisdom [21].

Creative thinking skills are one of the crucial cognitive aspects that require serious attention in the context of learning activities. This aligns with [26], who emphasizes the importance of developing these skills in the learning process. Problems that require resolution through creative thinking skills are still not being effectively addressed by students, influenced by various supporting factors in the implementation of the learning process [27]. Therefore, improvements are needed in supportive learning methods by adopting appropriate approaches and developing learning resources that meet the needs and characteristics of students to effectively enhance students' creative thinking abilities. Conventional learning modules are considered less effective in stimulating active student engagement and connecting science concepts with everyday life and local culture [16].

The use of e-modules as interactive learning media is becoming increasingly relevant in the digital era [28], [29]. PBL-based e-modules integrated with Ethno-STEM allow for adaptive, visual, and interactive material presentation, thereby supporting the development of 21st-century skills, particularly creative thinking [11]. Previous research has shown that Ethno-STEM-based e-modules on the topics of vibrations, waves, and sound have proven to be valid, practical, and effective in enhancing student engagement and learning outcomes [21]. Additionally, the advantage of e-modules lies in their ability to accommodate individual learning needs, provide a variety of project activities, and connect the material with local wisdom relevant to students' daily lives [2]. In efforts to present innovative and digital-based learning, the development of e-modules is a suitable choice. E-modules offer advantages such as flexible access, multimedia integration, and the ability to present material interactively and engagingly [21], [30]. When e-modules are developed using the PBL and Ethno-STEM approaches, students are not only invited to solve culture-based contextual problems but are also guided to build creativity through technology-based exploration [31].

Although various studies have investigated creative thinking, Ethno-STEM, and PBL independently, research that integrates PBL with Ethno-STEM in the form of digital-based learning resources, particularly e-modules, is still limited. Most existing studies emphasize effectiveness or practicality but rarely explore the combined potential of these approaches to explicitly enhance creative thinking in abstract science topics such as vibrations, waves, and sound. Moreover, contextual studies focusing on Indonesian regions such as Karanganyar where students' creative thinking remains low and achievement levels fall below the KKM are scarce. Thus, there is a clear need to develop Ethno-STEM integrated PBL e-modules as innovative learning media to systematically improve students' creative thinking skills while also connecting science with local wisdom and cultural identity.

2. RESEARCH METHOD

This study employs a qualitative descriptive design aimed at analyzing the needs, readiness, and responses of teachers and students toward the development of science e-modules [32]. The descriptive approach integrates both qualitative and quantitative methods [33], which allows for a more comprehensive understanding of the actual educational context. The qualitative component of the study focuses on exploring teacher perspectives regarding constraints, experiences, and expectations of learning media, while the quantitative component emphasizes student readiness, learning needs, and levels of creative thinking skills. This combination provides a holistic description of the existing conditions in schools and serves as the foundation for developing innovative Problem-Based Learning (PBL) integrated science e-modules based on the Ethno-STEM approach. Furthermore, this study also seeks to describe the initial level of students' creative thinking skills, which is a crucial competency in the 21st-century learning framework [34]. The assessment of creative thinking was conducted based on four indicators, namely fluency, flexibility, originality, and elaboration [36].

The research was conducted in October 2024 at several schools in Karanganyar Regency through a field study approach [2]. The population consisted of eighth-grade students and science teachers, with 32 eighth-grade students selected using random sampling to ensure representativeness [35], while science teachers were selected purposively from the Science Teacher Working Group (MGMP IPA) of Karanganyar Regency to ensure proportional representation of practitioners [35]. The combination of random and purposive sampling ensured that the data reflected both the student and teacher perspectives needed for comprehensive analysis.

Data collection was carried out by means of direct surveys at the research site, which involved the distribution of open and closed questionnaires to teachers and students. The instruments included an open-ended questionnaire for teachers, which contained questions regarding teaching constraints, previous experiences, and expectations for science learning media. Meanwhile, students were given a learning needs questionnaire consisting of 15 Yes/No items to examine the relevance, availability, and effectiveness of learning resources. In addition, students also completed a creative thinking skills questionnaire consisting of 18 items reflecting the four dimensions of creative thinking, with six items on fluency, four on flexibility, four on originality, and four on elaboration [36]. Through these instruments, qualitative data were obtained from the thematic analysis of teachers' responses, while quantitative data were obtained from student scales, checklists, and scores that reflected their learning needs, readiness, and creative thinking skills [37].

The data analysis technique applied in this study was qualitative descriptive analysis, which was used to interpret the trends and patterns of the collected data [38]. Teachers' open responses were analyzed thematically to identify recurring challenges and expectations regarding the use of science learning media. Meanwhile, student responses from the needs questionnaire and the creative thinking skills test were analyzed statistically in a descriptive manner to determine score trends across the four indicators of creative thinking. To ensure accuracy and reliability, triangulation was applied by combining qualitative and quantitative findings so that the analysis results could provide a deeper and more contextualized understanding of the conditions of science learning in schools. This methodological approach ultimately enabled the researchers to generate accurate information on the actual needs of both teachers and students, which can serve as the foundation for developing Ethno-STEM–based e-modules that are both innovative and relevant.

Table 1. Questionnate for Teacher Needs Analysis

No	Question
1	Who developed the teaching devices that you use in your teaching?
2	Have you ever created Ethno-STEM teaching devices to enhance students' creative thinking skills in your class?
3	What types of learning approaches have you ever implemented?
4	Based on your answer, what is the reason for choosing that approach?
5	What teaching models do you usually/ever use in science learning to enhance students' creative thinking skills?
6	Who developed the books/teaching materials that you have used so far?
7	Have you ever attempted to develop teaching materials to enhance students' creative thinking skills? Please provide your reasons.
8	In your opinion, how do you write interesting teaching materials on creative thinking skills?
9	Do you use Ethno-STEM worksheets in your teaching to improve students' creative thinking skills?
10	If you answered "Yes" or "if necessary" to question 9, who developed the Ethno-STEM worksheets you use to enhance creative thinking skills?
11	If you answered "Yes" or "if necessary," what do you consider to be good Ethno-STEM worksheets for enhancing students' creative thinking skills?
12	Do students find it difficult to follow lessons in your classroom?
13	According to you, what type of concepts are difficult for students to understand, making it hard for you to enhance their creative thinking skills?
14	Are you familiar with the concept of creative thinking skills? If you answered Yes, what do you think the concept of creative thinking skills is like?
15	Do you always want to improve students' creative thinking skills in learning?
16	Are there any difficulties students face in enhancing their creative thinking skills?
17	Do you relate your teaching to events/problems in daily life?
18	Do you guide students to understand phenomena based on science?
19	Do you organize learning activities that encourage students to create scientific ideas?
20	In your learning activities, do you guide students to draw conclusions based on activities and scientific discussions?
21	What aspects do you measure in evaluating the improvement of students' creative thinking skills?
22	In composing tests to improve students' creative thinking skills at the cognitive level, what do you measure?
23	Briefly explain your problems in PBM related to teacher and student aspects in enhancing students' creative thinking skills.
24	Briefly explain your problems in developing teaching devices related to teacher, student, facilities, and infrastructure aspects in enhancing students' creative thinking skills.
25	Are you familiar with Ethno-STEM devices to enhance students' creative thinking skills?
26	If yes, what do you mean by Ethno-STEM devices for students' creative thinking skills?

3. RESULTS AND DISCUSSION

Along with rapid changes in various sectors of life brought about by 21st-century developments, new challenges are also emerging in the field of education. These challenges demand the optimization of students' creative thinking skills as one of the key competencies required in modern learning [36], [39]. Therefore, innovation in science education is essential, not only to fulfill students' learning needs but also to support the systematic development of creative thinking skills. One promising approach is the integration of Problem-Based Learning (PBL) into digital teaching materials such as e-modules, as PBL has been shown to foster students' problem-solving abilities and stimulate creative thinking [40].

The science topics of vibrations, waves, and sound offer rich opportunities for integrating Ethno-STEM, particularly considering Indonesia's wealth of traditional musical instruments [39]. Research confirms that embedding ethnoscience elements into science learning—by linking modern knowledge with local wisdom—can enhance students' critical and creative thinking [21]. Traditional instruments such as *gamelan*, *angklung*, and *kendang* can serve as living laboratories for exploring physics concepts: *gamelan* illustrates resonance, harmonics, and acoustic space; *angklung* demonstrates natural frequency and transverse vibrations; while *kendang* provides concrete examples of amplitude, the role of medium, and wave propagation. This approach not only strengthens conceptual understanding but also reinforces students' cultural identity. Moreover, studies have shown that integrating local wisdom into learning increases students' intrinsic motivation and engagement [41].

The teacher needs analysis further revealed valuable insights into the implementation of teaching devices, learning approaches, and challenges in fostering creative thinking, particularly through Ethno-STEM. Most teaching devices and instructional materials were collaboratively developed by the MGMP teacher forum rather than individually (Q1, Q6, Q10). While this collaborative model facilitates resource sharing, it also demonstrates teachers' reliance on collective products due to limited time, expertise, and facilities. As a result, independent innovation remains low. Furthermore, teachers admitted that they had never created Ethno-STEM-based devices independently (Q2, Q25) and some were unfamiliar with the Ethno-STEM concept altogether (Q26). This underscores the need for professional development programs that equip teachers with the skills to design culturally relevant and creativity-oriented resources.

In terms of pedagogy, teachers most frequently employed the scientific approach (Q3–Q4), perceived as easier for students to understand, and relied heavily on experimentation (Q5) as a model to enhance creative thinking. While experimentation enables students to engage with scientific processes, opportunities to generate original scientific ideas remained limited (Q19). Teachers also identified key barriers such as difficulties in teaching abstract concepts (Q13), inadequate facilities, low student motivation, and limited capacity to keep up with scientific advancements (Q23–Q24). These findings align with previous studies which indicate that infrastructure, teacher competence, and contextual constraints strongly influence the success of innovative practices in science classrooms.

Teachers' evaluation practices also revealed limitations. Most assessments of creative thinking focused only on cognitive aspects (Q21), particularly analysis at the C4 level (Q22). Although this reflects attempts to engage students in higher-order thinking, it does not fully capture the multidimensional nature of creativity, which also involves originality, flexibility, and elaboration. Despite these challenges, teachers expressed strong commitment to improving students' creative thinking skills (Q15). They consistently linked science learning with daily-life contexts (Q17), guided students in interpreting scientific phenomena (Q18), and encouraged them to draw conclusions from discussions and activities (Q20). However, explicit efforts to nurture idea generation were only occasionally implemented, indicating that while the foundation for inquiry-based learning is present, the systematic integration of creativity remains limited.

The needs analysis also emphasized that although MGMP has played a central role in developing shared teaching devices, teachers still struggle with designing materials that are both innovative and engaging. Their use of the scientific and experimental models demonstrates a preference for hands-on learning, but without systematic strategies to encourage divergent thinking, flexibility, and originality, the impact on creativity development remains constrained. Furthermore, teachers noted that varying levels of student ability and motivation complicate the design of universally effective teaching resources.

Taken together, these findings point to an urgent need for the development of an integrated Ethno-STEM PBL e-module as a comprehensive solution for junior high school science learning [42]. Such a module would respond directly to teacher limitations in material development, while simultaneously aligning with students' preferences for digital, contextual, and culture-based learning. Teachers themselves acknowledged that Ethno-STEM worksheets are effective in fostering critical and creative problem-solving [43], yet 100% of respondents were not comprehensively familiar with the concept of Ethno-STEM. This reflects broader national findings that science education in Indonesia continues to face challenges in integrating local wisdom with modern STEM pedagogy. Hence, there is a pressing need for both material development and structured teacher training programs.

Students' preferences further reinforce the urgency of this innovation: 84.4% expressed interest in science learning that incorporates local culture, while 87.5% wanted learning to be connected with real-world issues. These preferences strongly justify the Ethno-STEM approach, which bridges indigenous wisdom and modern scientific knowledge. In the context of vibrations, waves, and sound, traditional Indonesian musical instruments provide authentic and culturally relevant entry points. Notably, no teachers reported having independently developed Ethno-STEM teaching devices to enhance creative thinking [44], confirming earlier research [45] that the implementation of Ethno-STEM in Indonesia remains limited despite evidence of its positive impact.

A survey of the student needs analysis revealed that more than 90.6% of students expressed difficulty in understanding science concepts solely from textbooks, indicating the limited effectiveness of conventional teaching materials. This aligns with research [23] which shows that Ethno-STEM integrated problem-based learning e-modules can enhance students' creative thinking abilities.

Table 2. Results of the Student Needs Analysis

No	Question	Percenatage (%)
1.	I find it difficult to understand science material only from textbooks	90.6%
2.	learn more easily if the material is accompanied by pictures, videos, or animations	93.8%
3.	I want to learn science in a more interesting and enjoyable way	96.9%
4.	I have difficulty understanding the concepts of vibration, waves, and sound in daily life	87.5%
5.	I am interested if learning is related to culture or things around me	84.4%
6.	I rarely use the internet to search for science learning materials	15.6%
7.	I am accustomed to learning science through digital media such as e-modules or educational videos	78.1%
8.	I understand the material better if it is accompanied by examples from the local environment or culture	15.6%
9.	I enjoy working in groups to solve problems in science lessons	9.4%
10.	I want interactive practice questions that can immediately show correct/incorrect answers	12.5%
11.	I feel not yet confident in answering science concept comprehension questions	18.8%
12.	I prefer to learn with modules that can be accessed through mobile phones/laptops anytime	93.8%
13.	I need learning that can help improve my creativity	90.6%
14.	I want to learn science through real problems that occur around me	87.5%
15.	I am interested if science learning is presented with a project approach or real activities	81.2%

From Table 2, several important findings can be highlighted regarding students' learning needs and challenges in science education. First, the data show that a large majority of students (90.6%) face difficulties when learning science solely through textbooks. In contrast, almost all respondents (93.8%) reported that they learn more effectively when the material is accompanied by visual supports such as pictures, videos, or animations. This reflects a strong demand for innovative, technology-based learning approaches that move beyond conventional textbook-centered instruction and toward more interactive and engaging formats. Consistently, 96.9% of students expressed a desire to learn science in a more enjoyable and interesting way, which further underscores the urgency of designing learning strategies that emphasize interactivity and engagement.

Second, difficulties in understanding abstract scientific concepts remain a significant challenge. A total of 87.5% of students reported struggling to apply the concepts of vibration, waves, and sound in daily life, while 18.8% admitted lacking confidence in answering comprehension questions. These findings highlight the importance of contextual learning, which explicitly connects science content to students' real-life experiences. Importantly, student interest in culturally grounded and context-based learning was also high: 84.4% indicated greater interest when science learning was linked to culture or their immediate environment, and 87.5% expressed a preference for learning science through real-life problems. These results strongly support the relevance of Ethno-STEM integration, which links scientific principles with local cultural practices and authentic phenomena to make abstract concepts more concrete and meaningful.

Third, the data indicate that students are relatively accustomed to digital learning environments. A total of 78.1% reported prior experience using e-modules or educational videos, and 93.8% preferred modules accessible via mobile phones or laptops at any time, demonstrating a clear orientation toward flexible, mobile-based learning resources. However, only 15.6% reported regularly using the internet to independently search for science materials, suggesting that students' digital learning practices remain largely dependent on structured resources provided by teachers rather than on self-directed exploration. This finding reflects the necessity of providing guided digital materials while simultaneously encouraging independent inquiry skills.

Interestingly, the data also revealed relatively low student preference for collaborative learning. Only 9.4% of respondents reported enjoyment in working in groups, and only 12.5% favored interactive practice questions with immediate feedback. This suggests that while students value engaging materials and digital resources, collaborative and interactive problem-solving activities have not yet become dominant learning preferences. Nevertheless, project-based or activity-oriented approaches were favored by 81.2% of students, indicating that they are more interested in meaningful, real-world applications of science learning than in routine group tasks or repetitive assessments.

Finally, 90.6% of students expressed a strong need for learning activities that could enhance their creativity. This finding resonates with previous literature emphasizing the central role of creativity in 21st-century learning and further underscores the urgency of designing science instruction that promotes critical and creative problem-solving. By integrating project-based learning, real-life problem contexts, and Ethno-STEM approaches, teachers can create learning environments that not only improve conceptual understanding but also foster creativity and engagement. Overall, the results demonstrate a clear gap between students' learning needs and current classroom practices. While students strongly prefer interactive, contextual, and digital-based learning resources, science instruction in many classrooms continues to rely heavily on textbooks and teacher-centered methods. These findings suggest an urgent need to redesign science learning by integrating technology, cultural contexts, and project-based approaches to enhance both comprehension and creative thinking skills.

The assessment of students' creative thinking skills conducted at one of the junior high schools in Karanganyar (N = 32, eighth-grade students) further confirms this gap. With an average score of 49.4%, students' creative thinking abilities are categorized as low (< 60%). The distribution of scores across indicators shows significant variation, highlighting specific dimensions of creativity that require targeted intervention. Detailed results of students' creative thinking performance are presented in Table 3.

Table 3. Creative Thinking Skills Analysis Results

No	Indicators of Creative Thinking Skills	(%)
1.	Fluency	51.3
2.	Flexibility	48.3
3.	Originality	45.3
4.	Elaboration	52.5
	Average	49.4

Based on the analysis of creative thinking skills among eighth-grade junior high school students, the findings indicate that students' creative thinking abilities fall into the low category, with an overall average score of 49.4%. According to [17], students' creative thinking skills can be categorized as low if their percentage score is below 55%. This result suggests that students' abilities in generating, developing, and applying creative ideas in science learning remain underdeveloped, which aligns with the argument of [30] that students' creative thinking varies depending on their thinking patterns and problem-solving approaches. The literature emphasizes that innovative pedagogical models are required to improve these skills. For instance, [46] highlight the effectiveness of Problem-Based Learning (PBL) in fostering creativity, as it creates a student-centered environment where learners are encouraged to express their own ideas [47]. Moreover, PBL actively engages students in problem-solving processes, reducing their dependency on teachers as the primary source of information [48].

In the creative thinking assessment, four indicators were measured: fluency, flexibility, originality, and elaboration. The results show that students scored an average of 51.3% in fluency, 48.3% in flexibility, 45.3% in originality, and 52.5% in elaboration, yielding an overall average of 49.4%. Fluency, which reflects students' ability to generate multiple ideas [41], [49], was slightly higher than the other indicators but still indicated limitations in producing diverse ideas in sufficient quantity. Flexibility, with an average of 48.3%, also fell into the low category, reflecting students' difficulty in approaching problems from different perspectives or generating varied solutions [1]. Originality, which measures students' ability to create unique and novel ideas [41], was the lowest indicator at 45.3%, showing that students struggle to develop genuinely new ideas and often rely on modifying existing ones. Elaboration, assessed at 52.5%, was the highest indicator, suggesting that while students can refine and develop ideas to some extent, their overall ability to elaborate systematically remains weak. Taken together, these results emphasize the urgent need for instructional designs that explicitly strengthen all dimensions of creative thinking, particularly originality and flexibility.

Furthermore, the findings from the needs analysis reinforce the necessity of developing an e-module that directly addresses students' learning challenges and preferences. The e-module must be designed with characteristics that include multi-platform accessibility, as 93.8% of students preferred learning resources accessible via mobile phones or laptops; interactive multimedia content, since 93.8% of students found it easier to learn through images, videos, or animations; and local cultural contextualization, as 84.4% expressed interest in learning connected to cultural practices or their environment. Additionally, 90.6% of students emphasized the need for collaborative and problem-solving activities to enhance creativity, highlighting the importance of integrating project-based learning and real-world applications into instructional design. The e-module should also be aligned with principles of good user experience, such as intuitive navigation and responsive feedback, to ensure effective engagement. Considering that junior high school students are still in a developmental stage that requires structured support, the e-module must provide adequate scaffolding without reducing learner autonomy [19]. Overall, these findings provide not only a baseline for learning interventions but also a strong justification for developing digital, contextualized, and creativity-oriented learning resources to bridge the gap between students' current abilities and the competencies required in 21st-century science education.

4. CONCLUSION

This research demonstrates that teachers and students at SMP Negeri Karanganyar have substantial needs for science learning media that are contextual, culturally grounded, and digitally interactive. The findings, particularly the low level of students' creative thinking skills, highlight an urgent gap between existing learning practices and the competencies required for 21st-century education. The needs analysis from the Science Teacher Working Group (MGMP), students, and creative thinking skills assessment indicates that the development of a PBL e-module integrated with Ethno-STEM is not only relevant but strategically necessary. Students' strong preferences for digital (93.8%), contextual (84.4%), and problem-based learning (87.5%) further validate this approach, while teachers' limited knowledge and skills in implementing Ethno-STEM highlight the necessity of providing structured support through accessible teaching resources and professional development. The baseline finding of low creative thinking skills (49.4%), especially in originality, underscores the importance of designing targeted scaffolding within the e-module to enhance all dimensions of creativity.

The implications of this research are both practical and strategic. Practically, the development of Ethno-STEM-based e-modules can serve as innovative media that integrate digital interactivity with local wisdom, making science learning more meaningful, engaging, and relevant to students' daily lives. Strategically, such media can empower students by strengthening critical, creative, collaborative, and digital skills, while also preserving cultural identity in the learning process. This dual contribution not only improves the quality of science education but also supports the creation of a generation prepared to face global challenges without losing connection to their cultural roots. Therefore, the integration of Ethno-STEM-based learning media should be prioritized as a transformative step in advancing science education, bridging the gap between local context and global competence.

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