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INNOVATIVE EVALUATION: UNCOVERING THE NEED FOR ETHNO-STEM TOOLS IN ASSESSING CREATIVE THINKING IN PHYSICS EDUCATION

RESEARCH ARTICLE

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Abstract
This study investigated the need for an ethno-STEM-based assessment tool to evaluate creative thinking skills in prospective physics teachers. Data collection was conducted through a quantitative descriptive survey involving 53 first-year physics education students at Universitas Sriwijaya using Google Forms. The collected data were analyzed using Microsoft Excel to provide a comprehensive overview. The findings revealed that 81.13% of the participants hailed from South Sumatera, 96.23% expressed a preference for basic physics courses, and 98.11% recognized the importance of mastering creative thinking skills. Furthermore, 81.13% students indicated a strong demand for the development of ethno-STEM-based assessment tools. These results underscore the potential impact of culturally relevant assessment methods on fostering creative thinking in physics education. Integrating ethno-STEM into assessments not only enhances student engagement, but also cultivates essential creative thinking skills. Ultimately, this approach aims to build a more meaningful and effective physics education experience by bridging theoretical knowledge with students' cultural backgrounds and real-world applications, thereby supporting future educators in delivering impactful lessons.

Keywords: assessment, creative thinking, ethno-STEM

Introduction

Assessment plays a crucial role in evaluating student performance and the effectiveness of the learning process (Winstone & Boud, 2022). Through assessments, educators can evaluate learning achievements, understand students' conceptions, and assess the overall learning process (Samsudin et al., 2021). A well-crafted assessment tool plays a pivotal role in ensuring the validity and practicality of evaluations, facilitating the enhancement of the teaching and learning process, and ultimately contributing to the improvement of overall learning quality (Adam et al., 2022). Without adequate instruments, it becomes challenging to evaluate students' learning outcomes and skills as well as the learning process, which may hinder efforts to enhance the quality and effectiveness of education, especially in fostering students' creative thinking skills as an essential challenge in the 21st century.
Creative thinking skills are the abilities that involve intellectual functioning, cognitive processes, and problem-solving to generate original and practical outcomes, which can be developed and enhanced over time (Tam et al., 2022). According to Nazhifah et al. (2024), creative thinking is not only about creating new products but also involves students' ability to offer multiple solutions to a single problem.

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This skill is particularly important in physics education as it enhances students' abstract thinking and problem-solving abilities (Nompo et al., 2024). Unfortunately, students' creative thinking skills in physics remain low, as evidenced by several studies on topics such as work and energy (Muflikhun & Setyarsih, 2022), linear motion (Rahmawati et al., 2022), science (Trisnayanti et al., 2020), and global warming (Wulandari et al., 2021). While several studies have evaluated students' creative thinking skills, research focusing on prospective teachers is still rare, even though they are future educators. Therefore, it is crucial to measure prospective teachers' creative thinking skills, particularly in basic physics, at an early stage.

Physics is the science that studies natural phenomena (Harefa et al., 2023). Basic physics is often perceived to be a challenging subject (Faridi et al., 2021; Wijayanti, 2016). Nevertheless, it is compulsory in both schools and universities. At the higher education level, physics helps develop critical and creative thinking skills (Akhsan et al., 2023). With creative thinking, students can solve problems using unique, logical, and diverse ideas (Leasa et al., 2021), which, in turn, enhances learning outcomes (Siburian et al., 2019; Supena et al., 2021). However, the development of assessment instruments to measure students' creative thinking skills, especially those that integrate STEM and local wisdom, is still very limited.

In this regard, the integration of STEM and local wisdom, known as ethno-STEM, offers an innovative framework for designing contextually relevant assessment tools. Ethno-STEM is an extension of the STEM approach that incorporates local wisdom from a specific region (Reffiane et al., 2021). Previous studies have demonstrated the effectiveness of STEM-based education for fostering creative thinking. For instance, Chen et al. (2019) found that collaborative problem solving in STEM education promotes creativity by enabling students to share perspectives and engage in mutual feedback. Rosidin et al. (2023) highlighted the use of project-based assessments to measure students' scientific literacy and creative thinking in physics. Shernoff et al. (2017) explored teacher professional development needs in integrated STEM approaches, while Iskandar et al. (2020) demonstrated that STEM-based instruction enhances high school students' creative thinking. Siew and Ambo (2018) further identified the potential of project-based STEM modules to improve scientific creativity among younger students.

However, these studies largely focus on general education settings and do not address the unique cultural and contextual dimensions that ethno-STEM can offer. The development of ethno-STEM-based assessment instruments tailored to measure creative thinking in prospective teachers, especially within the specific context of South Sumatera's local wisdom, represents a significant gap in the existing literature. One phenomenon observed is that an ethnographic study shows the process of making a bidar boat in South Sumatera involves various aspects of STEM (science, technology, engineering, and mathematics) integrated with the local wisdom of the community (Asmara et al., 2017). Creativity is manifested in the design, construction, and use of the unique and innovative bidar boat, which reflects the rich ethno-STEM heritage of South Sumatera (Fatima et al., 2023). By integrating these cultural elements into the STEM framework, this study aims to contribute to the relatively underexplored area of culturally relevant STEM education in higher learning, particularly in the field of basic physics. Thus, the objective of this study is to conduct a needs analysis to develop an ethno-STEM-based assessment instrument designed to measure prospective teachers' creative thinking skills in basic physics. This approach seeks to offer a more

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contextualized and meaningful learning experience, aligning with the demands of 21st-century education while addressing the specific needs of students in South Sumatera.

Literature Review

Assessment

Assessment is a process in which information is gathered related to the learning objectives (Wahyuni & Ariyani, 2020). Assessment can also be seen as a structured and continuous activity to interpret collected information about students' learning processes and results, intended to evaluate various aspects of learning (Shofiyah & Sartika, 2018). Tilaar (2018) described assessment as an ongoing information-gathering process to measure student performance and the effectiveness of the learning process. Thus, assessment can be defined as the process of collecting information to evaluate students' learning achievements in the learning process.

The role of assessment in learning is significant, because it provides students with opportunities to demonstrate their skills and knowledge (Ashford-Rowe et al., 2014). Through assessment, educators gain insights into students' learning achievements, conceptions, and progress, allowing them to evaluate the teaching and learning processes (Samsudin et al., 2021). Assessment is integral to learning as it reflects individual students' understanding and progress (Maemonah, 2018). Continuous feedback from assessments helps students improve their learning and supports the development of appropriate learning programs to enhance student outcomes. Accurate assessments also inform parents about student progress and other learning-related issues (Tilaar, 2018).

Ethno-STEM

Ethno-STEM is an extension of the STEM approach that incorporates local wisdom from a specific region (Reffiane et al., 2021). This approach merges ethnoscience with STEM, aiming to build scientific concepts through local wisdom and embedding them within STEM frameworks (Idrus & Suma, 2022; Sari et al., 2023). According to Muttaqiin et al. (2021), Ethno-STEM encompasses the integration of science and environmental awareness, fostering a learning experience rooted in scientific understanding and cultural relevance. Therefore, Ethno-STEM can be seen as a bridge connecting STEM education with local cultural knowledge.

In 21st-century learning, Ethno-STEM education can be effectively implemented with active teacher involvement in planning and delivering lessons (Sari et al., 2023). By applying ethno-STEM, educators can connect academic content with the cultural context, making learning materials more accessible and relatable for students (Awaliyah et al., 2022). This approach encourages students to develop an appreciation for their cultural heritage and national values (Nurhasnah et al., 2022). Furthermore, Ethno-STEM can enhance concept mastery, creative thinking skills, and higher-order thinking skills (HOTS), fostering deeper engagement in the learning process (Idrus & Suma, 2022; Karim et al., 2022; Martawijaya et al., 2023).

Ethno-STEM integration in education can be achieved through various strategies such as incorporating Ethno-STEM into teaching models, learning media, and assessment instruments (Idrus, 2022). This approach provides a comprehensive framework for teaching STEM subjects, while

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respecting and utilizing students' cultural backgrounds. Ultimately, ethno-STEM supports holistic educational outcomes by aligning learning with students' diverse cultural contexts.

Creative thinking skills

Creative thinking skills are the ability of an individual to produce works or ideas fluently, diversely, or in different ways (Hartati et al., 2023). Creativity is an ability to express new ideas that allow students to explore multiple approaches to solving a problem by introducing fresh perspectives (Faresta et al., 2020; Murwaningsih, 2022). Novelty in creative thinking does not need entirely new inventions; it can involve combining existing concepts in innovative ways. Therefore, Creative thinking skills are the ability to generate diverse and fresh solutions to problems by exploring new perspectives or combining existing concepts in innovative ways.

Creative thinking arises through the interaction of educators, students, and their learning environments (Armandita, 2018). This process encourages students to approach problems from multiple perspectives, avoiding one-dimensional thinking (Aldig & Arseven, 2017). Educators play a crucial role in this interaction by designing learning experiences that encourage students to think creatively (Istiyono et al., 2018). Creative thinking, as Kuspriyanto & Siagian (2013) explain, can be viewed in three dimensions: attitude, ability, and process. As an attitude, creativity is the openness to change and a willingness to explore ideas flexibly. As an ability, it encompasses generating ideas by combining, elaborating, and reapplying existing concepts. As a process, it involves problem-solving to refine or advance existing ideas or creations.

In physics education, creative thinking skills are crucial as they empower students to use principles and concepts to explain various natural phenomena (Istiyono et al., 2018). These skills involve generating diverse, multidirectional solutions to physics problems (Arini, 2017). Drawing from Ahmad et al. (2021) framework, creative thinking in physics learning is divided into four indicators: 1) Fluency represents the ability to generate multiple responses to a single question, enabling students to express ideas smoothly, interpret images or problems from diverse angles, and apply concepts in various ways, 2) Flexibility highlights a student's capacity to consider different solutions and adapt their responses across distinct categories, demonstrating an openness to alternative approaches, 3) Originality is shown through unique problem-solving methods and new patterns of thinking, where students produce novel and unconventional solutions, 4) Elaboration involves developing solutions in a detailed and structured manner, encouraging students to refine their ideas and generate new insights through comprehensive steps.

Methodology

Research design and approach of the study

This research employs a quantitative descriptive approach using a survey method. The purpose of this approach is to comprehensively analyze the needs of prospective physics teachers for ethno-STEM-based assessment instruments. The use of a quantitative descriptive design allows for an in-depth understanding of the participants' perspectives, providing researchers with valuable quantitative insights into the importance of ethno-STEM in enhancing creative thinking skills in physics education.

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This approach is well-suited for exploring and documenting the participants' perceptions, enabling the formulation of data-driven conclusions.

Research site and participants

The research was conducted at Sriwijaya University, with first-year physics education students as participants. The sample consists of 53 with first-year physics education students. The selection process was conducted using simple random sampling, providing each student with an equal opportunity to participate, thereby enhancing the generalizability of the study across similar educational settings (Sugiyono, 2020).

Data collection and analysis

The data collection tool was a survey questionnaire designed to extract quantitative information about participants' needs and their perspectives on the value of ethno-STEM-based assessment instruments. The purpose of this tool was to capture relevant data that align with the research objectives, particularly in assessing the understanding of and attitudes towards the role of ethno-STEM in fostering creative thinking within physics education. The questionnaire's structure was developed to ensure clarity and comprehensiveness, with items aimed at uncovering participants' specific experiences and viewpoints.

The survey was distributed online via Google Forms, which facilitated broad participation and convenience for respondents. This method aligns with modern data collection practices in educational research, where digital tools are used for efficiency and accessibility. The survey contained of multiple-choice to capture both factual information and subjective opinions regarding the integration of ethno-STEM in physics assessment tools.

Collected data were systematically organized and analyzed using Microsoft Excel. Descriptive statistical methods, including frequencies and percentages, were employed to summarize the responses, providing a clear depiction of the participants' collective needs and perceptions. This quantitative analysis approach ensures accurate representation of data and supports the generation of actionable insights for curriculum development and instructional planning. According to Ratminingsih et al. (2017), the formula applied to determine the percentage of the data collected from the questionnaire is as follows: Percentage = (Total score obtained/Maximum score) × 100%

Results

This study aimed to gather preliminary information regarding the need for ethno-STEM-based assessment instruments to evaluate prospective teachers' creative thinking skills in basic physics. The respondents, who were prospective teachers, represented various provinces across Indonesia. Table 1 provides a detailed overview of respondents' provincial distribution.

Table 1. *Respondents' province of origin*

Respondent Origin	Percentage (%)

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West Sumatera	1.89
Bangka Belitung	5.66
North Sumatera	11.32
South Sumatera	81.13

Based on Table 1, the majority of prospective physics education teachers at Universitas Sriwijaya were from South Sumatera, accounting for 81.13% of the total. By contrast, only 1.89% came from West Sumatera. The high number of prospective teachers from South Sumatera indicates that these students are more familiar with the local wisdom of South Sumatera compared to other provinces. Consequently, assessment instruments that integrate ethno-education and local wisdom from South Sumatera will facilitate students' understanding of the context of the questions. Furthermore, the basic physics course was identified as having the most content relevant to school physics materials, as evidenced by the prospective teachers in Table 2.

Table 2. *Prospective teachers' response to physics courses is the most material that appears in physics material at school*

Response of Prospective Teachers	Percentage (%)
Yes	96.23
No	3.77

According to Table 2, 96.23% of the prospective teachers confirmed that the basic physics course is the subject that appears most frequently in school physics. The basic physics course in the undergraduate physics education curriculum encompasses topics such as the concepts of space and time (the space-time concepts of Newton and Galileo), basic quantities of motion, types of motion, and analysis of a particle's motion in curved coordinates (polar, spherical, and cylindrical). Additionally, it includes Newton's laws of motion, work, and energy and Newton's law of gravitation. Table 3 presents the responses of prospective teachers regarding the essential subtopics of basic physics that they need to master, which frequently occur in school physics.

Table 3. *Prospective teachers' responses on basic physics subtopics important for prospective teachers to master and frequently appearing in school physics*

Subtopics	Percentage (%)
Basic Quantities of Motion	50.94
Newton's Laws of Motion	47.17
Newton's Law of Gravitation	43.40
Concepts of Space and Time (Newtonian and Galilean Concepts of Space-Time)	22.64
Types of Motion	20.75
Work and Energi	16.98
Particle Motion Analysis in Curvilinear Coordinates (Polar, Spherical, and Cylindrical)	15.09

Based on Table 3, basic quantities of motion are the most important subtopics for prospective teachers to master and are the most frequently encountered in schools. These basic quantities of motion are identical to kinematic concepts, such as displacement, position, velocity, and acceleration. In contrast,

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the subtopic of analyzing the motion of a particle in curved coordinates (polar, spherical, and cylindrical) is considered the last important material for prospective teachers to master, frequently appearing in school physics curricula. Thus, prospective teachers need to possess strong skills in the subtopic of basic quantities of motion, as they will play the role of educators who will teach students, making it essential to have good abilities, especially in terms of creative thinking skills. This necessitates solid abilities, especially in the area of creative thinking skills, which are crucial 21st-century competencies for future teachers. This importance is reflected in the responses of prospective teachers, as shown in Table 4.

Table 4. *Responses of prospective teachers regarding the need to master creative thinking skills*

Response of Prospective Teachers	Percentage (%)
Yes	98.11
No	1.89

As shown in Table 4, 98.11% of prospective teachers indicated that they needed to master creative thinking skills. Therefore, it is crucial for prospective teachers to possess creative thinking skills, and they must assess their proficiency in these skills. However, an assessment instrument specifically designed to measure the creative thinking skills of prospective teachers in basic physics courses, particularly in the subtopic of basic quantities of motion, has not yet been developed. According to respondents, an assessment tool that can effectively measure students' creative thinking skills is needed. Table 5 illustrates the responses of prospective teachers regarding the importance of such assessment instruments.

Table 5. *Responses of prospective teachers regarding the importance and need for an assessment instrument to measure their creative thinking skills*

Response of Prospective Teachers	Percentage (%)
Yes	98.11
No	1.89

Based on Table 5, 98.11% of prospective teachers indicated "Yes" that an assessment instrument capable of measuring creative thinking skills is important and necessary for them. Therefore, it is crucial to have an assessment instrument that can measure students' creative thinking skills, especially in the basic physics course. An effective option for this is an ethno-STEM-based instrument. Table 6 illustrates the responses of prospective teachers regarding how assessment tools integrating Ethno-STEM would facilitate their understanding of the given context, as it relates to local wisdom.

Table 6. *Responses of prospective teachers regarding assessment instruments that integrate ethno-stem, which facilitate understanding of contextual problems due to their connection to local wisdom*

Response of Prospective Teachers	Percentage (%)

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Yes	77.36
No	22.64

Based on Table 6, 77.36% of prospective teachers stated "Yes" that Ethno-STEM-based assessment instruments would facilitate their understanding of the context of the given questions, as they are related to local wisdom. Table 7 illustrates the responses of prospective teachers regarding the necessity and importance of developing ethno-STEM-based assessment instruments to measure students' creative thinking skills in the basic physics course.

Table 7. *Prospective teachers' responses on the need and importance of developing ethno-stem-based assessment instruments to measure students' creative thinking skills in basic physics materials*

Response of Prospective Teachers	Percentage (%)
Yes	81.13
No	18.87

According to Table 7, 81.13% of prospective teachers expressed that it is essential to develop ethno-STEM-based assessment instruments for measuring students' creative thinking skills in basic physics. This indicates a strong consensus among future educators regarding the importance of such assessments. Therefore, there is a clear need for integrating local wisdom into assessment practices in physics education.

Discussion

Based on Table 1, the majority of prospective physics education teachers at Universitas Sriwijaya were from South Sumatera, accounting for 81.13% of the total. By contrast, only 1.89% came from West Sumatera. The high number of prospective teachers from South Sumatera indicates that these students are more familiar with the local wisdom of South Sumatera compared to other provinces. Consequently, assessment instruments that integrate ethno-education and local wisdom from South Sumatera will facilitate students' understanding of the context of the questions. This is in line with the statements of Uge et al. (2019), who asserted that students are more likely to solve problems effectively when they comprehend the context, particularly when it involves understanding local wisdom. Furthermore, the basic physics course was identified as having the most content relevant to the school physics materials.

According to Table 2, 96.23% of the prospective teachers confirmed that the basic physics course is the subject that appears most frequently in school physics. This highlights the need for students to master basic physics, particularly because it is often perceived as a challenging subject (Arzak et al., 2021; Faridi et al., 2021; Wijayanti, 2016; Yanti & Erni, 2019). Despite its complexity, basic physics remains a core component of the school's physics curriculum. The basic physics course in the undergraduate physics education curriculum encompasses topics such as the concepts of space and time (the space-time concepts of Newton and Galileo), basic quantities of motion, types of motion, and analysis of a particle's motion in curved coordinates (polar, spherical, and cylindrical). Additionally, it includes Newton's laws of motion, work, and energy and Newton's law of gravitation.

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Based on Table 3, basic quantities of motion are the most important subtopics for prospective teachers to master and are the most frequently encountered in schools. These basic quantities of motion are identical to kinematic concepts, such as displacement, position, velocity, and acceleration. In contrast, the subtopic of analyzing the motion of a particle in curved coordinates (polar, spherical, and cylindrical) is considered the last important material for prospective teachers to master, frequently appearing in school physics curricula. Therefore, it is crucial for prospective teachers to have a good understanding of the basic quantities of motion. This is because these quantities are often perceived as difficult by students as they are rarely related to everyday life (Ruspitasari et al., 2022). The physical quantities of linear motion can be understood more easily when connected to everyday experiences (Aminah & Haryoto, 2018). Thus, prospective teachers need to possess strong skills in the subtopic of basic quantities of motion, as they will play the role of educators who will teach students, making it essential to have good abilities, especially in terms of creative thinking skills. This necessitates solid abilities, especially in the area of creative thinking skills, which are crucial 21st-century competencies for future teachers.

As shown in Table 4, 98.11% of prospective teachers indicated that they needed to master creative thinking skills. This aligns with the statements of (Fahmi & Wuryandini, 2020; Widiastuti et al., 2021), which emphasize that creative thinking skills are essential for students. With the development of creative thinking skills, learners can solve problems by generating unique, different, and logical ideas (Leasa et al., 2021). Additionally, these skills influence student learning outcomes (Mursid et al., 2021; Siburian et al., 2019; Supena et al., 2021) and support the learning process (Armandita, 2018). Therefore, it is crucial for prospective teachers to possess creative thinking skills, and they must assess their proficiency in these skills. However, an assessment instrument specifically designed to measure the creative thinking skills of prospective teachers in basic physics courses, particularly in the subtopic of basic quantities of motion, has not yet been developed. According to respondents, an assessment tool that can effectively measure students' creative thinking skills is needed.

Based on Table 5, 98.11% of prospective teachers indicated "Yes" that an assessment instrument capable of measuring creative thinking skills is important and necessary for them. This aligns with the statement by Armandita (2018), which emphasizes the need for assessment tools to evaluate creative thinking skills. Therefore, it is crucial to have an assessment instrument that can measure students' creative thinking skills, especially in the basic physics course. An effective option for this is an ethno-STEM-based instrument.

Based on Table 6, 77.36% of prospective teachers stated "Yes" that Ethno-STEM-based assessment instruments would facilitate their understanding of the context of the given questions, as they are related to local wisdom. This is consistent with the findings of Zakiyah & Sudarmin (2022), who indicated that ethno-STEM assessments can help students better comprehend the context of the questions presented. Furthermore, according to Sari et al. (2023); Sumarni & Kadarwati (2020), ethno-STEM-based assessments are effective in enhancing students' understanding. Therefore, it is essential to develop ethno-STEM-based instruments.

According to Table 7, 81.13% of prospective teachers expressed that it is essential to develop ethno-STEM-based assessment instruments for measuring students' creative thinking skills in basic physics. This indicates a strong consensus among future educators regarding the importance of such

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assessments. Therefore, there is a clear need for integrating local wisdom into assessment practices in physics education.

However, this study has several limitations. The majority of participants being from South Sumatera may limit the generalizability of the findings to a broader population. The focus on basic physics, particularly the subtopic of basic quantities of motion, reduces the applicability of the findings to other topics in the curriculum. Moreover, this study has not explored other 21st-century skills beyond creative thinking, nor has it compared the effectiveness of this instrument with existing tools. The use of ethno-STEM assessments also faces challenges in being applied to different cultural contexts. Further research is needed to overcome these limitations and validate the obtained results.

Conclusion and Implications

Based on the results and discussion of the study, this study highlights the importance of developing contextual ethno-STEM-based assessment instruments to measure the creative thinking skills of prospective basic physics teachers, particularly in relation to South Sumatera's local wisdom. The results indicate that most prospective teachers feel the need for such instruments to help them understand contextual problems and enhance their creative thinking skills. It is recommended that subsequent activities focus on developing and testing these assessment instruments to ensure their effectiveness in supporting physics learning quality that aligns with the local cultural values.

Disclosure statement

No potential conflict of interest was reported by the authors.

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