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## Applying Physics Knowledge and STEAM Education in High School: Connecting Traditional Vietnamese Culture Through the Moon-Shaped Lute Production Project

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**Abstract:** This article explores the integration of physics knowledge and science, technology, engineering, arts, and mathematics (STEAM) education in high schools through a unique project that connects traditional Vietnamese culture with the production of moon-shaped lutes. The moon-shaped lute, known as “Đàn Nguyệt” in Vietnamese, holds great cultural significance in Vietnam. By incorporating physics principles into the lute production process, students develop a deeper understanding of its construction, sound production, and structural stability. They explore concepts like material selection, sound propagation, and ergonomic design to enhance the instrument’s craftsmanship and playability. This interdisciplinary approach not only fosters scientific and technical skills but also preserves and promotes traditional Vietnamese culture. Engaging students in projects that combine art, science, and culture highlights the power of STEAM education in nurturing well-rounded individuals who have a strong connection to their heritage. The integration of physics knowledge and cultural elements in this project demonstrates the value of interdisciplinary learning and its impact on students’ appreciation for their cultural identity.

**Keywords:** High schools, moon-shaped lute, physics knowledge, project-based approach, STEAM.

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### Introduction

In today’s rapidly evolving world, the education system faces the challenge of equipping high school students with the necessary knowledge and skills to navigate a complex and technology-driven society. Science, technology, engineering, and mathematics (STEM) education has emerged as a powerful approach to fostering critical thinking, problem-solving, and innovation. However, the integration of the Arts, known as science, technology, engineering, arts, and mathematics (STEAM), offers an expanded framework that incorporates creativity, cultural appreciation, and interdisciplinary connections. Traditional Vietnamese culture is rich with heritage and embodies values deeply rooted in history. Preserving and promoting this cultural identity among the younger generation is crucial. One aspect of Vietnamese culture that holds particular significance is the moon-shaped lute, a traditional musical instrument with a unique craftsmanship. By applying physics knowledge and STEAM education principles, the Moon-shaped Lute Production Project presents an opportunity to connect high school students with their cultural heritage while providing a platform for interdisciplinary learning. Numerous research studies have underscored the advantages of project-based learning, as it actively enhances student engagement and facilitates a deeper grasp of the subject matter. In the context of crafting moon-shaped lutes, the integration of physics concepts allows students to delve into the scientific principles that govern the instrument’s design and functionality. Consequently, this approach not only enriches their understanding of physics but also instills an appreciation for the cultural importance of the moon-shaped lute. The main objective of this paper is to investigate the effects of applying physics knowledge and STEAM education in high schools through the Moon-shaped Lute Production Project. We will specifically concentrate on measuring and analyzing different aspects of the ‘impact,’ such as students’ engagement, knowledge acquisition, development of creativity, and their appreciation for traditional Vietnamese culture. The study aims to highlight the potential of this interdisciplinary approach in connecting traditional Vietnamese culture with contemporary education practices.

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## Literature Review

### *Enhancing Future Readiness: Integrating STEM and STEAM Education in Schools*

STEM education has gained recognition as a holistic approach to preparing students for future careers in science, technology, engineering, and mathematics. It emphasizes the integration of these disciplines to promote critical thinking, problem-solving, and innovation (McDonald, 2016; National Academy of Engineering & National Research Council, 2012). STEAM education expands on this approach by incorporating the Arts, recognizing the importance of creativity, imagination, and cultural connections in the learning process (Hartley, 2017). Research has shown the benefits of STEM and STEAM education in high school settings. Studies indicate that these approaches enhance student engagement, foster interdisciplinary connections, and promote real-world applications of knowledge (Wang et al., 2011). By integrating STEM and STEAM principles, students develop skills such as collaboration, communication, and adaptability, which are essential for success in the 21st century workforce (Breiner et al., 2012; Tinh et al., 2017).

### *Project-Based Learning Approach*

The project-based learning (PBL) approach is a widely recognized educational method that has been applied in various educational contexts. PBL focuses on learning through practical experience, where students engage in real-world and interesting projects to develop essential skills and knowledge for their everyday life and future careers.

According to research by the National Academy of Engineering & National Research Council (2012), PBL is considered an effective educational method that empowers students to learn in an autonomous, active, and engaging manner. In the PBL environment, students are not merely recipients of information from teachers but become investigators, researchers, and solution developers for real-world problems.

Several studies have highlighted the benefits of PBL in STEM education (Larmer et al., 2015). PBL not only helps students gain a deeper understanding of scientific concepts but also fosters crucial skills such as critical thinking, problem-solving, teamwork, communication, and creativity. Particularly in the context of STEAM, PBL facilitates the connection between science, arts, and culture, enabling students to grasp their interrelationships and apply knowledge in practical projects.

By applying the Project-Based Learning approach in this research, we aim to integrate STEM and STEAM education through the Moon-shaped Lute Production Project to provide students with an interactive and creative learning environment. It is expected that this approach will encourage them to develop important skills and gain a deeper understanding of traditional Vietnamese culture, as well as apply physics principles in real-life scenarios.

### *Previous Studies on the Integration of Physics Education in STEAM Projects*

Several studies have explored the integration of physics education in STEAM projects, highlighting its potential for enhancing student learning experiences. For instance, a study by Fan, et al. (2020) and Boytchev & Boytcheva (2020) investigated the impact of a physics-based STEAM program on students' conceptual understanding and creativity. The findings revealed that the integration of physics principles in artistic projects deepened students' understanding of physics concepts and promoted creative thinking. Similarly, another study by Tinh and Hieu (2019) examined the incorporation of physics education in a STEAM curriculum through project-based learning. The results demonstrated that students developed a stronger grasp of physics concepts and improved their problem-solving skills through hands-on, interdisciplinary projects. These studies illustrate the effectiveness of integrating physics education within STEAM projects, emphasizing the value of connecting scientific principles with artistic and cultural contexts.

### *Exploration of Traditional Vietnamese Culture and its Connection to Education*

Traditional Vietnamese culture encompasses a rich heritage that reflects the country's history, values, and artistic expressions. The moon-shaped lute, a traditional Vietnamese musical instrument, holds particular cultural significance. Its craftsmanship embodies the artistry and cultural identity of Vietnam (Vietnam National Administration of Tourism Vietnam, 2022). Scholars have highlighted the importance of integrating traditional culture into education as a means of preserving cultural heritage and promoting cultural identity among young generations. Incorporating traditional Vietnamese culture, such as the moon-shaped lute, into educational practices can foster a sense of pride and appreciation for cultural traditions (Shadoian-Gersing, n.d.). By exploring the connection between traditional Vietnamese culture and education, educators can create meaningful learning experiences that promote cultural understanding, creativity, and interdisciplinary learning.

### *Research Gaps*

Currently in Vietnam, there is a lack of research focusing on Promoting STEAM Education. Despite the growing importance of STEAM education in fostering critical thinking and creativity, there is a need for more studies that

explore its implementation and effectiveness in the Vietnamese education system (Boychev & Boycheva, 2020; Tinh & Hieu, 2019).

There is also a dearth of research on connecting Cultural Preservation with students' education. While the Moon-shaped Lute Production Project attempts to bridge traditional Vietnamese culture with education, further research is necessary to examine how such projects can effectively promote cultural appreciation and preservation among students (Shadoian-Gersing, n.d.).

Moreover, there is a lack of comprehensive studies on Enhancing Physics Education through hands-on, interdisciplinary projects. The research on how integrating physics principles with practical, STEAM-based activities like the Moon-shaped Lute can improve students' understanding and interest in physics is limited, calling for more research in this area (Krajcik et al., 2008).

Numerous studies have highlighted the waning motivation of students in traditional teaching approaches. However, further investigations are needed to understand the factors contributing to the decline in student motivation and how STEAM education can serve as a remedy to reignite students' passion for learning (Mcdonald, 2016).

The current competency of teachers in effectively bridging the gap between theoretical knowledge and practical application is limited. More research should be conducted to assess the proficiency of teachers in facilitating students' application of knowledge to real-life scenarios, and professional development programs should be designed accordingly to enhance their teaching strategies (Wang et al., 2011).

#### *Theoretical Foundations of Physics Education and STEAM Integration*

Physics education plays a crucial role in developing students' scientific understanding and problem-solving skills. Theoretical frameworks such as constructivism and inquiry-based learning provide the foundation for effective physics instruction (Driver et al., 1994). Constructivism emphasizes the active construction of knowledge by students through hands-on experiences and meaningful interactions with the environment. Inquiry-based learning encourages students to explore scientific phenomena, ask questions, and develop their own explanations (National Research Council, 2000). Integrating physics education into STEAM projects builds upon these theoretical foundations, allowing students to apply physics principles in interdisciplinary contexts. The integration of arts and culture in STEAM education further enhances students' engagement and promotes a deeper understanding of physics concepts.

#### *Concepts and Principles of Project-Based Learning*

Project-based learning (PBL) provides a framework for students to actively engage in authentic, real-world tasks. It promotes collaboration, critical thinking, and problem-solving skills (Krajcik et al., 2008). The key principles of PBL include student autonomy, authentic tasks, and the integration of multiple disciplines (Thomas, 2000). By adopting a project-based approach, students can explore the moon-shaped lute production project in a hands-on and immersive manner. They can investigate the physics concepts involved in the construction of the instrument, such as the principles of sound and vibration, while also considering cultural and artistic aspects.

#### *Cultural and Historical Context of the Moon-Shaped Lute*

The moon-shaped lute, also known as "Đàn Nguyệt" in Vietnamese, holds significant cultural and historical value in Vietnam. Its origins can be traced back to ancient times and it has been an integral part of Vietnamese traditional music and cultural performances. Understanding the cultural and historical context of the moon-shaped lute is essential for connecting it to educational practices. Exploring the moon-shaped lute within the project allows students to appreciate the cultural heritage of Vietnam and deepen their understanding of traditional Vietnamese music. It provides an opportunity to explore the craftsmanship, aesthetics, and functionality of the instrument.



Figure 1. Traditional Musical Instrument Performance (Source: FPT University, Vietnam)

*Connecting Traditional Vietnamese Culture through the Moon-Shaped Lute*

**Production Project** The moon-shaped lute production project is an example of applying physics knowledge to STEAM projects that connect traditional Vietnamese culture with contemporary education practices. By incorporating physics principles into the process of crafting moon-shaped lutes, students can explore the scientific aspects of the instrument's design and functionality while also appreciating its cultural significance. Here are some ways physics principles are incorporated into the moon-shaped lute production project:

- + **Material Selection:** Physics plays a crucial role in understanding the properties of different materials used in constructing the lute. The choice of wood, strings, and other components will affect the sound quality and resonance of the instrument. Knowledge of acoustics and material science can help select the appropriate materials for optimal performance.
- + **Sound Production:** The production of sound in musical instruments involves various physical phenomena. Understanding concepts such as vibrations, wave propagation, and resonance can help design and shape the lute's body to produce desired tones and harmonics.



*Figure 2. The Moon-Shaped Lute*

- + **Structural Stability:** Physics principles related to mechanics and structural engineering are essential for ensuring the durability and stability of the Moon-shaped lute. Knowledge of forces, stress, and strain can guide the design and construction of a sturdy instrument that can withstand tension from the strings and external factors.
- + **Ergonomics and Playability:** Physics knowledge can also contribute to enhancing the ergonomics and playability of the Moon-shaped lute. Considering factors like weight distribution, balance, and the placement of frets can improve the instrument's comfort and ease of use for musicians.
- + **Acoustic Amplification:** Physics concepts such as sound reflection, absorption, and diffraction can be applied to design and optimize the lute's acoustic amplification system. This can involve shaping the soundhole and resonating chamber to enhance the projection and clarity of the instrument's sound.

By incorporating physics knowledge into the Moon-shaped lute production project, STEAM enthusiasts can deepen their understanding of traditional Vietnamese culture while developing innovative techniques to improve the instrument's craftsmanship and performance. This integration of traditional artistry with scientific principles highlights the interdisciplinary nature of STEAM education and fosters a meaningful connection between heritage and modern innovation.

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### **Methodology**

#### *Research Design*

The objective of this study is to develop a STEAM project centered around traditional Vietnamese culture and evaluate its effectiveness as a learning tool. The study aims to achieve the following goals:

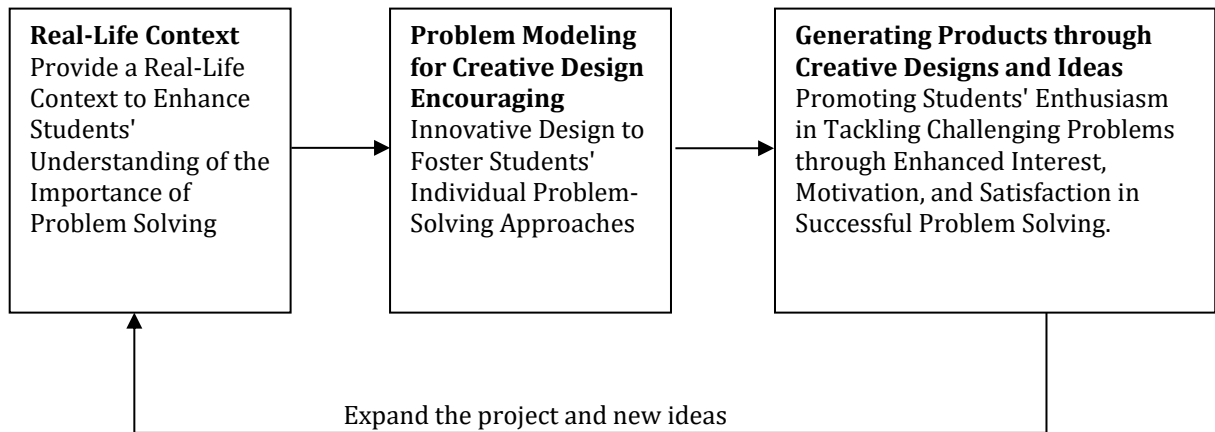


Figure 3. STEAM Project Implementation Process

*Development of a STEAM Project:* The primary aim is to create a STEAM project that is firmly rooted in traditional Vietnamese culture. This project will serve as a means to learn about and promote traditional Vietnamese culture in general, with a specific focus on the music art associated with the moon-shaped lute.

*Evaluation of the STEAM Project's Impact:* The study seeks to assess the impact of integrating the STEAM Project into the teaching and learning process, particularly in the context of a traditional Vietnamese musical instrument known as the moon-shaped lute. By incorporating the project into an educational setting, its effectiveness in enhancing students' understanding and engagement with this particular instrumental product will be examined. To accomplish these objectives, a combination of research methodologies and approaches was employed. The following methods were utilized throughout the study:

*Literature Review:* Extensive research was conducted to review existing literature, scholarly articles, and relevant research studies related to STEAM education, traditional Vietnamese culture, and music education. This literature review provided a comprehensive understanding of the current knowledge in these areas, which guided the development of the project and research design.

*Project Development:* In collaboration with experts in Vietnamese culture and music education, the STEAM project was developed. Their expertise, along with insights gained from the literature review, contributed to shaping the project's content, structure, and objectives. Traditional elements of Vietnamese culture were incorporated, with a specific emphasis on integrating them into the project, highlighting the moon-shaped lute.

*Project Implementation:* The STEAM project was implemented in an appropriate educational environment with the participation of a group of students. The project was designed to provide an immersive and interactive learning experience, combining science, technology, engineering, arts, and mathematics with traditional Vietnamese cultural knowledge and music education. Throughout the implementation phase, close observation and documentation of the students' progress and experiences took place.

*Data Collection:* Various methods were employed to collect relevant data and evaluate the project's effectiveness. These methods included observations, interviews with students and teachers, surveys, and assessments. The data collected encompassed both qualitative and quantitative aspects, enabling a comprehensive evaluation of the project's impact on students' learning outcomes and attitudes towards traditional Vietnamese culture and music. The research process is shown in the following steps:

- Step 1: Setting up STEAM project team
- Step 2: Studying and understanding contents related to knowledge and practice in reality
- Step 3: Selecting topics for STEAM project.
- Step 4: Developing STEAM project.
- Step 5: Getting evaluation from experts
- Step 6: Applying STEAM
- Step 7: Developing and looking for the STEAM program

The STEAM Project Development team for this study comprised a diverse group of experts. The team consisted of an Associate Professor and a Ph.D. candidate from Thai Nguyen University of Education, a Ph.D. candidate from the

National Academy of Education Management, an accomplished musician specializing in musical instruments, and the collaboration of two young students proficient in playing the Moon-shaped lute, violin, and piano. Additionally, a high school vice principal and four experienced high school teachers were also part of the team. The Associate Professors and Ph.D. candidate possessed extensive knowledge in science education and practical teaching methodologies, with prior experience in developing both STEM and STEAM projects, including expertise in physics and its applications. The Ph.D. candidate from the National Academy of Education Management had experience in implementing STEAM projects, and the vice principal had 22 years of experience teaching natural sciences and successfully developing various STEM projects in the past. Among the high school teachers, they specialized in teaching social sciences and cultural arts. Importantly, their research also involved evaluating the process and outcomes of STEAM projects. The collective experience of the team members provided a wealth of expertise in developing STEM and STEAM projects. The project development process began in February 2023, with the team selecting a topic aligned with Vietnamese traditional culture that would resonate with the students' daily lives. When choosing the topic, the team considered the integration of science and art, aiming for a harmonious blend of these elements. Subsequently, the team meticulously developed the project, including a comprehensive lesson plan, guided planning, and worktables. The primary focus of the project was to enable students to apply their physics knowledge and STEAM skills through practical experiences, going beyond traditional textbook-based learning. The project goals were designed to be achievable for the students, empowering them to attain tangible outcomes. Key components of the project included contextualizing real-world scenarios, engaging students in creative problem-solving and design processes, producing innovative artifacts through design thinking, and fostering an appreciation for artistic expressions. Throughout the project's development and implementation, the research team closely collaborated with external experts. These experts included an artist in Vietnam and a specialist with profound knowledge of ethnic musical instruments. Additionally, a collaboration was established with the Vietnam Composers' Association. The involvement of these external experts provided valuable insights and feedback, contributing to the overall effectiveness and high quality of the project. This iterative process of expert input validated the research methodology and results, further enhancing the study's credibility. The project took place over a four-week period, from the second week of February to the second week of March, involving 11th-grade students. After completing the project, the research team conducted in-depth interviews with all 16 participating students, utilizing semi-structured questionnaires comprising both closed-ended and open-ended questions. These interviews aimed to validate the project's relevance and assess its impact on the students' educational experience.

#### *Sample and Data Collection*

The research sample consisted of 16 11th-grade students who actively participated in the STEAM project, along with an additional 19 students who were part of the support and observation group. Data collection methods employed in this study included observations, interviews, surveys, and assessments. The collected data encompassed both qualitative and quantitative aspects, allowing for a comprehensive evaluation of the project's impact on students' learning outcomes and attitudes towards traditional Vietnamese culture and music. Interviews were conducted with a total of 35 students, and their responses were recorded and segmented into sentences. The key questions in the interviews aimed to assess the appeal of the STEAM project to students and the usefulness of incorporating STEAM elements. The inductive classification method was employed to analyze the students' responses. The interview data from the study participants were then organized into separate questionnaires for each target group. This analysis provided valuable insights into the project's effectiveness in achieving its objectives and generating a positive impact on students' learning experiences.

To validate the utility of the measurement tools used (surveys, assessments=35), we conducted a cross-validation process by comparing results from various methods. Firstly, we compared survey results with data collected from observations to confirm the consistency of the gathered information. The survey results accurately reflected the behaviors and attitudes we observed throughout the study.

Next, we compared interview findings with assessment data to verify the feasibility and reliability of the collected information. The interview responses reflected and clarified the measured outcomes using standard assessments. The correlation between these results reinforced the effectiveness of the measurement tools and their capability to provide accurate and reliable information about the project's impact.

Furthermore, we also performed an analysis of internal consistency and appropriateness of the questions within the measurement tools. This ensured that the questions were not only clear and comprehensible for the study participants but also reliably measured essential aspects of the project.

#### *Analyzing of Data*

During the research process, data analysis played a crucial role in examining the effectiveness of the STEAM project and its impact on students' learning outcomes and attitudes towards traditional Vietnamese culture and music. The collected data were subjected to a systematic analysis using appropriate qualitative and quantitative methods.

*Qualitative Analysis:* To ensure the reliability of analyzing qualitative data, a rigorous approach was adopted. Thematic analysis was employed to identify common themes, patterns, and relationships within the data. The process involved multiple researchers independently reviewing the data to establish inter-coder reliability. Consensus meetings were held regularly to discuss any discrepancies and reach a consensus on the emerging themes. Furthermore, member checking was utilized as a method of validation, where participants were provided with summaries of their interview responses and observations, allowing them to confirm the accuracy of the data. This step ensured that the interpretations reflected the participants' perspectives accurately. Additionally, an audit trail was maintained, documenting all steps of the analysis process, from data collection to final interpretations. This facilitated transparency and allowed for verification by external reviewers, enhancing the credibility of the findings. By employing these strategies, the study aimed to enhance the trustworthiness and validity of the qualitative analysis, providing a robust foundation for the interpretations and conclusions drawn from the data.

*Quantitative Analysis:* Quantitative data, obtained from surveys and assessments, were analyzed using statistical techniques. Descriptive statistics were employed to summarize the data.

*Integration of Findings:* The qualitative and quantitative findings were integrated to provide a comprehensive analysis of the data. By triangulating the results from different data sources and methods, a more holistic understanding of the STEAM project's impact was achieved. Interpretation and Discussion: The analysis of the data was followed by interpretation and discussion of the findings. The results were examined in light of the research objectives and existing literature, allowing for a deeper exploration of the project's effectiveness in connecting traditional Vietnamese culture through the moon-shaped lute production project. The analysis of data was instrumental in assessing the success and impact of the STEAM project, providing valuable insights for further refinement and development of STEAM education in the context of traditional Vietnamese culture.

### Findings/Results

After the theme of traditional Vietnamese culture is chosen, materials for students and teachers are developed according to the topic. This program is based on the high school science curriculum:

In the initial phase, students delve into the rich heritage of Vietnamese culture by immersing themselves in the traditions associated with the moon-shaped lute. This serves as the foundation for their understanding.

Moving forward, the subsequent stage involves a more analytical approach. Here, students engage in problem-solving for innovative design as they dissect and scrutinize the intricate composition of the moon-shaped lute.

The third stage, producing through the design and creative ideas and artistic emotions, this stage focuses on the implementation of making the moon-shaped lute and using it... During the implementation of our project, we used a computer to check the sound and adjust the components of the moon-shaped lute (the computer is installed with software to identify the sound for the moon-shaped lute). We divided 16 students into 4 groups (four groups of 4 students). The main content of the STEAM Project are shown in Table 1. The STEAM skills are as follows: Physics Knowledge (Phy); Scientific Skills (S), Technology (T), Engineering Skills (E), Art (A) and mathematical skills (M). The first stage, the real world context helps students recognize learning as a matter of life. In other words, they study the history and development of the moon-shaped lute in the traditional culture of the Vietnamese. Next, students try to learn how to play a moon-shaped lute and discuss the reason why playing a moon-shaped lute is difficult. In addition, students find out the reason for the change in string tension or the design of the sound box, the material used to influence the change in sound output. As a result, the student becomes immersed in the activity of the group because of the increased relevance between the presented situation and the student's life. The second stage, modeling problems for creative design is an important stage of the STEAM Project. This stage helps students reflect their own creative ideas in the context of actual learning. To do so, they experimented with measuring the frequency of the moon-shaped lute sound using computer applications, describing the image of the components of the moon-shaped lute (sound box, neck, tuning pegs, strings) and they learn about the design process through the Internet and through exchange with artisans. This stage allows students not only to learn but also to use their knowledge and experience, thereby improving their problem solving ability. By motivating students to identify and solve problems, students can become more creative problem solvers. The third stage, producing through design and creative ideas and artistic emotions.

We conducted interviews with students who participated in the moon-shaped lute production project. These interviews were meticulously recorded and transcribed. The aim of these interviews was to assess the students' understanding of the significance of applying physics knowledge in STEAM education projects. The findings from these interviews are summarized in Table 2, offering valuable insights into the students' comprehension of the concept of STEAM.

#### *Students' Perception of the Significance of the Project*

Based on the findings summarized in Table 2, a significant portion of the students (37.1%) perceived the project as a combination of problem-solving activities, utilizing physics knowledge, and various STEAM skills, while also



emphasizing integrated learning. Another notable proportion (34.3%) viewed the project as a means of acquiring transformative knowledge and achieving success. Additionally, a considerable percentage (28.6%) regarded the project as an opportunity to explore and discover their own solutions within real-life learning activities.

*Table 1. The Process of Implementing the Moon-Shaped Lute Project*

<b>Step</b>	<b>Content</b>	<b>Knowledge and applied skills</b>
Looking for context in the real world	Explore the connection between acquired knowledge and its practical applications in various aspects of life, encompassing emotions (through mediums like painting and music) as well as other areas (such as machinery, equipment, and construction).	Phy, S, A
	In the STEAM project, students have the opportunity to choose their own topics. One interesting option is to explore a traditional Vietnamese musical instrument known as the moon-shaped lute.	A
	It is important for students to understand that most Vietnamese musical instruments are crafted using materials like bamboo and wood. The sound produced by these instruments can vary based on factors such as the size, shape, and length of the instrument.	Phy, M, T
	Through their learning process, students discover that the sound of the instrument undergoes changes when they press their fingers on different positions of its surface.	Phy, E
Modeling problems for creative design through analyzing the composition of the moon-shaped lute	To acquire a moon-shaped lute for modeling and testing purposes, one can proceed with the purchase process.	M, E
	To measure the frequency of the sound produced by the moon-shaped lute, students utilize computer software in conjunction with a microphone. This enables them to accurately analyze and quantify the sound's frequency.	Phy, E, M
	Students grasp the concept that altering the proportions of the resonator box and the neck will result in varying sizes. They proceed to create an outline of the moon-shaped lute model on a drawing, capturing its distinctive shape and dimensions.	Phy, M, E
Produce the moon-shaped lute through the design and creative ideas, artistic feelings	Students take on the task of crafting their own wooden moon-shaped lute. They also design a moon-shaped lute that incorporates an adjustable truss rod, making it easier to play by adjusting the tension of the strings.	A, E, Phy, M
	Students demonstrate their musical prowess by performing a national composition using the moon-shaped lute that they have created	A, Phy
	Students provide their feedback on the moon-shaped lute, evaluating its design, sound quality, and playability. They also share their observations and critique the performance of the musicians who played the moon-shaped lute.	T, E, Phy, A, M
	Students engage in idea sharing and engage in a comparative analysis of the strengths and weaknesses of various application designs	S, T, E, Phy, A, M
Developing a broader STEAM project	Students engage in a collaborative exchange of ideas for future STEAM projects, sharing their visions and concepts	S, T, E, Phy, A, M



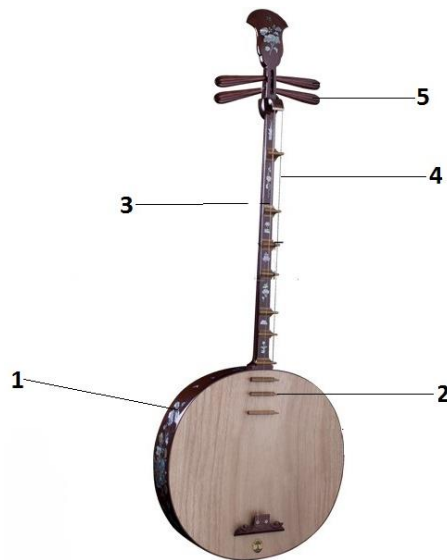


Figure 4. Design Wooden Moon-Shaped Lute

(1) Resonator: It is a flat, cylindrical-shaped hollow body, with a diameter of 30 cm and a depth of 6 cm. The resonator does not have a sound hole.

(2) The top surface of the resonator has a component called the bridge (also known as the “saddle”) located underneath, which is used to support the strings.

(3) Neck (or vertical neck): It is made of hard wood, long and slender, and is fitted with 8-11 frets. In the past, it had only 8 frets (even today, musicians playing traditional music from Southern Vietnam often use the 8-fret version). These frets are relatively tall and spaced unevenly.

(4) Strings: There are 2 strings, traditionally made of silk, but nowadays commonly made of nylon. Although there are 4 string slots, only 2 strings are installed (one thick string and one thin string). The method of string tuning may vary depending on the player. Sometimes, the two strings are spaced 4 intervals apart, while other times they are spaced 5, 7, or 8 intervals apart. However, the most common tuning method is spacing them 5 intervals apart.

(5) Headstock: It has a leaf-like shape and is attached to the top of the neck. It features 4 string slots and 4 tuning pegs, with two on each side.



Figure 5. The Frequency Meter, Used to Assist in Tuning the Moon-Shaped Lute, is Called a Tuner

Table 2. Students' Perceptions of the Project's Significance (N = 35)

Students' Perceptions Regarding the Significance of the Project	%
Navigating the Journey of Problem-Solving by Applying Physics Knowledge with STEAM Skills for Integrated Learning	37.1
Revealing Pathways for Exploring Knowledge	34.3
Empowering Self-Discovery through STEAM Endeavors	28.6

The project titled “Navigating the Journey of Problem-Solving by Applying Physics Knowledge with STEAM Skills for Integrated Learning” received a perception rating of 37.1%. This suggests that the students appreciated the project’s emphasis on problem-solving, the application of physics knowledge, and the integration of STEAM skills into their learning journey. The following excerpt is from an interview with student T.T.D. Student T.T.D: During our creative design discussions, I encountered some challenges, so I referred to the textbook and sought guidance from my friends and teacher regarding the principles of sound in the Moon-shaped lute. I received consistent answers, which made problem-solving easier for me through the activities of the project. This example illustrates how the application of physics knowledge and STEAM skills in integrated learning can contribute to problem-solving, fostering critical thinking and creativity. The perception rating for “Revealing Pathways for Exploring Knowledge” was 34.3%. This indicates that students recognized the project’s role in uncovering various pathways for exploring knowledge, potentially through interdisciplinary approaches and the integration of different subjects. The following excerpt is from an interview with student N.V.T: Student N.V.T: Within our group, none of us had prior knowledge or experience in producing and using a Moon-shaped lute. To overcome this challenge, we sought someone who possessed knowledge related to sound and the resonance box, which happened to be our physics teacher. We considered it a valuable learning experience. Therefore, we conducted this project activity by actively applying and finding solutions based on the ideas contributed by each group member. The perception rating for “Empowering Self-Discovery through STEAM Endeavors” was 28.6%. This implies that students felt empowered to discover more about themselves and their interests by engaging in STEAM endeavors within the project. They likely found opportunities for self-exploration and personal growth through hands-on experiences and the application of physics knowledge and STEAM skills. These percentages reflect the students’ positive perceptions of the project’s significance, indicating that they recognized the value of problem-solving, interdisciplinary learning, and self-discovery within the context of education intertwined with real-life experiences.

#### *Students' Awareness of The Necessity of STEAM*

*Table 3. Students' Perceptions of the Importance of STEAM (N = 35)*

<b>Students' Awareness of the Importance of STEAM</b>	<b>%</b>
Building Scientific Concepts through Idea Exchange	42.9
Developing Knowledge through Problem-Solving in Project Execution	37.1
Enhancing Critical Thinking Skills through Problem-Solving	20.0

Table 3 provides the breakdown of students’ perceptions regarding the importance of STEAM education. “Building Scientific Concepts through Idea Exchange” received a percentage of 42.9%. This indicates that a significant portion of the students (42.9%) are aware of the importance of STEAM in building scientific concepts. This suggests that they understand the value of exchanging ideas and collaborating with others to develop a deeper understanding of scientific concepts. “Developing Knowledge through Problem-Solving in Project Execution” received a percentage of 37.1%. This suggests that a considerable number of students (37.1%) recognize the importance of STEAM in developing knowledge through problem-solving activities. They likely appreciate the hands-on approach of STEAM projects, where they can apply their knowledge and skills to solve real-world problems and gain a deeper understanding of the subject matter. “Enhancing Critical Thinking Skills through Problem-Solving” received a percentage of 20.0%. This indicates that a smaller proportion of students (20.0%) perceive the importance of STEAM in enhancing critical thinking skills through problem-solving. Although this percentage is lower compared to the other categories, it still reflects a notable portion of students who recognize the value of STEAM in fostering critical thinking abilities. In summary, the table highlights that a significant number of students acknowledge the importance of STEAM education in building scientific concepts and developing knowledge through problem-solving. However, a smaller percentage of students recognize the role of STEAM in enhancing critical thinking skills. This suggests that there may be an opportunity to further emphasize and cultivate critical thinking within the context of STEAM education for these students.

#### *Usefulness and Difficulties Faced by Students in Implementing STEAM Projects*

Randomly interviewed ten out of thirty-five students. We received the following feedback:

V.T.L.H: "I found the STEAM project extremely useful as it allowed me to apply physics knowledge in a creative and practical way. However, one difficulty I faced was understanding some technical terms related to physics concepts. It would have been helpful to have more explanations or examples to clarify those concepts."

T.V.D: "The STEAM project was engaging and exciting, and I appreciated the opportunity to collaborate with classmates from different disciplines. One difficulty I encountered was managing my time effectively to balance the project with other academic commitments."

V.T.T: "I really enjoyed working on the Moon-shaped Lute Production Project as it connected me with Vietnamese culture. However, the integration of arts and science was challenging, especially when combining physics principles

with artistic design. More guidance on how to strike the right balance between science and aesthetics would have been beneficial."

P.V.C: "The STEAM project was valuable in fostering teamwork and communication skills. Nonetheless, I faced difficulty in finding appropriate resources for certain aspects of the project, which limited our ability to fully explore and experiment with different ideas."

D.L.S: "I liked the idea of connecting physics with Vietnamese culture through the Moon-shaped Lute Project. However, I found it challenging to present complex scientific ideas in a way that non-scientific team members could understand, and this impacted our collaboration."

N.T.V: "The STEAM project allowed me to see the practical applications of physics in our culture, and it was rewarding to witness the final product. Still, I encountered difficulties in balancing the workload, and at times, it felt overwhelming to manage multiple project components simultaneously."

N.T.H.Y: "The STEAM project was interesting, and I appreciated the opportunity to explore different aspects of physics and art. However, I struggled with time management, and this affected the depth of my contributions to the project."

T.T.A: "I found the STEAM project meaningful, but I faced challenges in accessing specific materials needed for the project. Limited resources affected our ability to fully realize our ideas and experiments."

T.H.Q: "The STEAM project was a unique experience, and I enjoyed learning about Vietnamese culture through the Moon-shaped Lute. However, I encountered difficulties in explaining scientific concepts to non-science students, and this affected the coherence of our final presentation."

P.V.M.N: "I loved the interdisciplinary approach of the STEAM project. Nevertheless, I faced difficulty in balancing the workload with other academic responsibilities, and this impacted the amount of time I could dedicate to the project."

After conducting the interviews with ten students, it is evident that the STEAM project has been perceived positively by the majority of the participants. Many students expressed enthusiasm and appreciation for the project's interdisciplinary nature, which allowed them to apply physics knowledge in a creative and practical manner while connecting with traditional Vietnamese culture through the Moon-shaped Lute Production Project.

However, the interviews also highlighted some common challenges faced by the students during the implementation of the STEAM project. These difficulties mainly revolved around technical aspects of physics concepts, time management, balancing workload with other academic commitments, and finding appropriate resources for certain project components. Additionally, some students faced challenges in effectively communicating complex scientific ideas to non-science team members, which affected collaboration and the coherence of final presentations.

Addressing these challenges will be crucial in enhancing the overall effectiveness of the STEAM project and ensuring that all students can fully engage and benefit from this interdisciplinary learning experience. Providing additional support, clarifications, and guidance on technical concepts, time management strategies, and resource accessibility could help alleviate some of the difficulties encountered by the students.

Overall, the interviews revealed valuable insights into students' perceptions and experiences with the STEAM project. By acknowledging and addressing the identified challenges, educators and project facilitators can create a more inclusive and supportive learning environment that maximizes the benefits of STEAM education for all students involved.

## Discussion

The research study has yielded intriguing and valuable findings that shed light on the integration of physics knowledge and STEAM education within the Moon-shaped Lute Production Project. The key discoveries provide essential insights into the outcomes and impacts of this interdisciplinary approach on students' learning experiences and cultural appreciation.

One significant finding from the study is that students who participated in the Moon-shaped Lute Production Project demonstrated an improved understanding of physics principles. Engaging in hands-on activities and practical involvement in crafting the Moon-shaped lute enabled students to gain knowledge about the physics of sound, resonance, and instrument design. This finding aligns with previous research on project-based learning and STEAM education, which highlights how active, experiential learning enhances students' grasp of scientific concepts (Krajcik et al., 2008).

Moreover, the integration of STEAM skills within the project provided students with a holistic and meaningful learning experience. By combining science, technology, engineering, arts, and mathematics in the production of the Moon-shaped lute, students successfully bridged the gap between traditional Vietnamese culture and modern scientific knowledge. This interdisciplinary approach has been shown to foster creativity, critical thinking, and problem-solving skills, all of which are crucial for students' success in the 21st-century workforce (Breiner et al., 2012).

The Moon-shaped Lute Production Project also played a significant role in promoting cultural appreciation and preservation among the students. Exploring traditional Vietnamese music and craftsmanship, students developed a deeper connection with their cultural heritage, instilling in them a sense of pride and a desire to preserve their cultural traditions. This finding is consistent with research that emphasizes the importance of incorporating cultural context in education to enhance students' cultural identity and understanding (Shadoian-Gersing, n.d.).

Notwithstanding the valuable insights gained from the research, the study would have benefited from a more in-depth discussion of the theoretical framework underpinning the integration of STEAM and physics education. Exploring the underlying mechanisms and reasons behind the positive outcomes resulting from this integration would have provided a more robust foundation for the research implications. Theoretical frameworks such as constructivist learning theory or the learning-goals-driven design model could have been explored to elucidate the cognitive processes that occur during STEAM learning (Driver et al., 1994; Krajcik et al., 2008).

Furthermore, a deeper exploration of the role of cultural context in the learning process would have further strengthened the implications of the findings. Understanding why the connection to traditional Vietnamese culture enhances students' engagement and appreciation for the project could have provided valuable insights for educators and researchers interested in promoting cultural integration in education.

In conclusion, the research study has made valuable contributions to the field of education. The findings underscore the benefits of integrating physics knowledge and STEAM education in high school settings, emphasizing the significance of cultural context in fostering students' learning experiences and cultural appreciation. However, delving into the theoretical framework and cultural context more extensively would enhance the research implications and provide a more comprehensive understanding of the project's impacts on students' learning outcomes and cultural understanding.

### Conclusions

The study "Applying Physics Knowledge and STEAM Education in High School: Connecting Traditional Vietnamese Culture through the Moon-shaped Lute Production Project" has provided valuable insights into the integration of physics knowledge and STEAM education within the context of traditional Vietnamese culture. This research has made significant contributions to the existing body of knowledge, and when compared to previous studies, it offers unique perspectives and findings. In a related study by Tinh (2018), which explored the impact of STEAM education on students' learning outcomes, the focus was on general STEAM activities without a specific cultural context. The current study extends this research by examining the application of physics knowledge and STEAM education within the context of traditional Vietnamese culture through the Moon-shaped Lute Production Project. By connecting the project with cultural elements, this study highlights the importance of preserving and promoting traditional practices, which differentiates it from previous research. Furthermore, the findings of the current study are consistent with previous research that emphasizes the positive effects of problem-solving and interdisciplinary approaches in STEAM education. Thus, the integration of multiple subjects, such as physics, music, and cultural studies, in the Moon-shaped Lute Production Project has facilitated students' holistic learning experiences and fostered their critical thinking skills. However, unlike previous studies that mainly focused on Western cultural contexts, such as the research by Thuy (2021), the current study provides insights into the application of STEAM education in the specific context of traditional Vietnamese culture. By incorporating physics knowledge and STEAM principles into the production of the Moon-shaped Lute, this research has effectively connected high school students with their cultural heritage, which has unique implications for education in Vietnam. In summary, the study "Applying Physics Knowledge and STEAM Education in High School: Connecting Traditional Vietnamese Culture through the Moon-shaped Lute Production Project" contributes to the existing literature by offering specific insights into the integration of physics knowledge, STEAM education, and traditional Vietnamese culture. The research findings extend the current understanding of STEAM education and its potential impact on cultural preservation and students' learning experiences. This study's unique focus and contributions provide valuable implications for educators, curriculum developers, and policymakers seeking to enhance STEAM education initiatives while promoting cultural appreciation and identity in high school settings.

### Recommendations

**Encourage the Incorporation of Cultural Elements in STEAM Projects:** To enhance students' cultural appreciation and understanding, educators should actively seek opportunities to incorporate traditional cultural practices and elements into STEAM projects. For example, when designing projects related to physics concepts, teachers can integrate traditional art forms, music, or craftsmanship that are relevant to the local culture. This approach not only enriches the learning experience but also fosters a sense of pride and identity among students as they connect with their cultural heritage.

**Provide Professional Development Opportunities for Teachers:** To effectively implement STEAM projects that integrate physics knowledge, teachers need adequate training and support. Educational institutions and policymakers should

invest in professional development programs and workshops that focus on STEAM education methodologies and the integration of physics principles into interdisciplinary projects. These training sessions should equip teachers with the necessary pedagogical strategies, resources, and hands-on experiences to confidently guide students through STEAM projects.

*Foster Collaboration Between Physics and Arts/Music Departments:* Collaboration between different subject areas, particularly physics and arts or music departments, can lead to more comprehensive and engaging STEAM projects. Educators from diverse disciplines should collaborate to design interdisciplinary projects that incorporate both scientific and artistic elements. For instance, a joint project between physics and music departments could involve the construction of musical instruments, where students explore the physics of sound while also learning about musical composition and performance.

*Establish STEAM Clubs and Extracurricular Activities:* To promote a culture of STEAM education and creativity, schools can establish STEAM clubs or extracurricular activities. These clubs provide additional opportunities for students to engage in hands-on projects and explore their interests beyond the regular curriculum. Encouraging student-led initiatives and fostering a supportive environment for experimentation and innovation can further enhance students' passion for STEAM subjects, including physics.

*Integrate Technology and Digital Tools:* Embrace technology and digital tools to enhance the learning experience and facilitate STEAM projects. Virtual simulations, computer-aided design (CAD) software, and data analysis tools can complement traditional hands-on activities, providing students with a well-rounded understanding of physics principles and their practical applications. Integrating technology also prepares students for the digital age and the increasing role of technology in various fields.

*Emphasize Reflective Practices:* Encourage students to reflect on their learning experiences during STEAM projects. Integrating reflective practices, such as journals or group discussions, allows students to articulate their thought processes, challenges faced, and lessons learned. Through reflection, students can deepen their understanding of physics concepts and the interdisciplinary connections they make during the project.

*Establish Partnerships with Local Art and Cultural Institutions:* Collaborating with local art galleries, museums, and cultural institutions can enrich the STEAM project experience. Such partnerships provide students with access to authentic cultural artifacts and experts in different fields, inspiring creativity and deepening their understanding of cultural heritage.

#### *Recommendations for Future Researchers*

In future research, it is essential for scholars to delve deeper into the long-term impact of integrating physics knowledge and STEAM education in high schools. Conducting longitudinal studies will enable researchers to track students' academic and career trajectories over time, providing valuable insights into the lasting effects of STEAM projects. Additionally, comparative studies should be undertaken to explore the effectiveness of different project designs, focusing on the balance between cultural elements and scientific concepts. Inclusive practices should be emphasized to ensure that STEAM projects benefit students from diverse backgrounds. Investigating the impact on teachers and involving them in the co-creation process will enhance project authenticity and student engagement. Furthermore, cross-cultural studies can shed light on how cultural factors influence STEAM education outcomes. Finally, researchers should explore sustainable practices and strategies for scaling up successful projects, facilitating the widespread adoption of STEAM education in high schools. By addressing these areas, future researchers can contribute to the continued development and implementation of effective STEAM education initiatives.

By implementing these recommendations, educators can effectively integrate physics knowledge and STEAM education in high school settings, fostering a dynamic and enriching learning environment for students. Emphasizing cultural context, teacher professional development, interdisciplinary collaboration, and technology integration will enhance students' understanding and appreciation for both scientific principles and their cultural heritage. Additionally, these efforts contribute to developing well-rounded and innovative individuals prepared for future challenges in an increasingly interconnected world.

#### **Limitations**

Despite the valuable insights gained from this study, there are some limitations that should be acknowledged:

**Sample size and generalizability:** The study was conducted in a specific high school setting in Vietnam, and the findings may not be directly applicable to other contexts or populations. Further research with larger and more diverse samples is needed to generalize the results.

**Time constraints:** The study was conducted within a specific timeframe, and the full potential of integrating physics knowledge and STEAM education in high schools may require longer-term implementation and evaluation.

### Ethics Statements

The research conducted in this study adhered to ethical guidelines and principles. The necessary permissions and consent were obtained from the participants involved. Data collection and analysis were conducted in an ethical manner, ensuring the confidentiality and anonymity of the participants

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