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Wetland Potential-Based PBL: Developing Creative Thinking and Entrepreneurship Skills of Vocational High School Students on the Topic of Static Fluid

Ikhwan Khairu Sadiqin and Akhmad Zulkarnain*
Department of Science Education, Faculty of Teacher Training and Education,
Universitas Lambung Mangkurat, Banjarmasin, Indonesia
*akhmadzulkarnain17@gmail.com

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Abstract

The creative thinking and entrepreneurship skills of Vocational High School (SMK) students are often considered less applicable to industrial needs. This is partly due to the lack of relevant learning models that utilize local potential. This study aims to analyze the profile of students' creative thinking and entrepreneurship skills through the implementation of a Project-Based Learning (PjBL) model based on wetland potential on the topic of static fluid. The method employed in this research is quantitative descriptive. The research subjects were Class X SMK students in Banjarmasin. Data were collected using creative thinking test instruments and entrepreneurship skill observation sheets, then analyzed using descriptive statistics. The results showed that the students' competence profile was in the "Very Good" category with a total average score of 83.14%. Specifically, creative thinking skills reached an average of 81.00%, and entrepreneurship skills achieved 86.00%. These findings indicate that integrating PjBL with wetland wisdom is effective in bridging the competency gap, equipping students not only with conceptual understanding but also with the ability to create innovative products and market them.

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INTRODUCTION

Vocational High Schools (SMK) play a strategic role in preparing their graduates to become competent workers and independent entrepreneurs. However, in reality, Indonesia still faces significant challenges in global economic competition. The nation's weak competitiveness is often linked to low labor productivity, which, according to the Asian Productivity Organization (2025), is approximately 14% of the productivity in Singapore. Vital industrial sectors, such as food and beverages, are still constrained by significant challenges identified at various industry levels, including complicated regulations, lack of access to quality raw materials, and a shortage of skilled labor with adequate technical and managerial knowledge (Clement et al., 2022; Isventina et al., 2015; Siswati et al., 2025). Within this industrial landscape, physics education in SMK serves as a critical foundation for understanding technical processes, yet it is often taught as an abstract subject disconnected from these industrial realities.

The education system, particularly at the SMK level, must innovate more by transforming science subjects like Physics into a platform for practical skill development. Education can be the primary means to equip students with relevant and practical skills. Equipping students with creative thinking and entrepreneurship skills from an early age is crucial in the disruptive digital era. In this regard, teachers must strive not only to transfer knowledge about the entrepreneurial process and business plan development but also to impart social skills and competencies that can be developed through active or practical teaching methods (Adeel et al., 2023). In the context of physics, creative thinking teaching methods address students' difficulties in creative problem-solving and enhance their engagement by linking scientific laws to real-world applications (Li et al., 2022). These skills include adaptability, critical thinking, and innovative problem-solving, which are essential for navigating the complexities of the food and beverage industry.

The difference between the competencies taught in school and the needs of the workforce remains a major issue. Most SMK graduates find it difficult to secure jobs that match their qualifications due to a lack of adequate skills (Effendi et al., 2023). This is caused by a curriculum that traditionally focuses more on vocational skills, while learning that fosters creative thinking and entrepreneurship skills specifically within science and physics modules has not been optimally integrated. Unlike traditional high schools (SMA), which largely focus on theoretical knowledge for higher education preparation, vocational education emphasizes practical training and technical expertise. However, current vocational education programs often fail to bridge the gap between theoretical physics topics, such as static fluid, and the industry-relevant skills demanded by local markets (Gadling & Bhosale, 2025).

To resolve this, innovation is needed in instructional design that accommodates the utilization of wetland potential to produce innovative learning products with high sales value. This transition is naturally facilitated when scientific concepts are applied to local resources. For instance, the landscape of wetlands, dominant in regions like Banjar, offers an ideal context for exploring static fluid principles. The abundance of natural resources in wetlands, such as freshwater fish, can be processed into products with economic value using techniques governed by physics, such as controlled fermentation and buoyancy-based processing. This approach aligns with the concept of the circular economy, where ecological and social value accumulates through rethinking business models (Suchek et al., 2021).

The systematic relationship between wetlands and physics is most evident in the preservation of wetland biological resources. For example, students can develop small-scale projects such as cage fish culture or processing freshwater fish into semi-finished products (Joy & Paul, 2021). In these projects, the concept of static fluid, specifically density (ρ), hydrostatic pressure, and Archimedes' Principle, becomes the scientific mechanism that determines product quality. However, the utilization of this potential in SMK learning is still not optimal, as students tend to learn theory without real practical experience. Understanding concepts in the context of Natural Sciences (IPA) should be the students' ability to comprehend relationships between concepts so they can be applied to solve industrial problems (Sadiqin et al., 2017).

Previous studies have demonstrated the importance of the Project-Based Learning (PjBL) model and local wisdom. Research by Anggreadi & Sutaya (2019) shows that PjBL is effective in improving learning outcomes in crafts and entrepreneurship, while Meyer & Wurdinger (2016) assert that PjBL significantly develops life skills. In the realm of critical thinking, Irhasyuarna et al. (2023) mapped skills based on local wisdom in thousand-river cities. Furthermore, STEM-integrated PjBL has been explored to enhance creative thinking (Mamahit et al., 2020) and ethnoscience-based PjBL has shown greater influence on student creativity compared to conventional methods (Wanggi et al., 2023). Despite these

developments, a critical research gap remains: most previous studies focus on high schools (SMA) and emphasize general critical thinking or theoretical mastery.

There is currently a lack of research specifically integrating PjBL with wetland potential to develop the creative thinking and entrepreneurship skills of SMK students in the specific context of physics. Unlike SMA students, SMK students require a model that transitions from scientific theory (static fluid) directly into psychomotor industrial skills and product marketability. No learning model has been structured to utilize local wetland wealth as the core focus of a physics project to train both of these crucial skills simultaneously. This limitation presents a challenge that requires an innovative and integrated solution. Thus, the solution proposed in this study is to implement a physics-focused Project-Based Learning (PjBL) model that incorporates wetland potential. Its learning emphasis lies in solving industrial problems by researching, analyzing, and presenting a scientific product based on real experiences (Affandi et al., 2021). Consequently, the learning process not only yields conceptual understanding of static fluids but also produces tangible products with economic value, bridging the competency gap from start to finish (Hartanti et al., 2024).

METHODS

This study employs a quantitative descriptive method. According to Creswell & Creswell (2018), a quantitative approach focuses on describing trends, attitudes, or opinions of a population by studying a sample of that population. This design was selected to analyze the profile of Vocational High School (SMK) students in Banjarmasin and its surrounding areas within the context of utilizing wetland potential. The discussion is presented descriptively based on numerical data obtained from creative thinking and entrepreneurship skills assessments.

The research subjects are Grade X students at SMKs in Banjarmasin and its surrounding areas. The sampling technique used was purposive sampling, considering school characteristics that implement a wetland environment-based curriculum. The subjects studied focus on students in the Banjarmasin area and its surroundings, based on the rationale that students in this region have empirical proximity to wetland environmental issues, making their experiences relevant to explore in achieving the research objectives.

Data collection utilizes a limited essay test consisting of 14 items. An instrument grid is required to ensure the validity of the measurement for each variable. This instrument was developed to measure two main dimensions of student competence. The first dimension is Creative Skills (Items 1–6), which refers to the creativity assessment guide from (Treffinger et al., 2002). The indicators measured in this dimension include (1) fluency, the ability to generate many relevant ideas; (2) flexibility, the ability to view problems from various perspectives; (3) originality, the ability to produce unique and novel ideas; and (4) elaboration, the ability to develop ideas in detail and thoroughly. Furthermore, the second dimension is Entrepreneurial Skills (Items 7–14), which measures students' ability to identify economic opportunities from environmental issues through three main indicators: (1) Creativity and Innovation in creating products with sales value from local raw materials; (2) Strategic Thinking or Business Management in making technical operational decisions and handling production risks; and (3) Marketing Ability, which covers strategies in packaging and promoting products.

Table 1 Categories of creative skills and entrepreneurial skills capabilities

Average Score	Category
81-100%	Very Good
61-80%	Good
41-60%	Medium
21-40%	Poor
1-20%	Very Poor

The score data obtained from the test instrument were processed using descriptive statistical techniques to obtain the average value for each indicator. These values were then converted into percentages to determine the position of the students' capability category based on the criteria in Table 1 above. This analysis aims to comprehensively describe the profile of students' creative and entrepreneurial skills.

RESULTS AND DISCUSSION

The application of the Project-Based Learning (PjBL) model, which focuses on wetland potential, has been proven effective in developing the creative thinking and entrepreneurship skills of SMK students. This is because a problem-centered learning model can train students to develop many ideas, be open-minded, and be responsive to various perspectives (Khoiriyah & Husamah, 2018). Based on the implementation results, students showed positive responses and active participation. They were enthusiastic about exploring creative ideas and were bold in attempting to process local potential into products with sales value. This learning process was designed to take place over four meetings, each with a specific focus and outcome.

Project-Based Learning Model

The Project-Based Learning (PjBL) model serves as a bridge to connect theory with practice, as well as the curriculum with the local context. PjBL is a learning model that uses a problem as the first step and creates a project as the final output to provide an understanding of critical, creative, and innovative thinking (Ramadhan & Hindun, 2023). The implementation of the Project-Based Learning (PjBL) model in this study followed the syntax guidelines by Lucas (Kementerian Pendidikan dan Kebudayaan, 2014) which comprises six steps:

- Start with the Essential Question: Pose a challenging and relevant question to spark students' curiosity.
- Design the Project Plan: Students and teachers collaborate in designing the project to be undertaken.
- Create a Schedule: Determining the activity schedule, deadlines, and tasks to be completed.
- Monitor Project Progress: The teacher monitors and provides guidance during the project work process.
- Test the Outcome: Evaluating the final product and students' understanding.
- Evaluate the Experience: Reflecting on the entire learning process and the results achieved.

This model is highly effective in addressing the gap between the competencies of SMK graduates and the needs of the workforce because it focuses on developing skills relevant to the industry. This is supported by Meyer & Wurdinger (2016) research, which found that students' skills develop significantly through PjBL. Through PjBL, students not only memorize material but also experience a meaningful learning process, where they are actively involved in designing, implementing, and evaluating their own projects. The strength of the PjBL model used here, compared to general studies like Affandi et al., (2021), is its focus on "semi-finished" products from wetlands, which requires students to engage in higher-level technical decision-making rather than simple craft production.

Project-Based Learning Scenario (4 Meetings)

This learning scenario adopts the PjBL syntax that has been adapted to the wetland context, making it a systematic and practical flow for students. As illustrated in Figure 1.

Figure 1 Classroom learning activity

Meeting 1: Problem Analysis and Product Idea Generation
Students are invited to start with a fundamental question: "How can we transform the wetland potential around our school into a product with high economic value?" The teacher facilitates the discussion by presenting contextual facts, such as the fish price drops during harvest season. Students, in groups, generate innovative ideas like modern-flavored *pakasam* or crackers. This scenario directly impacts "fluency" and "flexibility" in creative thinking. By connecting physics students to economic issues, their problem-solving shifts from academic exercises to industrial innovation (Weiss & Wilhelm, 2022).

Meeting 2: Product Development
Student groups executed the project with the teacher acting as a facilitator. In the *pakasam* project, students applied the static fluid concept centered on the density (ρ) variable. This meeting has a powerful impact on "Strategic Thinking." Students realize that incorrect salt calculations lead to product spoilage (due to buoyancy imbalance), which represents a business risk. Consequently, physics becomes a tool for "risk management," fostering a professional entrepreneurial mindset anchored in scientific precision. As illustrated in Figure 2.

Figure 2 Outdoor learning activity

The application of the static fluid concept in preparing fermentation solutions, such as in the pakasam project at the Vocational High School, centers on the density variable of the fluid. When students add salt (solute) into water (solvent), they directly increase the total mass of the solution without significantly changing the volume, resulting in an increased solution density. In physics, this density increase is crucial because it affects hydrostatic pressure and, more importantly, buoyant force according to Archimedes' Principle. Practically, a high-concentration salt solution ensures that the fermenting fish pieces are completely submerged while exerting a distinct buoyant force on impurities or

other solid materials, concurrently controlling microbial growth. This demonstrates how changing the composition of the static fluid is key to the success of this traditional preservation technique and the subsequent entrepreneurial product innovation.

Meeting 3: Sales and Product Promotion
Groups devised marketing strategies using digital platforms**.** This scenario impacts "Marketing Ability" and "Originality." Students must communicate the scientific value (e.g., preservation physics) of their products persuasively. This activity aligns with school-business partnerships, which support education for sustainability (Sholahuddin et al., 2021). As illustrated in Figure 3.

Figure 3 Student product results

Meeting 4: Sales Evaluation (Evaluating the Experience)
In the final meeting, each group presents their sales results and reflects on the entire project experience. They analyze sales data, evaluate the promotion strategies that were implemented, and identify the obstacles and solutions they found. This meeting serves as a forum for students to practice their critical and analytical thinking skills, specifically impacting the development of "elaboration" skills as students must detail why technical physics decisions (e.g., fluid density in preservation) led to specific market feedback. They are encouraged to provide feedback to other groups and formulate improvements for future projects. The teacher provides constructive feedback and directs the students to compile a final project report. This evaluation stage solidifies the learning that has been acquired, strengthens their understanding of the business cycle, and motivates them to continue innovating.

The evaluation process at the end of this project is an important part of Project-Based Learning (PBL). According to Wicaksono et al. (2023) in *Evaluasi dalam Project Based Learning*, this final evaluation can combine various methods to obtain a comprehensive picture. Some relevant methods include group presentations to demonstrate understanding, peer assessment to develop evaluative skills, and the creation of reflective journals or portfolios to record thoughts and experiences during the learning process.

Student Skills in Wetland-Integrated Learning Design
The implementation of this learning scenario not only produced a product but also had a significant impact on the development of two key skills in students. Based on the overall data analysis, the students demonstrated a very positive competence profile with a total average score of 83.14% (Category: Very Good).

Creative Thinking Skills
Creative thinking skills are an essential ability highly needed in the 21st century. In this study, the students achieved an average score of 81.00% (Category: Very Good). There are four main aspects highlighted: fluency, flexibility, originality, and elaboration. This finding addresses the research question by showing that the wetland context stimuli perspectival shifts. Compared to STEM-PjBL in high schools (SMA), as seen in Mamahit et al. (2020),

which often results in laboratory prototypes, this study shows that vocational students achieve higher "originality" because their projects must compete in a real market. The results of creative thinking skills are shown in Figure 4.

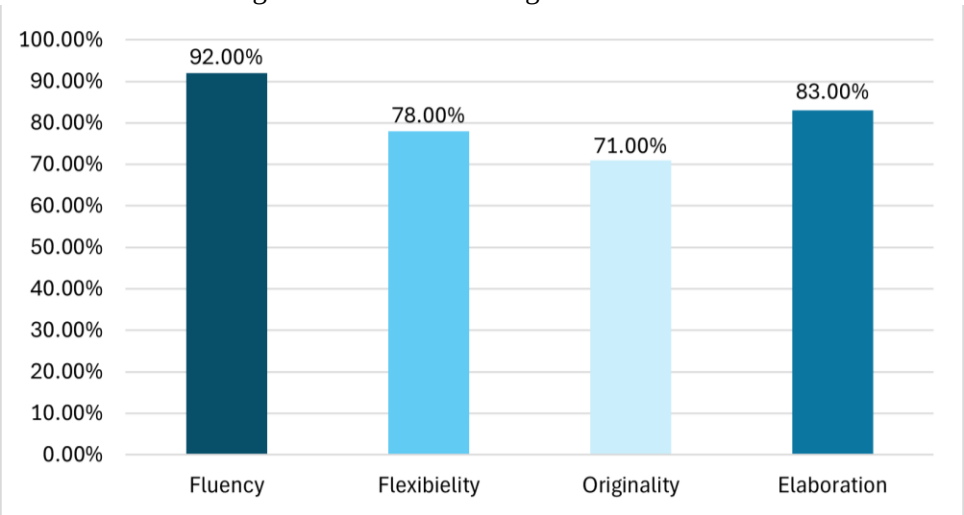

Figure 4 Creative thinking skills

According to Wanggi et al., (2023) the ethnoscience-integrated project-based learning model can improve students' creative thinking skills in science subjects; the improvement in students' knowledge shows they are more creative after being taught using this model. STEM-integrated project-based learning is effective for students' creative thinking skills; the STEM-integrated PjBL (PjBL-STEM) model can be used by teachers to support active learning and focus on scientific activities that require students to produce invented products and enhance their creative thinking skills (Mamahit et al., 2020). This learning model can improve other learning achievements or skills in line with the demands of the 21st century. Ethnoscience-integrated project-based learning also has a greater influence on students' creative thinking skills compared to conventional learning (Wanggi et al., 2023).

This changes the perspective that wetlands are often considered worthless, empty lands and are thus exploited indiscriminately (Wang et al., 2017). In the wetland-based project, students are encouraged to generate a variety of ideas for utilizing abundant local resources, such as freshwater fish during harvest season. This reflects the aspect of fluency, which recorded the highest achievement in this domain with a score of 92.00% (Category: Very Good). They are not only fixated on traditional processing methods but are also challenged to create new product variants. For instance, in the Pakasam project, students can develop new flavors or forms, or even combine them with other ingredients to create a unique product. This process trains the aspect of flexibility, which reached a score of 78.00% (Category: Good). Furthermore, by focusing on real problems in their environment, students are motivated to find solutions that have never existed before. These original ideas are crucial for creating added economic value from existing resources, which is the essence of the originality aspect, evidenced by a score of 71.00% (Category: Good). Additionally, the aspect of elaboration also showed strong results with 83.00% (Category: Very Good).

Entrepreneurship Skills

The results of entrepreneurial skills are shown in Figure 6.

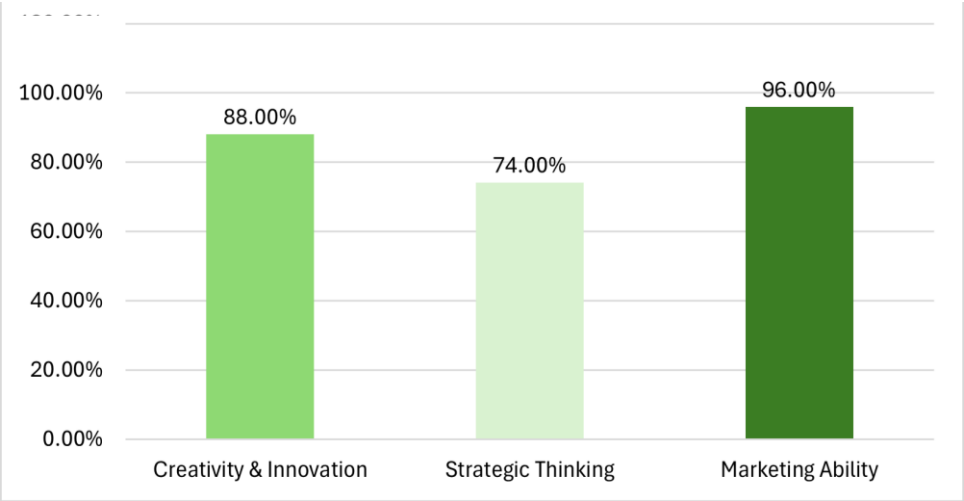

Figure 5 Entrepreneurship skills

Entrepreneurship skills are an individual's ability to identify business opportunities, plan, manage, and take risks to produce products or services that have economic value. In this dimension, students attained an average score of 86.00% (Category: Very Good). PjBL projects provide direct experiences that allow students' entrepreneurial abilities to develop (Anggreadi & Sutaya, 2019). The Creativity & Innovation indicator (specifically regarding product market value) showed an impressive result of 88.00% (Category: Very Good). Marketing Ability (96.00%) was a standout result. However, Strategic Thinking (74.00%) was the lowest (Category: Good). This highlights a critical contribution of the research: although students are creative in promotion, they still require intensive training in the "technical-scientific management" of production. This complements the limitations of general entrepreneurship studies (Affandi et al., 2021) which often separates marketing aspects from the technical science of production.

Critical Discussion and Addressing Study Limitations

Previous research has significant strengths but also notable weaknesses that this study addresses. STEM-PjBL models Mamahit et al. (2020) excel in cognition but often suffer from a "lab-to-market gap," where students lack commercialization skills. Conversely, ethnoscience models like Wanggi et al., (2023) excel in cultural context but often ignore the economic demands of modern industrial sectors. The primary weakness in those studies is the absence of a real product commercialization phase.

This study contributes by bridging these limitations with a holistic cycle. The novelty lies in the transformation of abstract physics theory (static fluid) into a tangible economic asset. Implementing these scenarios proves that SMK students do not just need to know "what" Archimedes' Principle is, but "how" it ensures their business survival. This "powerful" impact distinguishes this model from traditional academic PjBL, as it empowers students with innovation autonomy in their local environment while meeting global industrial standards.

Overall, the development of this PjBL model based on wetland potential has successfully addressed the challenge highlighted in the introduction, namely, bridging the gap between theoretical learning in schools and the real skill requirements of the workforce. Unlike previous studies that implemented STEM-integrated PjBL solely to enhance creative thinking (Mamahit et al., 2020) or PjBL for general entrepreneurship learning outcomes (Affandi et al., 2021), this study introduces novelty by integrating local wetland wisdom as the primary context for physics learning. Static fluid topics can be addressed concretely; the concepts of density and Archimedes' principle are directly applied in

determining the salt solution concentration for fish fermentation (Pakasam). Thus, this model proves that the integration of local potential in science learning is effective in cultivating SMK graduate profiles that are creative and entrepreneurial.

CONCLUSION

The implementation of the Project-Based Learning (PjBL) model integrated with wetland potential has proven to be effective in developing the creative thinking and entrepreneurship skills of SMK students, as evidenced by a "Very Good" competence profile with a total average score of 83.14%, where creative thinking skills reached 81.00% and entrepreneurship skills achieved 86.00%. These findings indicate that providing relevant and practical learning experiences through wetland-based projects allows students not only to master concepts but also to become innovative and independent entrepreneurs. Although the study was conducted within a specific scope of SMK in Banjarmasin, the implications offer a strong framework for vocational education, demonstrating that integrating PjBL with local wisdom serves as a viable solution to bridge the competency gap. The sustainability of this program can be achieved through its integration into the SMK curriculum and continuous collaboration with local industries to support the marketing of student products.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

The first author conceived the idea and checked the grammar and the logical flow. The second author implemented the idea and wrote the content.

AI DISCLOSURE STATEMENT

The author utilized Gemini during the preparation of this work for grammar checking and the selection of appropriate phrasing. After utilizing said tool/service, the authors have thoroughly reviewed and edited the content as necessary and assume full responsibility for the contents of the publication. The authors further declare that this research was prepared, investigated, written, and edited without the assistance of artificial intelligence (AI) techniques regarding the substance of the research material.

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AUTHOR PROFILES

Ikhwan Khairu Sadiqin, ikhwan.sadiqin@ulm.ac.id, Lecturer and research in Educational Technology, Teaching Methods and Teacher Education, Universitas Lambung Mangkurat.
https://scholar.google.co.id/citations?user=gAC68JUAAAAJ&hl=id
Sinta Link: https://sinta.kemdiktisaintek.go.id/authors/profile/6878613
https://www.scopus.com/authid/detail.uri?authorId=57223598510
Orchid Link: https://orcid.org/0009-0002-7465-2186

Akhmad Zulkarnain, akhmadzulkarnain17@gmail.com, Teacher and researcher, Universitas Lambung Mangkurat.
https://scholar.google.co.id/citations?user=MZBONZwAAAAJ&hl=id