**Indonesian Science Education Research (ISER)**
*Available online*
*https://jurnal.unimed.ac.id/2012/index.php/iser*
e-ISSN: 2715-4653
p-ISSN: 2797-6262

# Mapping Pre-Service Science Teachers' Understanding, Attitudes, and Skills in Entrepreneurial Thinking within Science Projects

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Accepted: September 2nd, 2025. Published: September 2nd, 2025

## Abstract

This study aims to map the understanding, attitudes, and skills related to Entrepreneurial Thinking (ET) in the context of science projects among pre-service science teachers. ET is an essential component that can be integrated into science education, as it has the potential to enhance creativity, innovation, and the social impact of project-based learning outcomes. This research employed a descriptive quantitative method with a sample of 73 pre-service science teachers from various regions of Indonesia. Data were collected through an online questionnaire that measured three main aspects: conceptual understanding, attitudes, and ET-related skills within science projects. The results indicated that, in general, pre-service science teachers possess a good understanding of the concept of ET and its application in science projects. Attitudes toward ET were also highly positive, as shown by the strong enthusiasm for integrating ET into science projects. Furthermore, the participants demonstrated competency in ET-related skills, although certain aspects, such as designing innovative solutions and brainstorming, still require further development. These findings suggest that the integration of ET into science education holds significant potential in shaping innovative and solution-oriented mindsets among pre-service science teachers.

**Keywords:** Entrepreneurial thinking, science project, preservice, science teacher.

## Introduction

In the face of accelerating global competition and rapid technological advancement, Entrepreneurial Thinking (ET) has emerged as a critical twenty-first-century competence (Buang et al., 2009; Ahmad & Siew, 2021; Karlsson et al., 2021). Recognized as a multifaceted construct, ET encompasses a range of cognitive and behavioral attributes—including risk-taking, creativity, curiosity, confidence, and strategic planning—that collectively enhance individuals' capacity to identify opportunities, devise innovative solutions, and generate meaningful societal impact (Weicht et al., 2020; Deveci & Seikkula-Leino, 2016; Leiva-Lugo et al., 2024). Far beyond its traditional association with entrepreneurship, ET is now viewed as a transformative mindset that fosters leadership, ethical awareness, and adaptive problem-solving across disciplinary contexts (Lekashvili, 2015).

Recent literature underscores the potential of ET to be integrated not only in business and economics but also in diverse educational domains, including science education (Bacigalupo et al., 2016; Davis, 2019). In entrepreneurship education, two interrelated yet distinct paradigms have emerged: the first focuses on venture creation and value generation in economic, social, or cultural terms; the second emphasizes entrepreneurial cognition—the ability to formulate creative ideas and innovative solutions in various real-world contexts (Davis, 2019). This broader understanding of ET provides a compelling rationale for its integration into science education, a field that inherently emphasizes inquiry, innovation, and relevance to societal challenges (Deveci & Çepni, 2017).

Integrating ET into science education offers the potential to cultivate learning environments that foster creativity, socio-economic value creation, and critical engagement with authentic, real-world problems (Chowdhury, M. A., 2016). When framed within inquiry-based and project-based pedagogies, ET can enhance students' capacity to generate science-informed solutions with tangible community benefits. Such integration not only bridges the gap between scientific knowledge and societal needs but also prepares learners to become ethically responsible and innovative contributors in an increasingly complex world.

Despite its promise, the integration of ET into science education remains underexplored and unevenly conceptualized in both policy and practice (Tiberius & Weyland, 2023). At the policy level, frameworks linking science education with entrepreneurial competencies are still evolving, while at the practical level, implementation remains fragmented and exploratory in many educational contexts (Panizzon & Corrigan, 2017; Elo & Kurtén, 2019). Furthermore, there is a lack of clarity surrounding how science projects can generate socio-economic value—a key tenet of entrepreneurial engagement—and how such value can be meaningfully articulated and assessed by educators (Eltanahy et al., 2020; Kaya et al., 2018; Ahmed & Siew, 2021). Consequently, science innovation projects often lack commercialization potential, primarily due to limited understanding of ET and inadequate skills in identifying or framing the socio-economic implications of scientific work (Zozimo et al., 2023).

Over the past decade, growing attention has been paid to exploring the connections between ET and science education, particularly in relation to teachers' pedagogical approaches and students' project development. Existing studies have examined pre-service teachers' abilities to assess the value of science-based innovations (Davis, 2019), K-12 educators' implementation of ET in science classrooms (Martin et al., 2018), and teachers' perceptions of open inquiry as a vehicle for entrepreneurial learning (Elo & Kurtén, 2019). These efforts represent early-stage attempts to conceptualize and map the role of ET within science education practice.

Given the importance of teacher preparation in shaping future educational landscapes, this study not only seeks to describe pre-service science teachers' understanding, attitudes, and competencies related to ET, but also aims to provide actionable insights for designing teacher education programs that foster entrepreneurial capacities. Specifically, the research explores how pre-service teachers conceptualize and apply entrepreneurial thinking in science projects,

with emphasis on their ability to identify socio-economic value, adopt creative problem-solving strategies, and engage in community-oriented scientific inquiry.

## Research Method

This study adopted a descriptive quantitative research design to explore and map the understanding, attitudes, and skills associated with Entrepreneurial Thinking (ET) in the context of science projects among pre-service science teachers. This approach was deemed appropriate to obtain a comprehensive overview of participants' perceptions and competencies related to the integration of ET within science education practices. The study involved 73 pre-service science teacher students recruited through purposive sampling, based on their active involvement in science project-based activities during their academic coursework. Participants were drawn from teacher education institutions located across three major islands in Indonesia—Java, Sumatra, and Kalimantan—to ensure regional diversity and contextual representation. The sample distribution was as follows: 41.1% from Sumatra, 28% from Java, 20% from Kalimantan, and the remaining participants originated from other regions beyond these three islands.

Data were collected using a structured questionnaire consisting of three main sections corresponding to the key dimensions of Entrepreneurial Thinking: 1) Understanding of Entrepreneurial Thinking (ET) in Science Projects. 2) Attitudes Toward Entrepreneurial Thinking in Science Projects. 3) Entrepreneurial Thinking Skills in Science Projects. Each section was measured using a four-point Likert scale tailored to the respective dimension. For understanding, the scale ranged from 1 (Not Understood at All) to 4 (Very Well Understood); for attitude, from 1 (Strongly Disagree) to 4 (Strongly Agree); and for skills, from 1 (Very Unskilled) to 4 (Highly Skilled).

The questionnaire items were developed based on an extensive review of literature on ET and science education, and were subjected to expert validation to ensure content relevance and construct clarity. To enhance transparency, sample items are presented in the appendix. Furthermore, a pilot test was conducted with a small sample of respondents to examine both item clarity and reliability. The instrument demonstrated acceptable reliability, with a Cronbach's alpha score of 0.87, thereby strengthening the credibility of its validity.

Data were gathered through an online survey platform, providing both accessibility and standardization in administration. Participants were informed about the purpose and scope of the research and provided informed consent prior to participation. Participation was entirely voluntary and anonymous. Descriptive statistical analysis was conducted to examine frequency distributions and percentage responses across all items, enabling pattern recognition and comparative insight into respondents' competencies. Additionally,

## Result and Discussion

### Conceptual Understanding of Entrepreneurial Thinking in Science Projects

Entrepreneurial Thinking (ET) is a cognitive and strategic approach that emphasizes creativity, innovation, and risk-taking to develop value-driven solutions for societal challenges. Within the realm of science education, ET emerges as a vital competence for pre-service teachers, enabling them not only to master scientific concepts but also to apply entrepreneurial mindsets in designing science-based projects with tangible benefits for the community.

In science education, understanding ET implies the ability to conceptualize and apply entrepreneurial principles—such as opportunity recognition, value creation, and solution orientation—within scientific contexts. Table 1 presents the pre-service science teachers' self-reported levels of understanding of ET in the context of science project development.

**Table 1. Pre-Service Science Teachers' Understanding of ET in Science Projects**

| No | Item | % Response | | | |
|---|---|---|---|---|---|
| | | Very Well Understood | Understood | Not Understood | Not Understood at All |
| 1 | Understanding the concept of ET and its application in science projects | 5.3 | 83.6 | 9.6 | 1.4 |
| 2 | ET can enhance innovation in science project development | 31.5 | 67.1 | 1.4 | 0.0 |
| 3 | Identifying entrepreneurial aspects within the science projects I have developed | 6.8 | 84.9 | 8.2 | 0.0 |
| 4 | Understanding how to assess the socio-economic value of a science project | 6.8 | 79.5 | 12.3 | 1.4 |
| 5 | ET is not solely about business, but also about creating innovative societal solutions | 24.7 | 72.6 | 1.4 | 1.4 |

The results indicate a generally positive perception and solid conceptual grasp of ET principles among participants. The highest agreement was seen in item 2, indicating that most pre-service teachers understand the role of ET in fostering innovation. However, there is a relatively lower rate of full comprehension (i.e., "very well understood") in identifying entrepreneurial aspects and assessing socio-economic value, suggesting areas requiring deeper pedagogical engagement.

These findings align with Neck and Greene (2011), who describe ET as a mindset that combines creativity, innovation, and proactive opportunity recognition under uncertainty. In science education, fostering such a mindset equips students and future educators with the competencies needed to navigate real-world challenges through scientific and entrepreneurial reasoning.

Moreover, literature underscores the significance of embedding ET into teacher education curricula. Ruskovaara and Pihkala (2013) found that entrepreneurship education enhances pre-service teachers' pedagogical content knowledge, particularly in designing contextualized and student-centered learning. Similarly, Akrami (2022) reported that integrating ET into STEM projects enables learners to shift from passive knowledge acquisition to active problem-solving. Lackéus (2015) emphasizes that ET promotes meaningful learning when knowledge construction is tied to societal impact.

The findings also reflect principles of constructivist learning theory, where knowledge is not merely transmitted but actively built through experience and contextualization (Tala, S., & Vesterinen, 2015). The integration of ET into science education can thus reinforce professional development by encouraging pre-service teachers to envision science teaching as a vehicle for community-oriented transformation.

**Attitudes Toward Entrepreneurial Thinking in Science Projects**

Attitudes serve as a key affective domain influencing the readiness of pre-service teachers to adopt ET in educational practice. Positive attitudes can significantly enhance

motivation, willingness to innovate, and openness to interdisciplinary learning, all of which are critical in 21st-century science education (Chang et al, 2022).

**Table 2. Pre-Service Science Teachers' Attitudes Toward ET in Science Projects**

| No | Item | % Response | | | |
|---|---|---|---|---|---|
| | | Strongly Agree | Agree | Disagree | Strongly Disagree |
| 1 | I feel confident applying ET principles in science projects | 6.8 | 82.2 | 11.0 | 0.0 |
| 2 | I am interested in integrating ET into future science teaching | 28.8 | 69.9 | 0.0 | 1.4 |
| 3 | I consider ET an essential skill for science educators | 24.7 | 75.3 | 0.0 | 0.0 |
| 4 | I am willing to learn more about the link between ET and science | 41.1 | 58.9 | 0.0 | 0.0 |
| 5 | I believe ET can help students think more creatively and innovatively in solving scientific problems | 32.9 | 67,1 | 32.9 | 32.9 |

The data reflect overwhelmingly positive attitudes. Items 4 and 5, which highlight willingness to engage further and the perceived value of ET in promoting creative problem-solving, received unanimous agreement. This underscores the high motivational potential for embedding ET systematically within science teacher preparation programs.

These attitudes are consistent with the affective learning framework, which posits that emotional and value-based commitment influences the depth of concept internalization (Jones & Bursens, 2015). Strong affective orientations toward ET suggest not only receptivity to new pedagogical paradigms but also readiness to cultivate similar dispositions among future learners. Lackéus (2015) emphasizes that affective engagement is critical for meaningful entrepreneurship education, fostering traits such as empathy, responsibility, and resilience. Rae (2007) and Ruskovaara and Pihkala (2013) further argue that positive attitudes among teacher candidates catalyze curricular innovation and promote the use of inquiry-based, project-driven learning methods.

Thus, the favorable attitudes observed in this study may function as a motivational foundation upon which teacher education institutions can build capacity for implementing entrepreneurial learning strategies in science education. Attitude formation, therefore, is not merely supplementary but central to the broader goal of educational transformation.

**Entrepreneurial Thinking Skills in Science Projects**

The development of entrepreneurial skills represents the behavioral component of ET, operationalizing cognitive understanding and attitudinal readiness into action-oriented competencies. Skills in this domain encompass identifying opportunities, designing solutions, articulating ideas, and estimating socio-economic impact (Buheji, 2019).

**Table 3. Pre-Service Science Teachers' ET Skills in Science Projects**

| No | Item | % Response | | | |
|---|---|---|---|---|---|
| | | Highly Skilled | Skilled | Unskilled | Very Unskilled |
| 1 | Ability to identify real-world problems | 8.2 | 78.1 | 13.7 | 0.0 |

| | | | | | |
|---|---|---|---|---|---|
| | solvable by science projects | | | | |
| 2 | Ability to design innovative and value-driven science project solutions | 13.7 | 72.6 | 12.3 | 1.4 |
| 3 | Ability to communicate project ideas clearly and persuasively | 9.6 | 79.5 | 8.2 | 2.7 |
| 4 | Ability to engage in brainstorming for innovative science solutions | 6.8 | 76.7 | 15.1 | 1.4 |
| 5 | Ability to estimate the social and economic impact of science projects | 19.2 | 75.3 | 5.5 | 0.0 |

These findings suggest that while foundational ET skills are present among many participants, there remains a substantial proportion who report lower proficiency, particularly in ideation and innovation design. This gap may stem from a lack of structured exposure to real-world entrepreneurial contexts or insufficient scaffolding in reflective practice.

Vygotsky's theory of social constructivism advocates for scaffolded learning through meaningful social interaction (Mishra, 2023). Collaborative, real-life project engagement—authentic project-based learning (APBL)—can serve as a vehicle for developing these competencies (Ustati, 2024). APBL environments support higher-order thinking, negotiation, and iterative problem-solving, all of which are essential to ET. Lackéus (2015) found that interdisciplinary and practice-based entrepreneurial projects significantly enhance learners' metacognitive and socio-emotional capacities. Gibb (2002) and Ilonen et al. (2018) also emphasize the need for learning environments that encourage agency, risk-taking, and adaptability to uncertainty.

Therefore, enhancing ET skills in pre-service science teachers necessitates a curriculum that blends theoretical instruction with experiential learning opportunities. Activities such as business model canvassing, social innovation mapping, science entrepreneurship simulations, and community-based inquiry should be embedded in teacher training to bridge conceptual understanding and applied competence.

In summary, the integration of ET into science education not only enriches the learning process but also aligns with global education goals of fostering responsible, creative, and socially impactful future educators. The findings of this study provide empirical justification for embedding entrepreneurial thinking across science teacher education curricula and call for ongoing pedagogical innovation that prepares educators to meet the demands of an increasingly complex world.

## Conclusion

This study highlights that pre-service science teachers exhibit a solid conceptual grasp of Entrepreneurial Thinking (ET) within the context of science projects, accompanied by positive attitudes and a strong intrinsic motivation to incorporate ET into their future instructional practices. They have demonstrated foundational competencies in key ET-related skills, including problem identification, idea communication, and assessment of the socio-economic impact of science-based initiatives. However, areas such as innovative solution design and creative ideation (e.g., brainstorming) remain underdeveloped and warrant targeted instructional support. These findings underscore the potential of ET as a strategic pedagogical approach in science education to foster more contextual, solution-oriented, and socially impactful learning. Based on these insights, it is recommended that science instruction should implement authentic, collaborative, and reflective project-based learning strategies to comprehensively develop students' understanding, attitudes, and skills related to ET. Based on these insights, it is recommended that teacher education programs incorporate authentic, collaborative, and reflective project-based learning to strengthen ET-related competencies. In

addition, explicit training in creative ideation and innovative solution design should be provided to better equip pre-service teachers for future instructional practices

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