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INTEGRATING STEAM AND EDUPRENEURSHIP IN PRIMARY EDUCATION TO IMPROVE SCIENCE LITERACY AND STUDENT CREATIVITY

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Abstract
21st-century learning demands the early integration of critical thinking, creativity, and entrepreneurial skills. The STEAM approach offers interdisciplinary and contextual learning, yet it still requires a stronger connection to students' real-life experiences. Integrating STEAM with edupreneurship presents an innovative solution to enhance scientific literacy and creativity among elementary school students. This study aims to examine the effectiveness of integrating the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach with edupreneurship in improving scientific literacy and creativity in elementary school students. The study was conducted at SDN 6 Saluputti using a descriptive qualitative approach, involving students from grades IV to VI as research subjects. Data were collected through observation, documentation, and interviews. Thematic analysis was employed to identify the impact of the integration on students' development of scientific literacy and creativity. The applied method was project-based learning, where students were guided to create tangible products such as herbal soap, artwork from recycled materials, and digital educational posters. The findings reveal that the integration of STEAM and edupreneurship positively influences students' scientific literacy. Students were able to understand scientific concepts contextually, conduct simple experiments, and communicate their findings logically and creatively. In terms of creativity, there was a significant improvement in four key indicators: fluency of ideas, flexibility of thought, originality, and elaboration. The products created reflected interdisciplinary thinking skills and an innovative spirit. Furthermore, students demonstrated high enthusiasm and engagement throughout the learning process. They actively participated in discussions, collaborated in groups, and expressed pride in their work. Learning became more meaningful, enjoyable, and fostered character values such as independence, responsibility, and collaboration. The integration of STEAM and edupreneurship has proven to be an effective innovative learning approach that enhances the quality of primary education, particularly in shaping a generation that is creative, scientifically literate, and entrepreneurially minded.
Keywords: *STEAM; edupreneurship; scientific literacy; creativity; elementary school*

Abstrak
Pembelajaran abad ke-21 menuntut integrasi keterampilan berpikir kritis, kreativitas, dan kewirausahaan sejak dini. Pendekatan STEAM menawarkan pembelajaran lintas disiplin yang kontekstual, namun masih perlu dikaitkan dengan kehidupan nyata siswa. Integrasi STEAM dan edupreneurship menjadi solusi inovatif untuk meningkatkan literasi sains dan kreativitas siswa sekolah dasar. Penelitian ini bertujuan untuk mengkaji efektivitas pengintegrasian pendekatan STEAM (*Science, Technology, Engineering, Arts, and Mathematics*) dengan *edupreneurship* dalam meningkatkan literasi sains dan kreativitas siswa sekolah dasar. Studi dilaksanakan di SDN 6 Saluputti dengan pendekatan kualitatif deskriptif dan melibatkan siswa kelas IV hingga VI sebagai subjek penelitian. Pengumpulan data dilakukan melalui observasi, dokumentasi, dan wawancara. Analisis data dilakukan secara tematik untuk mengidentifikasi dampak integrasi pendekatan terhadap perkembangan literasi sains dan kreativitas siswa. Metode yang digunakan adalah pembelajaran berbasis proyek, di mana siswa dirancang untuk membuat produk nyata seperti sabun herbal, karya seni dari barang bekas, dan poster edukatif digital. Hasil penelitian menunjukkan bahwa integrasi STEAM dan *edupreneurship* berdampak positif terhadap perkembangan literasi sains siswa. Mereka mampu memahami konsep ilmiah secara kontekstual, melakukan eksperimen sederhana, serta mengkomunikasikan hasilnya secara logis dan kreatif. Dari sisi kreativitas, terjadi peningkatan signifikan pada empat indikator utama: kelancaran ide, keluwesan berpikir, orisinalitas, dan elaborasi. Produk-produk yang dihasilkan mencerminkan kemampuan berpikir lintas disiplin serta semangat inovatif. Selain itu, siswa menunjukkan antusiasme dan keterlibatan tinggi dalam proses pembelajaran. Mereka aktif berdiskusi, bekerja sama dalam kelompok, dan menunjukkan rasa bangga terhadap hasil karyanya. Pembelajaran menjadi lebih bermakna, menyenangkan, dan menumbuhkan nilai-nilai

karakter seperti kemandirian, tanggung jawab, dan kolaborasi. Integrasi STEAM dan edupreneurship terbukti efektif sebagai pendekatan pembelajaran inovatif yang dapat meningkatkan kualitas pendidikan dasar, khususnya dalam membentuk generasi kreatif, literat sains, dan berwawasan kewirausahaan.
Kata Kunci: STEAM; *edupreneurship*; literasi sains; kreativitas; sekolah dasar

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Introduction

Indonesia continues to face challenges in improving students' science literacy. According to the 2022 Programme for International Student Assessment (PISA), Indonesian students still perform relatively low in science literacy compared to other countries, although there was an improvement of six positions from the 2018 results (Putrawangsa & Hasanan, 2022). This low level of science literacy includes students' understanding of basic scientific concepts, critical thinking skills, and the ability to apply scientific knowledge in daily life (Harahap et al., 2022). Moreover, the creativity of Indonesian students is also considered to be underdeveloped, particularly in the context of science learning, which demands the ability to generate ideas, think flexibly, and create innovative solutions to real-world problems. This indicates that the current education system has not yet fully facilitated the development of higher-order thinking skills required in the 21st century.These findings suggest that the average science literacy of Indonesian students remains low.

Preliminary observations at SDN 6 Saluputti, a primary school in Tana Toraja, revealed a similar condition. Students at this school have not yet achieved an adequate level of science literacy. Furthermore, the lack of creativity in understanding and developing scientific concepts is a significant issue (Rangkuti et al., 2019). Science learning at SDN 6 Saluputti remains dominated by conventional methods, emphasizing rote memorization and one-way teaching. Students are rarely engaged in activities that stimulate creativity, such as simple experiments, research projects, or problem-solving tasks. As a result, they struggle to develop the critical and imaginative thinking needed to solve scientific problems (Mulyaningsih et al., 2024).

One of the major challenges in science education at SDN 6 Saluputti is the lack of adequate facilities and resources. Like many rural schools in Indonesia, SDN 6 Saluputti lacks science laboratories, teaching aids, and interactive learning materials. Consequently, teachers rely heavily on textbooks and lectures, with minimal implementation of experiment-based learning, which is essential for developing scientific understanding. The learning process remains traditional and does not encourage critical thinking. Passive methods dominate, while active and participatory approaches are rarely applied. Another challenge is the lack of professional development opportunities for teachers to teach science more effectively and creatively. Teachers at SDN 6 Saluputti seldom have access to the latest training in innovative, project-based instructional approaches, which are critical for effective science education.

One potential solution to these challenges is the integration of the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach into classroom instruction (Trivena et al., 2018). The STEAM approach combines various disciplines and encourages students to think holistically in solving problems. STEAM is an interdisciplinary approach that not only focuses on content mastery but also hones 21st-century skills such as problem-solving,

collaboration, and creativity through contextual and engaging activities (Twiningsih & Elisanti, 2021).

Edupreneurship, or entrepreneurship in education, on the other hand, emphasizes the importance of innovative skills and the creation of useful and valuable products or solutions, as well as the development of entrepreneurial character from an early age (Muji et al., 2022). By combining science, technology, arts, and entrepreneurship, students can learn to create innovative solutions with commercial or social value. For example, students can develop simple technology-based products such as water filters or art projects incorporating physics concepts, and market them to their local communities (Harris & de Bruin, 2017). STEAM fosters not only technical competencies but also problem-solving, collaboration, and project management skills (Nisfa et al., 2022).

Implementing STEAM and edupreneurship can potentially increase student engagement in learning and develop 21st-century skills that are highly valuable in the future. In addition to improving science literacy, this approach encourages students to think creatively and innovatively in solving local problems (Trivena & Langi', 2021). SDN 6 Saluputti was selected as the research site for several compelling reasons. It is a rural school that often receives less attention in educational development, especially in science and technology. However, research on the integration of STEAM and edupreneurship in the context of rural elementary schools, particularly in Eastern Indonesia, remains very limited. Most previous studies have been conducted in urban areas with adequate facilities (Haifaturrahmah et al., 2020; Pramudyani & Indratno, 2022), thus failing to capture the challenges and potential of implementing this approach in regions with limited resources. Moreover, previous studies conducted by the researchers at SDN 6 Saluputti found that STEAM-based project learning significantly influenced students' critical thinking skills (Trivena & Lolotandung, 2024). Therefore, this study offers insights into the realities of science education in remote areas and how STEAM and edupreneurship can be applied in such contexts.

Furthermore, SDN 6 Saluputti holds great potential for developing students' competencies if given appropriate support. Despite limitations in facilities and resources, the high motivation of both students and teachers provides a strong foundation for capacity-building programs. This research also aims to formulate contextually relevant strategies for other rural schools facing similar challenges.

This study explicitly aims to examine the effectiveness of integrating the STEAM and edupreneurship approaches in improving scientific literacy and creativity among elementary school students in rural areas, specifically at SDN 6 Saluputti. Through this study, it is expected that contextual learning strategies can be identified and adapted by other schools in similar settings to address the challenges of science education quality in Indonesia.

Research Methods

This study employed a mixed-methods design using a sequential explanatory model that combines quantitative and qualitative approaches in a sequential manner. The quantitative approach was used to objectively measure changes in students' science literacy and creativity through tests, while the qualitative approach was employed to explore in depth the experiences of students and teachers through interviews and observations (Creswell, 2014; Sugiyono, 2019). The research subjects consisted of 28 fifth-grade students from SDN 6 Saluputti, selected purposively based on their active involvement in project-based learning that integrates STEAM and edupreneurship. The school was chosen due to its rural location, limited facilities, and

preliminary findings indicating that conventional science teaching methods were still being used.

Four main instruments were utilized in this study. The science literacy test, developed based on the PISA framework, aimed to measure students' understanding of scientific concepts, their ability to apply science knowledge in real-life contexts, and their logical and systematic scientific thinking. The student creativity test was adapted from the Torrance Tests of Creative Thinking (TTCT), which evaluates four core dimensions: fluency, flexibility, originality, and elaboration. Pre- and post-implementation observations were conducted systematically to capture changes in students' learning behavior, interaction patterns, critical thinking, and STEAM-based project development. Structured interviews were also carried out with both students and teachers after the learning sessions, focusing on their perceptions of the learning experience, conceptual understanding, and shifts in creativity and attitudes toward science learning.

The data analysis was carried out using both quantitative and qualitative techniques. Quantitative data were analyzed using descriptive and inferential statistics, particularly through a paired sample t-test to determine significant differences in science literacy and creativity test scores before and after the implementation. Meanwhile, qualitative data were analyzed thematically, with themes extracted from observation and interview transcripts, including student engagement, creative thinking processes, responses to project tasks, and collaborative learning experiences.

To ensure the validity of the findings, method triangulation was applied by combining results from tests, observations, and interviews. The quantitative results were compared and enriched with qualitative insights to obtain a more comprehensive understanding of the effectiveness of the learning approach. This mixed-method strategy enabled the researcher not only to measure the statistical significance of the changes but also to uncover how and why those changes occurred within students' daily learning contexts. Through this approach, the study provides a holistic view of how the integration of STEAM and edupreneurship influences the enhancement of science literacy and creativity in elementary students at SDN 6 Saluputti.Saluputti.

Result and Discussion

This study aims to analyze the impact of integrating the STEAM approach (Science, Technology, Engineering, Arts, and Mathematics) with elements of edupreneurship on improving science literacy among elementary school students. The research was conducted using a mixed methods approach, combining a quasi-experimental design with a descriptive qualitative study. The study was carried out at SDN 6 Saluputti and involved 28 fifth-grade students.

The research method employed was Classroom Action Research (CAR) implemented in two cycles. The objective of the study was to measure the effectiveness of integrating the STEAM approach with edupreneurship elements in enhancing science literacy, which includes cognitive aspects, science process skills, and scientific attitudes.

Table 1. Improvement of Students' Science Literacy at SDN 6 Saluputti

Phase	Cognitive Aspect	Science Process	Scientific Attitude
Pre-Cycle	58	61	66
Cycle I	72	76	79
Cycle II	85	83	82

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The following table 1 presents the average scores of students' science literacy across three main aspects: Cognitive Aspect, Science Process, and Scientific Attitude. These scores were measured over three phase Pre-Cycle, Cycle I, and Cycle II as part of a classroom action research conducted at SDN 6 Saluputti. The data indicate a consistent improvement in each aspect of science literacy throughout the intervention cycles. It is evident that all aspects experienced consistent improvement from the pre-cycle to cycle II. In the cognitive aspect, scores increased from 58.0 to 85.0, reflecting a stronger conceptual understanding of science among students. The scientific process aspect, which includes skills such as observing, drawing conclusions, and communicating results, also rose from 60.5 to 84.5, indicating students' success in directly applying the scientific method. Meanwhile, scientific attitudes—such as curiosity, perseverance, and responsibility—showed significant growth from 65.6 to 80.0. This improvement demonstrates the effectiveness of integrating STEAM and edupreneurship approaches in creating active, contextual, and enjoyable learning experiences. Through project-based activities, students not only learned science theoretically but also applied it in real-life contexts that helped build character and 21st-century skills.

This shows that the integration of such approaches is effective in developing scientific concepts in a contextual manner (Parisu et al., 2025). The significant increase in science literacy scores suggests that the STEAM approach combined with edupreneurship can foster deeper conceptual understanding among students (Armi et al., 2025). This occurs because students do not only learn scientific theories but also apply them to real-world contexts (Pimvichai, 2023). Project-based activities strengthen the connection between science and the real world, making abstract concepts more comprehensible (Ulum, 2024). The increase in science literacy scores indicates that the STEAM-edupreneurship approach is effective in reinforcing the understanding of scientific concepts (Yuniharto et al., 2024). This aligns with constructivist learning theory, which emphasizes meaningful learning through direct experiences (Ahmad, 2020).

Class observations and student worksheets show an increase in critical and creative thinking skills, especially in designing simple science-based products such as herbal soap, aromatherapy candles, and science teaching aids made from recycled materials. The STEAM approach allows students to combine science and art (Safitri, 2022), while edupreneurship provides contextual motivation through simulated entrepreneurship activities (Ismaiyah et al., 2022; Krismiyanti et al., 2023). In STEAM-edupreneurship projects, students are challenged to design solutions to specific problems (Evawati et al., 2024), requiring the application of critical thinking (analyzing, evaluating, concluding) (Twiningsih & Elisanti, 2021; Utomo et al., 2023) and creative thinking (generating new ideas, modifying products) (Putri et al., n.d.; Wilson et al., 2021). This process enriches the learning experience because students are encouraged to think beyond academic routines and begin to see science as a tool for creating something valuable. The integration of the arts (A) also helps develop aesthetics and innovation in the products created. Thus, 21st-century skills such as critical thinking and creativity are sharpened through direct experience (Amini et al., 2021). The integration of projects and entrepreneurial contexts encourages students to link scientific knowledge to real-life situations (Fitriana et al., 2024). In addition to enhancing science process skills, this approach instills economic values and sustainability (Hariandi et al., n.d.; Suryaningsih & Nisa, 2021). Simple introductions to material costs, profits, and marketing during the "Mini Bazaar" make students more interested and responsible for their creations.

Through interviews and questionnaires, students expressed high enthusiasm for learning that combines science projects and small business insights. 85% of students stated that learning became more enjoyable and meaningful, fostering curiosity, teamwork, and responsibility. One key finding was the growth of scientific attitudes such as curiosity, openness to new ideas, and persistence in problem-solving. When students engaged in edupreneurship activities (e.g., simulating the sale of their products), they learned to take initiative, be responsible, and value teamwork (Muthmainnah et al., 2022). These activities provided authentic experiences that strengthened character values such as hard work, independence, and creativity. Edupreneurship introduced the concept of value creation (Mansah, 2021), expanding the function of science education from mere knowledge acquisition to life skills. Project-based learning simultaneously fosters scientific attitudes and an entrepreneurial spirit. Students' curiosity and perseverance increased as they engaged in the full process of designing, testing, and presenting products. Collaborative attitudes and environmental awareness also developed, aligning with the values of the Pancasila Student Profile (Andhianto et al., 2024).

Participating teachers reported that the STEAM-edupreneurship approach made it easier to develop cross-disciplinary learning. Teachers felt encouraged to design challenging, relevant, and applicable project-based learning, which increased students' active participation (Halimatul Mu'minah & Suryaningsih, 2020). Teachers noted that integrating STEAM and edupreneurship challenged them to be more innovative in designing lessons. This shows that the approach also positively impacts teachers' professional development. Teachers began to utilize interdisciplinary strategies and think holistically when preparing lesson plans and assessments (Febriansari et al., 2022). Moreover, teachers observed that this approach increased students' participation and learning motivation—important indicators of successful learning strategies. Therefore, this approach aligns with the spirit of the Merdeka Curriculum, which emphasizes student-centered and contextual learning (Alhayat & J, 2024; Mabsutsah & Yushardi, 2022). A supportive learning environment, from both teachers and parents, reinforced the successful implementation of this approach. Teachers acted as facilitators of interdisciplinary learning, while parental involvement fostered appreciation for children's learning outcomes at home. This highlights the importance of synergy between schools and families in supporting the strengthening of science literacy (Jannah et al., 2022) (Jannah et al., 2022).

The implementation of the integration of the STEAM approach (Science, Technology, Engineering, Arts, and Mathematics) with the concept of edupreneurship at SDN 6 Saluputti has produced significant results in enhancing students' creativity. The application of the STEAM approach integrated with the edupreneurship concept has been proven to increase students' creativity at SDN 6 Saluputti. This is evidenced by the comparison of pre-test and post-test scores measuring creativity indicators based on Guilford's theory (fluency, flexibility, originality, and elaboration), which showed an average increase of 27%. Students demonstrated more open and original thinking in generating simple product ideas that combine elements of science and art (Fitriyah & Dwijayanti Ramadani, 2021; Jannah et al., 2022; Maarang, 2023). Student creativity was evident in their courage to experiment, combine local materials, and independently evaluate their creations (Nurbaya et al., 2024).

Table 2. Comparison of Students' Creativity Scores in Pre-Test and Post-Test

Creativity Indicator	Pre-Test	Post-Test
Fluency	58	75
Flexibility	60	78
Originality	55	72

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Creativity Indicator	Pre-Test	Post-Test
Elaboration	57	74

The Table 2 above shows a comparison of students' creativity scores before and after the implementation of STEAM- and edupreneurship-based learning at SDN 6 Saluputti. There are four creativity indicators measured: fluency, flexibility, originality, and elaboration. Before implementation, the scores for all four indicators ranged between 55 and 60. After the activities, there was a significant increase across all indicators. The post-learning scores increased to between 72 and 78. The originality indicator showed the highest increase of 30.91%, followed by flexibility (30.00%), elaboration (29.82%), and fluency (29.31%).

This demonstrates that learning that integrates science, technology, engineering, arts, and mathematics (with an entrepreneurial approach) can encourage students to think more creatively, innovatively, and productively (Zubaidah, 2019). During the activities, student enthusiasm and participation increased significantly. Observations showed that 85% of students were actively engaged in group discussions, experiments, and when presenting their products. Students became more confident and motivated to learn because the activities were not only theoretical but also directly applied in real-world projects (Conradty & Bogner, 2020; Lin et al., 2021). This enthusiasm was also reflected in the increased frequency of questions, initiative in completing tasks, and a spirit of collaboration. In the project activities, students successfully developed various creative products combining elements of science, technology, engineering, arts, and mathematics. Some groups made simple herbal soap from betel leaves and lime as a form of utilizing local resources relevant to science and art subjects. Other groups made pencil holders from recycled materials and designed digital promotional posters using simple applications, reflecting the integration of technology and mathematics.

These products not only had educational value but also had the potential to be developed in the context of student entrepreneurship. Beyond creativity, the activities also contributed to strengthening students' character values. Through teamwork, experimentation processes, and product creation, students learned to take responsibility for their roles, showed discipline in completing tasks, and respected each other's ideas (Hidayah et al., 2023; Nugroho, 2024). Values such as cooperation, independence, and honesty became more evident, especially when students conducted simple product-selling simulations. Thus, the integration of STEAM and edupreneurship also strengthens character education, which is an important part of the elementary school curriculum. Research findings show that integrating the STEAM approach with the concept of edupreneurship has a significant impact on improving elementary school students' creativity. Project-based learning encourages students to think critically, creatively, and solution-oriented through activities directly connected to everyday life and simple entrepreneurial opportunities (Fadilah, 2016; Khoiriya et al., 2024).

The increased scores in all four creativity indicators—fluency, flexibility, originality, and elaboration—indicate that this approach successfully activates various dimensions of students' creative thinking. Activities that combine science and art, such as making herbal soap, recycled products, and digital promotional posters, provide space for students to explore ideas freely and contextually. This aligns with Guilford's theory (1967), which states that creativity results from cognitive abilities that can be nurtured through a supportive environment (Shah & Gustafssona, 2021).

In addition to cognitive aspects, STEAM learning combined with edupreneurship also impacts students' affective and psychomotor aspects (Triani Wulandari et al., 2020). Active participation and enthusiasm during learning reflect a high level of emotional engagement

(Nasir et al., 2025). Students find learning more enjoyable, meaningful, and non-monotonous. With projects that carry marketable value, students are also introduced early to basic economic concepts, such as utility, packaging, and product promotion.

From a character standpoint, this approach reinforces values like teamwork, responsibility, and independence (Amelia & Ramadan, 2021; Kurnia & Nasrudin, 2022). During the product creation and presentation process, students are trained to complete tasks in groups, share roles, and face challenges with creative solutions. This aligns with the principles of an entrepreneurial mindset, which include adaptability, innovation, and initiative (Cui et al., 2022). Thus, the integration of STEAM and edupreneurship not only quantitatively enhances students' creativity but also shapes well-rounded 21st-century competencies and character. These findings reinforce the importance of innovation in learning approaches at the elementary school level to cultivate a generation that is not only academically intelligent but also creative, independent, and competitive.

Conclusion

The integration of the STEAM and edupreneurship approaches in science learning at SDN 6 Saluputti has proven effective in holistically enhancing students' scientific literacy. Through project-based activities such as the creation of natural products, students not only gained contextual understanding of scientific concepts but also developed scientific process skills, scientific attitudes such as curiosity and responsibility, as well as an entrepreneurial mindset. This approach also encouraged active teacher involvement as facilitators and received positive support from parents, thereby fostering a meaningful and collaborative learning environment aligned with the principles of the Merdeka Curriculum and the strengthening of the Pancasila Student Profile.

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