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Implementation of the steam learning model in pgmi on the creativity of prospective students of madrasah ibtidaiyah teachers at stai al hikmah tanjung balai: A descriptive qualitative study

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ABSTRACT

This paper aims to analyze the implementation of the STEAM (Science, Technology, Engineering, Arts, and Mathematics) learning model in enhancing the creativity of students in the Elementary School Teacher Education Program (PGMI) of STAI Al Hikmah Tanjung Balai. The background of this research is based on the need to strengthen the creativity of prospective MI teachers so they are able to design innovative and relevant learning to meet the demands of the digital era. This research uses a descriptive qualitative approach through observation, interviews, and documentation of lecturers and students who attended STEAM-based lectures. The results show that the implementation of STEAM learning can improve students' creative thinking, collaborative thinking, and problem-solving skills through project activities that integrate elements of science, technology, arts, and mathematics in the context of Islamic education. Lecturers act as facilitators who encourage the exploration of students' ideas, while supporting factors for implementation include the availability of digital media and institutional support; while constraints include limited facilities and lecturers' readiness in cross-disciplinary integration. Overall, this research contributes to strengthening the theoretical and practical foundations of STEAM implementation in Islamic higher education and provides implications for the development of a more innovative PGMI curriculum to foster creativity and professional readiness of prospective MI teachers.

Introduction

According to Piaget and Vygotsky, knowledge is not transferred directly from teacher to student, but is constructed through active interaction with the environment and socio-cognitive processes. This aligns with the characteristics of STEAM, which requires students to engage in exploration, collaboration, inquiry, experimentation, and reflection as a process of constructing new knowledge. Through this approach, students not only receive information but also construct understanding through hands-on experiences such as projects, experiments, and the creation of learning products (Yakman, 2008).

From a creativity theory perspective, STEAM is also considered capable of fostering divergent thinking skills and generating novel ideas. Guilford and Torrance in Yakman, (2008) explain that creativity is characterized by fluidity of ideas, flexibility of thinking, originality, and the ability to develop new solutions. Project-based and collaborative learning in STEAM provides space

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for students to develop these four components through product design, problem-solving, and innovation based on real-world needs. In the context of teacher education, creativity is crucial because creative teachers are better able to design engaging, meaningful, and adaptive learning that meets students' learning needs.

21st-century education demands the development of critical and creative thinking skills in students to prepare them to face global challenges and contribute productively to society (Mariana & Kristanto, 2023). In this context, the Science, Technology, Engineering, Arts, and Mathematics learning model is relevant because it has the potential to enhance student creativity through an interdisciplinary approach and problem-solving (Fariza & Kusuma, 2024). This STEAM approach combines the arts with core subjects to enhance student engagement, innovation, and problem-solving skills (Shen et al., 2021). The focus on PGMI in the context of STAI Al Hikmah Tanjung Balai highlights the importance of equipping prospective Madrasah Ibtidaiyah teachers with methodologies capable of stimulating creative and innovative thinking in elementary school students (Fariza & Kusuma, 2024). This aligns with 21st-century needs, where mathematical creative thinking skills are essential not only for solving routine problems but also for empowering various alternative solutions and designing innovative ideas (Afifah et al., 2025).

The latest STEAM teacher training model emphasizes the importance of developing 21st-century competencies, cross-disciplinary collaboration, and the use of digital technologies, including Augmented Reality, to increase the motivation and readiness of prospective teachers to implement STEAM in the classroom (Guncaga et al., 2024; Katalina & Marcelo, 2024). Living Labs and project-based approaches have proven effective in enhancing prospective teachers' pedagogical competencies, collaboration, and innovation, while supporting personalized learning (Martín-Cudero et al., 2024). However, STEAM teacher education still faces major challenges in terms of teacher readiness, the need for ongoing training, and the availability of adequate technological infrastructure (Anisimova et al., 2020). In the context of Islamic education, the integration of Islamic values into STEAM learning encourages the realization of a holistic education that combines mastery of science with spiritual character building, which in turn requires a flexible curriculum, cross-disciplinary collaboration, and specialized training for teachers (Hadi, 2025). The Re-STEAM (Religion, Science, Technology, Engineering, Arts, Mathematics) approach has been proven to increase student motivation to learn, critical thinking skills, and understanding of Islamic Religious Education materials, while preparing them to face the challenges of the 21st century (Adiyono et al., 2024). Findings from various case studies in Islamic boarding schools and madrasas indicate that the integration of STEAM and Islamic values strengthens students' academic, ethical, and spiritual competencies through project-based learning and directed collaborative practices .

The integrated and contextual application of the STEAM model through project-based learning has proven effective in facilitating students' conceptual understanding and social skills. Various studies have shown that implementing the STEAM approach can significantly increase students' active participation, encourage creativity, and deepen their understanding of complex concepts, particularly in science subjects. This approach is highly effective because it presents a collaborative, exploratory, and contextual learning process, in accordance with the characteristics of 21st-century learners. Empirical studies also indicate that implementing STEAM through project-based activities can significantly foster 21st-century skills such as critical, creative, and collaborative thinking, engaging students in authentic and contextual learning experiences (Lestari et al., 2025).

However, STEAM integration at the elementary education level often faces obstacles such as limited facilities, low teacher readiness in integrating STEAM elements holistically, and the unavailability of relevant teaching tools (Lestari et al., 2025). Therefore, an adaptive and comprehensive implementation strategy is needed, especially for prospective elementary school teachers, to overcome these challenges and maximize the potential of the STEAM approach in enhancing student creativity (Dina, 2025). This study aims to explore the implementation of STEAM learning in the Elementary School Teacher Education study program at STAI Al Hikmah Tanjung Balai and identify the challenges faced in efforts to increase the creativity of prospective elementary school teacher students (Lestari et al., 2025; Nuragnia et al., 2021). This study will analyze in depth

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how the STEAM learning model can be effectively integrated into the PGMI curriculum to produce innovative prospective teachers who are ready to face the era of the industrial revolution 5.0 (Surmilasari et al., 2022). This research will also discuss how STEAM strategies can help students develop the skills needed to face the challenges of the 21st century (Dina, 2025).

Specifically, this study will evaluate the impact of project-based learning, an integral part of the STEAM approach, on enhancing the creativity, motivation, and collaborative skills of prospective elementary school teacher students (Astuti et al., 2025; Kusumasari et al., 2025). These skills are crucial considering that global environmental changes, such as climate change and pollution, require innovative, scientifically based solutions (Tran et al., 2021). This study will also identify supporting and inhibiting factors for STEAM implementation in the PGMI environment, in order to formulate practical recommendations for optimizing its application in an effort to improve the quality of prospective teacher education (Lestari et al., 2025). Thus, this research is expected to make a significant contribution to the development of PGMI curricula and innovative teaching practices, particularly in preparing prospective teachers capable of fostering 21st-century skills in elementary school students (Maulida, 2023).

Furthermore, the implementation of the STEAM model aligns with the Merdeka Curriculum policy, which emphasizes the importance of project-based learning and strengthening the Pancasila student profile. Therefore, the application of STEAM in the context of PGMI is not only theoretically relevant but also contextually relevant to national and global educational needs.

Based on the description, this study aims to analyze the implementation of the STEAM learning model in enhancing the creativity of prospective elementary school teacher students at STAI Al Hikmah Tanjung Balai. The results of this study are expected to contribute to the development of innovative learning models in Islamic religious higher education environments, as well as serve as a reference for PGMI lecturers in designing learning that fosters creativity and innovation in prospective MI teachers.

Method

This study uses a qualitative approach with descriptive methods. This approach was chosen because it aims to understand in-depth the process of implementing the STEAM (Science, Technology, Engineering, Art, and Mathematics) learning model in enhancing the creativity of students in the Elementary Madrasah Teacher Education Study Program (PGMI) at STAI Al Hikmah Tanjung Balai. According to Creswell & Creswell, (2023), qualitative research is used to explore the meaning constructed by individuals or groups regarding a social phenomenon, with a focus on the experiences, contexts, and processes that occur in the field.

This research was conducted at the PGMI Study Program of STAI Al Hikmah Tanjung Balai in the even semester of the 2024/2025 academic year. The research subjects consisted of 15 PGMI students taking the Media and Learning Innovation course and two lecturers who implemented the STEAM learning model in the lecture process. The subject determination was carried out using a purposive sampling technique, namely the deliberate selection of informants based on the criteria of relevance and direct involvement in the implementation of the STEAM learning model. According to Sugiyono & Lestari, (2021), purposive sampling allows researchers to select participants who are considered to have the best understanding and are able to provide the necessary information related to the phenomenon being studied.

The types of data used in this study include primary and secondary data. Primary data were obtained through direct observation of learning activities, in-depth interviews with lecturers and students, and documentation of student project work. Secondary data were obtained from course documents such as Semester Learning Plans (RPS), lecturer notes, and scientific literature relevant to the STEAM concept and creativity in elementary madrasah teacher education.

Data collection techniques were conducted through observation, in-depth interviews, and documentation. Observations were conducted in a participatory manner to directly observe the STEAM-based learning process, student activities, and interactions between lecturers and students. Spradley, (2016) stated that participatory observation allows researchers to understand the

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behavior and meaning contained in social activities contextually. In-depth interviews were conducted with lecturers and students to obtain information regarding experiences, perceptions, and obstacles in implementing the STEAM model. According to Maleong, (2019), qualitative interviews serve to explore participants' views more openly and reflectively. Documentation is used as a complement to obtain empirical evidence through photos of activities, project results, and academic records.

This study also adheres to ethical standards for qualitative research. Before data collection began, the researcher obtained official permission from the PGMI Study Program at STAI Al Hikmah Tanjung Balai. All participants were provided with an explanation of the research objectives, data collection procedures, potential benefits, and the right to refuse or discontinue participation at any time without consequence. Consent was obtained through written and verbal informed consent. To maintain confidentiality, the identities of lecturers and students were disguised and not included in the research results. All collected data were stored securely and used only for academic purposes. The principles of anonymity and confidentiality were applied in accordance with ethical guidelines for social-humanities research.

The researcher's role in this study was as an external observer not involved in the teaching or assessment process, thus minimizing potential bias. The researcher also used a reflective journal to reduce interpretive bias and maintain objectivity during data collection and analysis. The research's rigor was ensured through various credibility strategies, such as triangulation of sources and methods, member checking to ensure the accuracy of interpretations, an audit trail that systematically documents the entire research process, and peer debriefing through discussions with colleagues to test the consistency of the findings.

Data analysis was conducted interactively following the Miles & Huberman, (2014) model, which includes three stages: data reduction, data presentation, and conclusion drawing. In the reduction stage, data were selected, classified, and focused on aspects of STEAM implementation and its influence on student creativity. The data presentation stage was carried out by compiling a descriptive narrative that illustrated learning patterns and student work results. Next, the conclusion drawing stage was carried out by interpreting the data and linking it to relevant theories. To ensure data validity, source and method triangulation techniques were used. According to Lincoln & Guba, (1985), triangulation aims to increase the credibility of research results by comparing various data sources and information collection methods. Furthermore, member checking was also carried out by requesting confirmation of interpretations from informants to ensure the findings are valid and in accordance with reality on the ground.

With this approach and procedure, this study is expected to be able to provide a comprehensive picture of how the STEAM learning model is implemented in the context of Islamic education and the extent to which the model is able to encourage increased creativity of prospective elementary madrasah teacher students at STAI Al Hikmah Tanjung Balai.

Result

Implementation of the STEAM Learning Model in PGMI Lectures

Research findings indicate that the implementation of the STEAM learning model in the PGMI Study Program at STAI Al Hikmah Tanjung Balai not only increases student engagement but also triggers concrete changes in learning behavior, particularly in terms of creativity, collaboration, and problem-solving skills. In general, the project-based learning process implemented in the Media and Learning Innovation course follows a repetitive process: identifying contextual problems, exploring related scientific/Islamic literature and concepts, brainstorming design ideas, prototyping, testing, reflection, presentation, and revision based on feedback. This series of activities serves as a practical arena for students to construct knowledge based on a constructivist framework (Vygotsky), while simultaneously fostering creative thinking skills as defined in the creativity literature (fluency, flexibility, originality, elaboration).

Descriptions of class activities demonstrate the practical nuances of STEAM implementation. In each meeting, the lecturer opens with a brief scaffolding (linking scientific

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concepts to Islamic values), after which students work in groups of 4-5 on an integrated project. Observation activities show students conducting simple experiments (e.g., a simple electrical circuit experiment for a light sensor demonstration), designing visual elements (art aspect) for props, and constructing simple calculations or logic (mathematics/engineering aspect). Learning activities often utilize digital platforms e.g., prototyping a simple Android app for a religious education quiz or an AR simulation showcasing scientific concepts related to the verses of creation, where groups take turns presenting prototype developments and receiving peer-to-peer feedback before finalization. The entire process is documented in a project portfolio that serves as a formative assessment tool.

The implementation of the STEAM (Science, Technology, Engineering, Art, and Mathematics) learning model in the Elementary Madrasah Teacher Education Study Program (PGMI) at STAI Al Hikmah Tanjung Balai is an educational innovation designed to develop students' creative, collaborative, and solution-oriented thinking skills as prospective madrasah teachers. This transformation of the learning paradigm is a strategic step in facing the challenges of 21st-century education, where teachers not only act as transmitters of knowledge, but also as facilitators capable of fostering students' creativity and learning independence. The STEAM learning model provides a learning experience oriented towards exploration, innovation, and solving real problems.

Islamic education has a significant responsibility in preparing teachers who are not only intellectually intelligent but also possess noble character and morals. The implementation of STEAM in the PGMI STAI Al Hikmah Tanjung Balai environment emphasizes that modern learning can coexist with Islamic spiritual values. The integration of science, technology, art, and mathematics is carried out without abandoning the foundation of Islamic morality. Each learning project is directed towards students understanding that science is a means to recognize the greatness of Allah SWT and contribute to the welfare of the community. This thinking aligns with the view of Al-Attas, (1980), who emphasized that Islamic education aims to shape civilized individuals through the unification of knowledge and divine values.

The STEAM concept implemented at PGMI STAI Al Hikmah Tanjung Balai combines theoretical and practical aspects in a single learning process. Students are encouraged to integrate various disciplines into contextual and applicable activities. A concrete example is seen in the project activities for creating thematic learning media that combine science, art, and Islamic values, such as the design of teaching aids about the solar system linked to verses of the Quran regarding the creation of the universe. This approach trains students to think holistically, see the relationship between science and faith, and understand the essence of creation as a sign of God's greatness.

A STEAM-based learning environment encourages students to actively participate in every stage of learning. The learning process takes place through group discussions, problem exploration, solution design, and the creation of learning products. These activities foster collaborative skills and shared responsibility. This teamwork model trains students to respect differences of opinion, build effective communication, and develop empathy for colleagues. Beers, (2011) stated that collaborative learning within the STEAM approach can hone students' social skills, leadership skills, and adaptability to global challenges.

The role of lecturers in the implementation of STEAM at PGMI STAI Al Hikmah Tanjung Balai has shifted from an information center to a facilitator guiding students to discover the meaning of each learning process. Students are given the freedom to explore ideas, conduct experiments, and express their reflections. This process fosters independent thinking while enhancing a sense of academic responsibility. Learning is no longer one-way, but rather dialogic and constructive. Students learn to understand that mistakes are part of the process of seeking knowledge. This pattern fosters the character of true learners who continue to develop in accordance with the spirit of lifelong learning.

The creativity of prospective madrasah teacher students grows through hands-on experience combining knowledge, skills, and Islamic values. The process of creating works requires them to think divergently and generate innovative and solution-oriented ideas. Henriksen et al., (2016) explain that STEAM-based learning strengthens creative thinking skills by challenging

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students to find solutions from multiple perspectives. PGMI students who are familiar with this method tend to be more innovative in designing engaging and meaningful learning plans for elementary madrasah students.

The social context of education at STAI Al Hikmah Tanjung Balai also reinforces the meaning of STEAM implementation. Students focus not only on academic achievement but also on developing projects that benefit the surrounding community. Several student groups developed simple learning media based on local technology that MI teachers used in the teaching and learning process. This activity reflects the spirit of devotion and the application of knowledge for the common good. The values of ta'awun (mutual assistance) and ukhuwah (brotherhood) form the basis for building a collaborative culture on campus.

The implementation of the STEAM learning model at PGMI STAI Al Hikmah Tanjung Balai ultimately gave birth to a new paradigm in modern Islamic education. The integration of science and spiritual values is a key pillar in shaping prospective madrasa teachers who are professional and have character. Students not only learn teaching theory but also learn how to instill values, guide by example, and innovate with full moral responsibility. STEAM-based education makes them prospective educators who are not only academically competent but also possess a strong religious and social vision to bring positive change to the world of Islamic education in Indonesia. The implementation of STEAM in the PGMI environment is carried out in an integrated manner within the Learning Media and Innovation course, where students are directed to develop learning projects based on an interdisciplinary approach. Each project is designed to enable students to combine elements of science, technology, art, and mathematics in the context of basic education. For example, students are asked to create thematic teaching aids containing elements of science and art, such as "solar system teaching aids made from recycled materials" or "Android application-based learning media for basic fiqh learning." These activities involve scientific thinking processes, simple technological design, the application of aesthetic principles, and mathematical calculations.

The STEAM learning model is implemented through several stages: planning, implementation, and evaluation. During the planning stage, lecturers prepare Semester Learning Plans (RPS) that emphasize project development and collaboration among students. The implementation stage involves discussions, problem exploration, simple experiments, and the creation of learning products. Lecturers act as facilitators who provide guidance, not as the sole source of knowledge. During the evaluation stage, students present their project results and receive feedback from lecturers and peers.

This approach aligns with Yakman, (2008) opinion, which states that STEAM is a learning model that harmoniously integrates various disciplines to develop higher-order thinking skills and 21st-century skills. Learning with the STEAM model also encourages students to think reflectively, creatively, and innovatively through activities that require them to create solutions to contextual problems. PGMI lecturers who implement this approach state that students become more enthusiastic and actively involved in the learning process because they feel they have the freedom to experiment and create.

Furthermore, the implementation of STEAM at STAI Al Hikmah Tanjung Balai also aligns with Islamic values. Students are guided to view science and technology as a means to understand the greatness of Allah SWT and strengthen their faith. This aligns with Al-Attas, (1980) view, which emphasizes that knowledge, from an Islamic perspective, should lead humans to an understanding of God and strengthen the spiritual dimension. Therefore, the STEAM approach at PGMI not only produces prospective teachers who are academically competent but also possess noble character and a vision of education grounded in Islamic values.

The STEAM learning model has proven effective in increasing the creativity of prospective elementary school teacher students, encouraging them to integrate various disciplines in solving problems that are relevant to the real world (Ahmad et al., 2021; Lestari et al., 2025). This approach facilitates the development of critical and creative thinking skills, which are essential for educators in the 21st century (Mariana & Kristanto, 2023). However, the implementation of STEAM at the

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elementary level, especially in fifth grade, often faces challenges such as limited facilities and teacher readiness to integrate STEAM elements comprehensively (Lestari et al., 2025).

Furthermore, the availability of teaching materials aligned with the national curriculum and student characteristics in Islamic elementary schools remains a challenge. Therefore, innovative adaptation strategies and ongoing training for lecturers and prospective teachers are needed to optimize the potential of this learning model (Lestari et al., 2025). This aligns with research findings showing that implementing project-based learning can significantly enhance student creativity, encourage active participation, and develop critical and creative thinking skills. Teachers, as key actors in education, play a crucial role in creating a stimulating learning environment and facilitating the development of new ideas (Fariza & Kusuma, 2024; Nuragnia et al., 2021).

The application of the STEAM approach in the learning process has been proven to increase active student participation, encourage creativity, and deepen conceptual understanding, particularly in science subjects (Lestari et al., 2025). The collaborative and non-monotonous learning environment created through the STEAM approach allows students to enjoy the learning process more and engage emotionally and intellectually (Lestari et al., 2025). Utilizing this model also supports the development of adaptive and innovative individuals, ready to face global challenges (Sonthong et al., 2023). Furthermore, the STEAM model, particularly the project-based one, can develop early childhood skills in the era of the Industrial Revolution 5.0 by combining science, technology, engineering, art, and mathematics (Indahwati et al., 2023). This implementation allows students to actively engage in the learning process, solve problems, and develop crucial critical and creative thinking skills (Fariza & Kusuma, 2024).

Conceptually, these findings strengthen the relationship between STEAM practices and constructivist and creativity theories. The observed scaffolded project-based learning process reflects how collaborative experiences place students in their zone of proximal development, allowing knowledge and creativity to develop through social interactions and authentic tasks. These results align with research by Beers, (2011); Henriksen et al., (2016) which shows that cross-disciplinary design tasks facilitate creative thinking and 21st-century skills. Specifically for Islamic education pedagogy, this study demonstrates that STEAM can be an integrative medium that enables the integration of scientific knowledge and religious values: students not only understand scientific concepts but also reflect on their meaning within a faith framework. For example, when groups link natural phenomena to verses from the Quran, class discussions demonstrate the process of internalizing values such as tawhid (the unity of creation) and amanah (responsibility towards the environment) into learning designs. Thus, STEAM in the context of PGMI contributes to holistic pedagogy developing intellectual and spiritual competencies simultaneously and enriches the literature on the adaptation of STEAM in religious education.

The Impact of STEAM Implementation on Increasing Student Creativity

The results of the study indicate that the implementation of the STEAM model has a significant impact on increasing the creativity of prospective elementary school teacher students. Students who participated in STEAM-based learning demonstrated improved abilities in generating new ideas, thinking critically, and solving problems innovatively. Student creativity was evident in the way they developed learning media that were not only visually appealing but also had high educational value and were easily applicable in the elementary school context.

Creativity in the context of teacher education not only means the ability to produce something new, but also the ability to adapt to various learning situations and create effective solutions according to students' needs. In STEAM-based activities, students are encouraged to think divergently, namely thinking from various perspectives and combining different disciplines. This is in line with the view of Henriksen et al., (2016) that the STEAM approach fosters creative thinking skills through active engagement in the process of exploring ideas and solving problems across fields.

In practice, students demonstrate increased creativity through project activities that combine scientific and Islamic aspects. For example, a student group developed a "science-based

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learning medium for understanding the concept of ablution" using a simple scientific experiment approach linked to Islamic principles of cleanliness. This project demonstrated the students' ability to integrate scientific and spiritual aspects while producing contextual and meaningful learning media.

Interviews with lecturers also showed that students became more confident in expressing ideas, were more willing to take academic risks, and were highly motivated to produce their best work. Student creativity was also evident in their ability to collaborate and divide tasks according to the potential of each group member. This demonstrates that the implementation of STEAM not only fosters individual creativity but also fosters collective creativity within the team.

In the context of educational theory, creativity is crucial for prospective teachers because creative teachers tend to produce enjoyable and meaningful learning for students. Munandar, (2014) states that creativity is the ability to think originally and flexibly to generate new, useful ideas. The STEAM learning model provides students with the opportunity to develop these skills naturally because they are directly involved in the process of discovering ideas and transforming them into concrete products.

Furthermore, the implementation of STEAM also increases students' self-efficacy, namely their confidence in their ability to overcome learning challenges and create innovation. Bandura, (1997) stated that self-efficacy is a crucial factor in motivating individuals to achieve. In this context, PGMI students feel they have the ability to teach using innovative methods and are not afraid to fail when trying new things. Thus, the implementation of STEAM has proven effective in improving students' cognitive, affective, and psychomotor dimensions.

The results of this study align with Beers, (2011) findings, which state that STEAM-based learning has a positive impact on students' higher-order thinking skills and creativity. Beers explains that a challenging, collaborative, and contextual learning environment can stimulate the brain to generate new, more original ideas. Therefore, implementing STEAM in the PGMI environment is a strategic step in producing creative and innovation-oriented prospective madrasah teachers.

Challenges and Solutions in Implementing STEAM at STAI Al Hikmah Tanjung Balai

Although implementing the STEAM learning model offers numerous benefits, this study also identified several challenges. The first challenge is the limited facilities and infrastructure to support project-based activities. Facilities such as mini-laboratories, science demonstration equipment, and digital technology devices are still inadequate. This presents a barrier to developing projects requiring simple experimental tools and technology. However, lecturers and students are working to overcome this by utilizing readily available local materials and optimizing free digital media as alternatives.

The second challenge is the readiness of lecturers to comprehensively understand and apply STEAM concepts. Not all lecturers have the interdisciplinary scientific background that underpins the STEAM approach. Therefore, training and mentoring are needed to improve lecturers' competency in designing integrative learning. Lecturers are expected to be creative facilitators, not simply transmitters of material. Rahmawati & Kurniati, (2019) emphasized that the success of STEAM implementation in higher education depends heavily on lecturers' readiness to integrate scientific values and local contexts into the learning process.

The third challenge is students' learning habits, which tend to be passive and dependent on lecturers. PGMI students are generally accustomed to conventional learning patterns oriented toward lectures and memorization. When faced with a learning model that demands independent exploration, collaboration, and critical thinking, some students struggle to adapt. To address this, lecturers need to provide motivation, guidance, and greater opportunities for student expression.

In addition to the challenges, this research also identified various solutions applied in the implementation of STEAM at STAI Al Hikmah Tanjung Balai. One of these solutions is adapting the STEAM approach to the local context and resource availability. Students are encouraged to use simple materials, such as cardboard, used bottles, wood, and recycled paper, to create learning

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media. This approach not only fosters creativity but also instills environmental awareness and Islamic economic values, such as thrift and responsibility for natural resources.

Furthermore, integrating Islamic values and local wisdom into STEAM projects is also an effective solution. Lecturers guide students to ensure that each learning project incorporates moral, social, and spiritual values relevant to the goals of Islamic education. For example, in creating a teaching aid on the concept of water, students not only discuss the scientific aspects but also relate them to Quranic verses about the creation of water as a source of life. This aligns with Aisyah, (2020) perspective, which emphasizes the importance of integrating Islamic values into every form of educational innovation so that the results are not only academically beneficial but also have religious value.

Based on student reflections, the majority stated that the STEAM learning experience provided new insights into how to become a creative and innovative teacher. They felt better prepared to face the challenges of Islamic elementary education because they were accustomed to thinking across disciplines and finding solutions to limitations. Thus, the application of STEAM not only produces learning outcomes but also shapes the mindset and professional character of prospective teachers.

For program sustainability, it is recommended that institutions provide training and collaboration between lecturers across study programs, for example, between PGMI lecturers and lecturers in science, mathematics, and educational technology education. This collaboration can result in more comprehensive learning designs and strengthen the scientific basis of the STEAM approach. Furthermore, policy support from universities is needed in the form of equipment procurement, training, and incentives for lecturers who implement STEAM-based learning innovations.

Thus, the implementation of the STEAM learning model in the PGMI Study Program at STAI Al Hikmah Tanjung Balai has had a positive impact on improving the creativity, motivation, and competence of prospective elementary school teachers. Although technical and structural obstacles remain, the results of this study indicate that the STEAM model can be effectively implemented in the context of Islamic education by adapting to local values and Islamic spirituality.

Conclusion

This study concludes that the implementation of the STEAM learning model in the PGMI Study Program at STAI Al Hikmah Tanjung Balai not only enhances students' technical creativity but also fosters interdisciplinary thinking that enables them to integrate science, technology, art, and Islamic values into educational practice. The synthesis of findings indicates that collaborative, reflective, and contextual project-based learning experiences are key factors encouraging students to generate original ideas, adapt to challenges, and develop learning innovations with pedagogical and spiritual value. Thus, STEAM is proven not only as a learning method but also as a pedagogical framework that enriches teacher education in Islamic education environments by strengthening 21st-century competencies, fostering creative thinking habits, and internalizing religious values in learning design.

More broadly, this study emphasizes the importance of STEAM as a strategic approach in teacher education to meet the demands of the Industrial Revolution 5.0 era, where teachers are expected to integrate digital literacy, collaborative skills, and value orientation in the learning process. STEAM provides a solid foundation for prospective teachers to not only master teaching materials but also act as innovators capable of designing meaningful learning experiences and facilitating problem-solving through cross-disciplinary integration. In the context of Islamic education, STEAM facilitates a harmonious relationship between science and spirituality, enabling prospective teachers to instill a monotheistic perspective, ethics, and noble character through teaching aids, learning media, and the creative projects they produce.

This study has several limitations that need to be considered in interpreting the results. First, the relatively small sample size and involvement of only one study program limit the generalizability of the findings. Second, limited facilities and technological resources prevented

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some STEAM projects from being optimally developed. Third, the study's limited duration of one semester meant that long-term changes in student behavior could not be fully observed. Therefore, future research should involve a larger and more diverse sample, including other Islamic educational institutions, so that the relevance of the findings can be tested in a broader context.

Furthermore, further research is recommended to explore the long-term effectiveness of the STEAM model, for example through longitudinal studies to observe the development of prospective teachers' creativity and pedagogical competence from semester to semester. Future research could also examine the integration of Re-STEAM (Religion–STEAM) in greater depth to map a conceptual model that enables the systematic integration of science, technology, and Islamic values. Comparative experiments between classes using STEAM and classes using conventional approaches are also essential to more measurably measure pedagogical impacts. Finally, given the central role of technology in STEAM, future research could focus on the development of AR/VR-based media, educational artificial intelligence, or Living Labs, so that the resulting innovations can be more relevant to the needs of 21st-century education.

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