

Review Article

Islamic Educational Thought on STEM (Science, Technology, Engineering, Mathematics): Perspectives and Implementation

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ABSTRACT

This research explores a new paradigm in Islamic educational thought regarding the integration of STEM (Science, Technology, Engineering, and Mathematics). The primary focus is on bridging the dichotomy between religious and secular sciences through an integrative approach grounded in the concept of tauhid (the oneness of God). Through this integration, STEM is seen as a means to comprehend the Ayat Kauniyah (signs of God in the universe), thereby positioning STEM learning as both an act of worship and a means of exploring God's creation. The study also examines the implementation of the I-STEM model developed in Malaysia, which incorporates Islamic principles into STEM education. Although this paradigm shows great potential, significant challenges exist in its implementation, including gaps between philosophical conceptualization and practical application, as well as cultural resistance within certain communities. To address these challenges, initiatives such as the development of contextual teaching materials and teacher training programs have been introduced. The research underscores the importance of developing a STEM curriculum aligned with Islamic ethical values and highlights the contribution of STEM-Islam in character building and social ethics. Thus, integrating STEM into Islamic education can serve as a catalyst for scientific revival in the Muslim world without compromising its religious identity.

Keywords: STEM; Islamic education; science integration

1. INTRODUCTION

Islamic education has played a significant role in shaping the thinking and civilization of Muslims over the centuries. Since the golden age of Islam, Muslim scholars have made significant contributions in various fields of science, including science, technology, engineering, and mathematics. However, along with the development of the times and rapid progress in these fields, new challenges have emerged for the world of Islamic education to remain relevant and able to answer the needs of modern society. One of the approaches that is currently receiving global attention in the world of education is STEM (Science, Technology, Engineering, Mathematics). This approach emphasizes the integration of science, technology, engineering, and mathematics in the learning process, with the aim of preparing learners to face the challenges of the 21st century (Zeid et al., 2019). In the context of Islamic education, STEM integration is an interesting and important topic to study. This is based on the fact that the majority of Muslim countries today face challenges in the development of competitive human resources in the field of science and technology. According to a report by the Organization of Islamic Cooperation (OIC) in 2020, OIC member countries are still lagging behind in the global innovation and scientific production indices compared to developed countries (OIC, 2020). This situation requires critical and innovative thinking in developing an Islamic education system that is able to produce graduates who excel in STEM fields, without putting aside Islamic values and principles.

The Islamic educational approach to STEM is not only limited to the technical aspects of teaching science and technology, but also involves the philosophical, theological, and ethical dimensions. Contemporary Muslim thinkers seek to find a common ground between the teachings of Islam and the development of modern science. They advocate a holistic and integrative approach, in which STEM is not seen as an entity separate from Islamic spiritual and moral values, but rather as a manifestation of the majesty of God's creation and a means to better understand the universe (Hashim & Rossidy, 2020). The implementation of STEM in the context of Islamic education faces various challenges, ranging from limited

resources and infrastructure to cultural resistance and a lack of understanding of the importance of integrating STEM in the curriculum. However, several educational initiatives and models that combine Islamic principles with STEM approaches have begun to emerge in various Muslim countries. For example, in Malaysia, the concept of I-STEM (Islamic Science, Technology, Engineering, and Mathematics) has been developed as an effort to integrate Islamic values into STEM education (Salleh et al., 2019). The importance of examining Islamic educational thinking on STEM is also based on the need to bridge the gap between the classical Islamic intellectual tradition and the demands of the modern world. History records that Islamic civilization was once a center of science and innovation, with great contributions from Muslim scientists in various STEM fields. However, over time, there was a dichotomy between religious science and general science which resulted in a decline in scientific production in the Islamic world. Therefore, efforts to reintegrate STEM with Islamic values are seen as an important step in reviving the scientific spirit in the Islamic tradition (Daneshgar, 2020).

In a global context, discussions on the integration of STEM in Islamic education are also relevant to efforts to achieve the Sustainable Development Goals (SDGs) set by the United Nations. In particular, SDG 4, which focuses on quality education, and SDG 9, which emphasizes innovation and infrastructure, are closely linked to the development of STEM education. Muslim countries, as part of the global community, are required to contribute to the achievement of these goals. Therefore, the development of STEM approaches that are aligned with Islamic values can be a strategic solution in meeting global demands while maintaining cultural and religious identities (Fauzi & Zakaria, 2021). One of the important aspects of Islamic educational thinking about STEM is the concept of monotheism or the oneness of Allah as an epistemological foundation. The monotheistic paradigm views all science as a manifestation of the greatness of Allah, so that there is no dichotomy between religious science and general science. In this context, STEM education is understood as a means to understand the *kauniyah* verses (signs of God's greatness in the universe) more deeply. This approach not only encourages students to master technical skills in STEM fields, but also develops spiritual and ethical awareness in the application of science (Musa, 2022).

The implementation of Islamic educational thinking about STEM also involves the reconstruction of the curriculum and teaching methods. Islamic education experts propose learning models that integrate STEM concepts with Islamic values. For example, in the teaching of mathematics, concepts such as symmetry and patterns can be associated with the art of Islamic geometry and mosque architecture. In the field of science, natural phenomena can be studied not only from an empirical perspective, but also as evidence of the miracles of God's creation. This approach aims to develop a holistic understanding of the universe and the role of humans as caliphs on earth (Rahman et al., 2020). Information and communication technology (ICT) also plays an important role in the implementation of STEM in Islamic education. Rapid developments in ICT are opening up new opportunities for distance learning, access to global educational resources, and the development of innovative learning methods. However, the use of technology in the context of Islamic education also raises ethical and cultural challenges that need to be overcome. For example, how to ensure a balance between the use of modern technology and the maintenance of traditional Islamic values. Several Islamic educational institutions have begun to develop online learning platforms that integrate STEM content with Islamic perspectives, in an effort to answer this challenge (Al-Alwani & Alzahrani, 2020).

In addition, Islamic educational thinking about STEM also emphasizes the importance of character and moral development in the learning process. STEM education is not only seen as a means to produce a skilled workforce, but also to form ethical and responsible individuals. This concept is in line with the main mission of Islamic education, which is the formation of *kamil* people or perfect human beings who have a balance between intellectual, emotional, and spiritual intelligence. In this context, STEM education is seen as a tool to develop critical thinking skills, creativity, and problem-solving, while still upholding Islamic moral and ethical values (Halim & Mohd Salleh, 2021). The implementation of STEM in Islamic education also requires special attention to gender issues. Historically, women's participation in STEM fields in Muslim countries has tended to be low. This is due to a variety of factors, including misinterpretation of religion and gender stereotypes. However, contemporary Islamic educational thought emphasizes the importance of equal access to education for men and women, including in STEM fields. Several initiatives have been launched in various Muslim countries to encourage women's participation in STEM, using an approach that is sensitive to cultural and religious values (Khelifi, 2019). In a global context, Islamic educational thinking about STEM is also related to efforts to overcome environmental challenges and sustainable development. Islam teaches the concept of caliph *fil ardh*, where humans are seen as the guardians of the earth. Therefore, STEM education in an Islamic perspective focuses not only on the development of technology, but also on how it can be used responsibly to preserve the environment and improve the quality of human life. Several Islamic educational institutions have begun to develop programs that integrate STEM with the concepts of sustainability and environmental preservation (Guessoum, 2018).

The implementation of Islamic educational thinking on STEM also involves cooperation between various stakeholders,

including the government, educational institutions, industry, and society. In some Muslim countries, partnerships have been formed between Islamic universities and technology companies to develop STEM curricula that are relevant to industry needs and aligned with Islamic values. This kind of initiative aims to bridge the gap between education and the world of work, while ensuring that graduates have the competencies needed to compete in the global market (Ismail et al., 2022). One of the challenges in the implementation of STEM in Islamic education is the need to develop competent educators. Teachers are not only required to master STEM materials, but also be able to integrate them with Islamic perspectives. Several Muslim countries have begun to develop teacher training programs that focus on the integration of STEM and Islamic values. These programs aim to equip teachers with the knowledge and skills necessary to teach STEM with a holistic approach and in accordance with the context of Islamic culture (Aziz et al., 2020). Islamic educational thinking about STEM also considers the psychological and developmental aspects of students. The approach taken must be in accordance with the child's cognitive and emotional development stage, while still instilling Islamic values. For example, in teaching science to early childhood, basic concepts can be introduced through stories from the Quran and Hadith related to natural phenomena. This approach aims to foster curiosity and love for science from an early age, while strengthening the foundation of faith (Munadi et al., 2021).

In the context of higher education, Islamic thinking about STEM leads to the development of a university model that integrates modern science with Islamic intellectual heritage. Several Islamic universities have begun to develop programs that combine STEM studies with Islamic studies, with the goal of producing graduates who are not only technically competent but also have a deep understanding of Islamic ethics and values. This model is seen as an effort to revive the Islamic scientific tradition that once produced great scientists such as Ibn Sina, Al-Khawarizmi, and Al-Biruni (Hassan et al., 2023). The implementation of STEM in Islamic education also requires a sensitive approach to the local context and cultural diversity in the Muslim world. Each country or region has unique challenges and opportunities in the development of STEM education. Therefore, the developed STEM education model must be adaptable to local needs and conditions, while still maintaining the universal principles of Islam. Several countries have developed "Islamic STEM curricula" tailored to their socio-cultural contexts, in an effort to bridge the gap between modernity and tradition (Noor et al., 2019). Another important aspect of Islamic educational thinking about STEM is the role of research and development. To advance STEM education that is aligned with Islamic values, significant investment in educational research, curriculum development, and pedagogical innovation is needed. Several Islamic research institutions have begun to focus on this area, with the aim of producing knowledge and best practices that can be applied in various contexts of Islamic education. This effort also involves international cooperation and knowledge exchange between Islamic educational institutions around the world (Zulkifli et al., 2022). The implementation of STEM in Islamic education is also closely related to efforts to build a knowledge-based economy in Muslim countries. Many Islamic countries are currently seeking to diversify their economies and reduce their dependence on natural resources. In this context, STEM education is seen as a strategic investment to develop the human resources needed to drive innovation and economic growth. However, the approach taken must ensure that the economic development is in line with Islamic economic principles, such as social justice and sustainable development (Al-Hakim & Susilowati, 2021).

Islamic educational thinking about STEM also considers the role of media and popular culture in shaping perceptions and interest in science and technology. Several initiatives have been launched to develop media content that depicts scientists and engineers. Muslims as a positive role model, especially for the younger generation. This is seen as an effort to overcome negative stereotypes and increase career aspirations in STEM fields among Muslims. Several Muslim countries have begun producing television programs, children's books, and digital content featuring Muslim STEM figures, both historical and contemporary, in an effort to inspire and motivate the younger generation (Shahali et al., 2019). In the context of globalization and the industrial revolution 4.0, Islamic educational thinking about STEM must also consider the latest technological developments such as artificial intelligence (AI), Internet of Things (IoT), and big data. Islamic education needs to prepare students to face an increasingly connected and automated world, while maintaining ethical and spiritual values. Some contemporary Muslim thinkers have begun to explore the ethical and theological implications of these new technologies from an Islamic perspective, and how they can be integrated into the educational curriculum (Alsolami et al., 2021). The implementation of STEM in Islamic education also involves the development of supporting infrastructure and facilities. Many Islamic educational institutions, especially in developing countries, face challenges in terms of the availability of laboratories, equipment, and technology necessary for effective STEM education. Therefore, several initiatives have been launched to develop innovative and cost-effective solutions, such as virtual labs and mobile science kits, that can be used in the context of Islamic education with limited resources (Rahman et al., 2021).

Another important aspect of Islamic educational thinking about STEM is its integration with local wisdom and traditional knowledge. Islam recognizes the value of knowledge that is passed down from generation to generation, and

many traditional practices in Muslim societies have a scientific basis that can be explored through STEM approaches. For example, traditional irrigation techniques, herbal medicine, or vernacular architecture can be a starting point for contextual and culturally relevant STEM learning. This approach not only enriches the learning experience, but also helps preserve cultural heritage and strengthen students' cultural identity (Halim et al., 2020). Islamic educational thinking about STEM also considers the role of spirituality and worship in the learning process. Some Muslim thinkers have proposed an educational model that integrates spiritual practices, such as reflection and dhikr, into STEM learning. This approach aims to develop not only intellectual intelligence, but also spiritual intelligence of learners. For example, in the study of astronomy, the observation of celestial bodies can be associated with the practice of determining prayer times and the direction of the qibla, linking scientific knowledge to the practice of daily worship (Aswirna & Fahmi, 2021). The implementation of STEM in Islamic education must also consider controversial issues and scientific ethics. Some developments in STEM fields, such as genetic engineering or artificial intelligence, raise ethical questions that need to be answered from an Islamic perspective. Therefore, STEM education in the context of Islam needs to include components of ethics and science *fiqh*, which equip students with the ability to assess the moral and spiritual implications of scientific and technological developments (Musa, 2020). In the context of higher education, Islamic thinking on STEM also leads to the development of research models that integrate modern scientific methodologies with Islamic ethical principles. Some Islamic universities have begun to develop research ethics guidelines that not only meet international standards, but also take into account Islamic values such as honesty, integrity, and social responsibility. This approach aims to ensure that STEM research conducted in Islamic institutions is not only scientifically high-quality, but also ethical and beneficial to society (Hassan et al., 2022).

The implementation of STEM in Islamic education also involves the development of holistic evaluation and assessment methods. Traditional approaches that focus solely on written tests and standardized exams are considered insufficient to assess complex STEM competencies, especially when they are linked to Islamic values. Therefore, some Islamic educational institutions have begun to adopt alternative assessment methods, such as project-based assessment, portfolio, and self-reflection, which can capture not only the mastery of STEM materials, but also the development of students' Islamic character and values (Suhendi et al., 2022). Islamic educational thinking about STEM also considers the role of society and family in supporting learning. Islam emphasizes the importance of the role of parents and society in children's education. In the context of STEM, this means involving parents and the community in learning activities, such as community-based science projects or mentoring programs. Several initiatives have been launched to increase STEM literacy among Muslim parents and encourage them to support their children's interest in STEM fields (Asghar, 2020). Another important aspect of the implementation of STEM in Islamic education is the development of 21st century skills such as critical thinking, creativity, collaboration, and communication. These skills are not only essential for success in STEM careers, but they are also in line with Islamic values that emphasize the importance of science, innovation, and cooperation. Therefore, the learning approach used must encourage the development of these skills, for example through project-based learning or collaborative learning (Zulkifli et al., 2021). The implementation of STEM in Islamic education must also consider the needs of students with special needs. Islam teaches the importance of inclusivity and equality in education. Therefore, the STEM approach developed must be able to accommodate the diversity of students' abilities and learning styles. Several Islamic educational institutions have begun to develop inclusive STEM programs that use assistive technology and tailored learning strategies for learners with special needs (Noor et al., 2020).

Islamic educational thinking about STEM also considers the role of non-formal and informal education. Much STEM learning takes place outside of the classroom, through extracurricular activities, science clubs, or self-paced learning. In the context of Islam, this can be associated with the concept of *tholabul 'ilmi* or the search for knowledge as a lifelong obligation. Several initiatives have been launched to develop STEM programs outside of schools that are integrated with Islamic values, such as mosque robotics clubs or Ramadan science camps (Al-Hakim et al., 2021). The implementation of STEM in Islamic education also involves the development of appropriate teaching materials and learning resources. Many of the existing STEM textbooks and learning materials do not consider Islamic perspectives or Muslim cultural contexts. Therefore, several Islamic publishers and educational institutions have begun to develop STEM teaching materials that integrate scientific content with values and examples relevant to Islam. This includes the development of textbooks, online modules, and digital learning resources that combine STEM with Islamic perspectives (Ismail et al., 2023).

In a global context, Islamic educational thinking on STEM is also concerned with efforts to enhance international collaboration and knowledge exchange. Several initiatives have been launched to facilitate cooperation between Islamic educational institutions in different countries in the development of STEM curricula, student and lecturer exchanges, and joint research projects. This effort aims to build STEM capacity in the Muslim world and encourage innovation that is in line with Islamic values (Guessoum, 2020). The implementation of STEM in Islamic education also requires conducive

policy and regulatory support. Several Muslim countries have begun to develop national policies that encourage the integration of STEM in Islamic education curricula, including budget allocations for infrastructure development and teacher training. However, the implementation of these policies often faces challenges, including resistance from conservative groups worried about the "westernization" of education. Therefore, effective dialogue and communication are needed to show that the integration of STEM with Islamic values can strengthen, not weaken, Muslim identity (Salleh et al., 2020). Islamic educational thinking on STEM also considers the role of technology in the preservation and dissemination of Islamic intellectual heritage. Many of the classic Islamic manuscripts and scientific works containing STEM knowledge have not been fully digitized or widely accessed. Several projects have been launched to use digital technologies in preserving, analyzing, and disseminating these works, opening up new opportunities for STEM research and learning inspired by Islamic intellectual heritage (Daneshgar, 2021).

The implementation of STEM in Islamic education also involves the development of an entrepreneurial model that is aligned with Islamic economic principles. Many Muslim countries encourage the development of STEM-based startups and innovations as economic development strategies. However, the entrepreneurial model developed must consider Islamic values such as social justice, risk sharing, and the prohibition of usury. Several Islamic educational institutions have begun to develop STEM entrepreneurship programs that integrate the principles of Islamic economics, aiming to produce innovators who are not only financially successful but also socially responsible (Rahman et al., 2023). In the context of higher education, Islamic thinking about STEM also leads to the development of a research university model that integrates Islamic scientific traditions with international standards in research and innovation. Several Islamic universities have begun to invest in the development of centers of excellence in STEM fields, focusing on areas relevant to the needs of the Muslim world, such as renewable energy technology, halal biotechnology, or geographic information systems for hajj management. This approach aims to position Islamic higher education institutions as key players in the global landscape of STEM innovation (Hassan et al., 2021).

The implementation of STEM in Islamic education must also consider the social and ethical implications of technological developments. For example, the use of big data and artificial intelligence in decision-making raises questions about privacy, fairness, and accountability that need to be answered from an Islamic perspective. Therefore, STEM education in the Islamic context needs to include components of digital literacy and technological ethics, which equip students with the ability to assess and respond to ethical challenges arising from technological innovation (Alsolami et al., 2022). Thus, Islamic educational thinking about STEM encompasses a variety of complex and interrelated aspects. Starting from philosophical reinterpretations of the relationship between Islam and science, the development of integrative curricula and teaching methods, to ethical and social considerations in the implementation of technology. This holistic approach aims to produce a generation of Muslims who are not only competent in STEM fields, but also have strong character and high ethical awareness. Through the integration of STEM with Islamic values, it is hoped that Islamic education can play an important role in preparing Muslims to face the challenges of the 21st century, while still maintaining their cultural and spiritual identity. However, the implementation of this vision still faces various challenges, ranging from limited resources to cultural resistance. Therefore, close collaboration is needed between various stakeholders, including governments, educational institutions, industry, and civil society, to realize the full potential of STEM integration in Islamic education.

2. RESEARCH METHOD

This study adopts a qualitative approach by applying a systematic literature study method to examine Islamic educational thinking about STEM and its implementation. The data collection process involves a comprehensive search of relevant journal articles, books, research reports, and policy documents from leading databases such as Scopus, Web of Science, ERIC, and Google Scholar. The inclusion criteria applied include publications in the 2018-2023 range, in United Kingdom or Indonesia, with a primary focus on the integration of STEM in the context of Islamic education. Data analysis was carried out through thematic coding to identify key themes, followed by in-depth content analysis to explore various perspectives and forms of STEM implementation in Islamic education. Narrative synthesis is then used to integrate findings from diverse sources, providing a comprehensive overview of the topic being researched. As a theoretical framework, this study uses the science and religion integration model developed by Ian Barbour, and applies the *Maqasid al-Shariah* approach to evaluate the relevance and impact of STEM implementation in the context of Islamic education. To ensure the validity of the data and increase the credibility of the analysis, this study applies source triangulation and involves peer review by experts in the field of Islamic education and STEM. The entire research process is carried out by adhering to the principles of research ethics, including proper citation and avoiding all forms of plagiarism. Through this methodology, the research aims to produce a comprehensive analysis of Islamic education thinking related to STEM, as

well as identify best practices and challenges in its implementation, making a significant contribution to the development of STEM integration in Islamic education.

3. RESULTS AND DISCUSSION

STEM Integration Paradigm in Islamic Education

The results of the study show that there is a paradigm shift in Islamic education thinking about STEM. There are significant efforts to integrate STEM with the Islamic worldview, overcoming the traditional dichotomy between religious and general sciences that once dominated the discourse of Islamic education. Contemporary Muslim thinkers, such as Nidhal Guessoum and Osman Bakar, advocate an approach called "Islam and Science Reconciliation" or "Islamic Science Integration" (Guessoum, 2018). The concept of monotheism (the oneness of Allah) is the epistemological foundation in the integration of STEM with Islamic education. This paradigm views the universe as *kauniyah* verses that reflect the greatness of Allah, so studying STEM is considered a form of worship and exploration of His creation (Moses, 2022). This approach is in line with the "Integration" model in Ian Barbour's typology of the relationship between science and religion.

The implementation of this integration paradigm can be seen in the development of curriculum and learning models that combine STEM with Islamic values. One of the prominent models is I-STEM (Islamic Science, Technology, Engineering, and Mathematics) developed in Malaysia (Salleh et al., 2019). This model integrates Islamic principles into STEM learning, for example by using stories from the Quran and Islamic history as the context for science and mathematics learning. However, the implementation of this integration paradigm still faces various challenges. First, there is a gap between philosophical conceptualization and practical operationalization. Many Islamic educational institutions have difficulty translating abstract concepts of integration into daily learning practices. Second, there is resistance from some groups who are worried that STEM integration will threaten traditional Islamic values.

To address these challenges, several initiatives have been launched. For example, the development of teaching materials that explicitly link STEM concepts to Islamic teachings, as well as teacher training programs that focus on STEM-Islamic integration methodologies. The International Islamic University of Malaysia (IIUM) has developed an "Islamization and Integration of Knowledge" model applied in their STEM curriculum (Hashim & Rossidy, 2020). This integration paradigm also has an impact on ethical and social aspects in STEM education. There is a growing awareness of the need to develop an Islamic ethical framework in STEM research and innovation. Concepts such as "Islamic Bioethics" and "Islamic AI Ethics" began to be developed and integrated into the Islamic higher education curriculum (Musa, 2020). This shows that STEM-Islamic integration is not only about technical mastery, but also about the formation of character and ethical values that are in harmony with Islamic teachings.

Implementation and Challenges of STEM in the Context of Islamic Education

The implementation of STEM in the context of Islamic education faces various challenges as well as opportunities. The results show that despite the increasing awareness of the importance of STEM, many Islamic educational institutions still face obstacles in their implementation. One of the main challenges is the limitation of resources and infrastructure. Many schools and madrasas, especially in rural areas or low-income Muslim countries, lack the laboratory facilities and equipment necessary for effective STEM learning. To address this, several innovative initiatives have been developed, such as the use of virtual laboratories and affordable mobile science kits (Rahman et al., 2021). Teacher competence is also a key factor in the success of STEM implementation. Several studies reveal a gap between teachers' conceptual understanding of STEM-Islam integration and their ability to implement it in the classroom (Aziz et al., 2020). To overcome this, various teacher professional development programs have been launched, such as Professional Development for Islamic STEM Teachers (PDIST) in Indonesia, which aims to improve teachers' competence in integrating STEM with Islamic values.

The adoption of technology in the implementation of STEM in Islamic educational institutions also shows a positive trend. Several Islamic universities have developed STEM-based distance learning programs and adopted technologies such as AI and VR in the learning process (Al-Alwani & Alzahrani, 2020). However, the adoption of this technology also raises new challenges, such as the digital divide and the need to ensure that the use of technology is aligned with Islamic values. Gender and inclusivity issues in STEM are also a concern in the context of Islamic education. There is a significant gender gap in STEM participation in many Muslim countries. To overcome this, various initiatives have been launched, such as the "Muslim Women in STEM" program which aims to encourage women's participation in STEM fields (Khelifi, 2019). In addition, there are efforts to develop inclusive STEM education that accommodates students with special needs in Islamic

schools (Noor et al., 2020).

The implementation of STEM in Islamic education is also closely related to efforts to build a knowledge-based economy in Muslim countries. Many Islamic countries are currently encouraging the development of STEM-based startups and innovations as economic development strategies. However, the entrepreneurial model developed must take into account Islamic values such as social justice and business ethics. Several Islamic universities have begun developing STEM entrepreneurship programs that integrate Islamic economic principles (Rahman et al., 2023). Another challenge in the implementation of STEM is the need to develop learning materials that are contextual and relevant to the socio-cultural realities of Muslim society. Several initiatives have been undertaken to integrate local wisdom and traditional Islamic knowledge into STEM learning. For example, the use of traditional Islamic architectural techniques in geometry learning, or the exploration of Islamic herbal medicine practices in biology lessons (Halim et al., 2020).

4. CONCLUSION

The implementation of STEM in the context of Islamic education shows positive development, with various innovative initiatives that have been launched. However, there are still significant challenges that need to be overcome, ranging from limited resources to social and cultural issues. A holistic and collaborative approach, involving various stakeholders, is needed to develop an effective and sustainable STEM-Islamic education model. Thus, the integration of STEM in Islamic education can be a catalyst for a scientific awakening in the Muslim world, while still maintaining Islamic values and identity.

RECOMMENDATIONS

First, there needs to be further efforts to address the gap between philosophical conceptualization and practical implementation of STEM-Islamic integration. This can be done through the development of contextual and explicit teaching materials that link STEM concepts to Islamic values, as well as intensive training for teachers to better understand integration methodologies. **Second**, limited resources in educational institutions, especially in rural areas, can be overcome with innovations such as virtual laboratories and affordable mobile science kits. In addition, governments and educational institutions must increase investment in infrastructure and technology that supports STEM learning. **Third**, inclusivity efforts in STEM education must be strengthened with programs that encourage the participation of women and students with special needs. Programs like "Muslim Women in STEM" need to be expanded and adopted in more Muslim countries. **Finally**, the development of the STEM curriculum should take into account Islamic ethical values, such as social justice and entrepreneurship based on Islamic economic principles, so that STEM education not only focuses on technical aspects but also on the formation of Islamic character.

AUTHOR'S CONTRIBUTIONS

All authors discussed the results and contributed to from the start to final manuscript.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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