Integration of Science, Technology, Engineering, and Mathematics (STEM) in Islamic Education Using Strategic Assumption Surfacing and Testing (SAST)

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Abstract

Islamic education has undergone a significant transformation with the development of technology. Technology has a major impact on the development of Islamic Education in the form of the use of technology in learning, both by educators, students, and the development of teaching materials. The need for technology in Islamic Education is increasingly strengthened by the demands of 21st-century learning and sustainable development goals, in a multidisciplinary context. Science, Technology, Engineering, and Mathematics (STEM) is a multidisciplinary approach that is integrated with technology, which is used as an alternative for achieving the institutional vision of a state Islamic university to support graduate learning outcomes. Therefore, it is necessary to formulate a strategy to strengthen the institutional vision that develops Islamic scholarship, science, and technology in an integrated manner. The purpose of this research is to provide recommendation strategies to policymakers for improving the quality of Islamic Education in Indonesia. The Strategic Assumption Surface and Testing (SAST) method were adopted in this study through focus group discussions and interviews with selected experts, which included 2 experts and 8 educators. The results of the assumptions are grouped according to the level of importance and certainty in the quadrant graph. This study found that there were 25 strategic assumptions that were formulated to increase the achievement of integrated learning outcomes with Science, Technology, Engineering, and Math (STEM). The results of the SAST method classify strategic assumptions into 4 quadrants. There are 15 items that assume the strategy is at a high level of importance and certainty in quadrant 1 and are a priority for implementation. This research has limitations in determining the priority of assumptions to be applied. Further research is recommended to carry out weighing and ranking in selecting the best strategic assumptions by policymakers.

Keywords
Integration, Islamic Education, STEM, Learning Outcomes, SAST

1.Introduction

Islamic education in Indonesia is undergoing a profound transformation to address the challenges of changing times. This transformation encompasses various aspects of Islamic education, including curriculum development, teaching methods, infrastructure enhancement, technological integration, management, and the enhancement of human resources quality. The ultimate goal is to produce graduates who are well-equipped to navigate the complexities of the modern world while upholding Islamic values. The demands of the 21st century have ushered in new requirements for Islamic education, including critical thinking, problem-solving abilities, creativity, innovation, effective communication skills, and technological proficiency (Joke M. Voogt 2023).

State Islamic Universities (UIN) are higher education institutions characterized by their Islamic foundations and government mandates, through the Ministry of Religion, to advance Islamic studies with an integrative and interconnected approach. This approach aims to meet the demands of scientific and technological advancements by integrating Islamic principles with various scientific clusters and fostering the development of high-quality human resources (Directorate of Islamic Religious Higher Education, Directorate General of Islamic Education, 2019).

The concept of knowledge integration stems from the notion that there has been a historical separation (dichotomy) between religious sciences and other fields of study (Aidil Ridwan Daulay and Salminawati, 2022). All State Islamic Universities in Indonesia have embraced this concept as a mandate to adopt a holistic and comprehensive approach to knowledge. To fulfill this curriculum mandate, foundational courses are designed to offer students, regardless of their majors, a comprehensive introduction to Islamic traditions and scholarly contributions. The pedagogical approach in teaching aspects of Islamic science should be comprehensive and holistic, given that students are simultaneously studying disciplines previously considered "unrelated" to Islam, such as science, technology, engineering, art, mathematics, and others. The curriculum structure is oriented toward cultivating competencies aligned with educational levels and is effectively designed to meet the requirements of scientific and technological advancements while supporting knowledge integration in accordance with the university's vision. Furthermore, the curriculum is designed to be comprehensive, competitive, flexible, and adaptable to changing scientific and technological landscapes, all while embodying the principles of knowledge pursuit in Islam.

Science, Technology, Engineering, and Mathematics (STEM) represent a multidisciplinary approach integrated with technology that serves as an alternative means to achieve the goals of Islamic education at State Islamic Universities. The STEM approach emphasizes interdisciplinary learning, where science, technology, engineering, and mathematics concepts are applied in practical contexts. This approach aims to deepen students' understanding of science and technology while enhancing critical thinking, problem-solving, and creativity (Hafni et al. 2020). Consequently, students are expected to possess a foundational grasp of mathematics, science, and information and communication technology, along with proficiency in utilizing digital tools for learning.

The integration of Science, Technology, Engineering, and Mathematics (STEM) into Islamic education holds tremendous potential to enhance learning effectiveness, expand educational access, and provide students with more interactive and relevant learning experiences. However, the incorporation of STEM should be executed thoughtfully, with a focus on maintaining religious and ethical values as the primary guiding principles. As STEM serves as an alternative means to realize the institutional vision of State Islamic Universities, which involves advancing Islamic knowledge, science, and technology in an integrative manner, it is imperative to devise a strategic framework to fortify this institutional vision.

1. Literature Review

The integration of Islamic education with a STEM (Science, Technology, Engineering, and Mathematics) approach represents an endeavor to meld Islamic values, teachings, and ethics with STEM-based learning. Islamic education imparts knowledge about Allah's creation and fosters an understanding that scientific and technological innovations are expressions of Allah's creativity. This perspective underscores the significance of environmental conservation and the responsible stewardship of natural resources. This approach fosters a holistic educational environment that not only aids students in developing scientific and technological acumen but also cultivates a profound comprehension of Islamic principles and the application of ethical values in the realms of science and technology.

As emphasized by (Ramli & Ibrahim 2017), the integrated STEM approach to Islamic education, particularly within the context of the Al-Qur'an, aims to produce individuals who are adept at harmonizing STEM within a scientific framework and an Islamic context. STEM education frequently employs problem-based projects as a pedagogical method. In this context, these projects are thoughtfully designed to address societal issues or challenges that align with Islamic teachings and values. For instance, students may be tasked with identifying technological solutions that align with Islamic ethics to tackle prevailing social concerns.

Furthermore, the integration of Islamic education into STEM underscores the paramount importance of ethics in the development of technology and science. Students are instilled with principles such as honesty, fairness, and benevolence that must be upheld in all their STEM endeavors. STEM learning materials can be presented within the context of Islamic religious teachings, enabling students to perceive the interconnectedness between science, technology, and their religious convictions. For instance, when studying natural sciences, students can gain insight into how the universe's creation aligns with Islamic beliefs.

This alignment of STEM education with Islamic values resonates with the overarching goal of transforming Islamic higher education into a State Islamic University (UIN). This transformation necessitates a shift in scientific thinking, one that forges a novel scientific paradigm by seamlessly integrating Islamic sciences with the natural and social sciences (Khozin and Umiarso 2019).

The integration of Islamic education with STEM can encompass the development of an integrated curriculum that seamlessly blends STEM concepts with Islamic religious teachings, creating a more immersive learning experience. Research by (Rusydiyah et al. 2021) focused on science education students and revealed that the curriculum of science education programs must incorporate a STEM learning environment approach to enhance teaching abilities.

In STEM education, technology frequently serves as a learning tool. The fusion of Islamic education with STEM can involve the creation of digital resources and technology applications that meld Islamic concepts with STEM learning. As articulated by (Hamzah et al. 2019), technology's presence offers opportunities for the widespread dissemination of Islamic knowledge. For instance, the development of a prayer learning application for the Android platform can aid parents and children in learning to pray independently.

In response to the challenges posed by globalization, Islamic education in Indonesia contributes in two significant categories: character formation, encompassing qualities like good human character, spiritual character, and militancy character, as suggested by (Tolchah & Mu'ammar 2019). Consequently, one strategic approach for Islamic education in the era of globalization is the utilization of information technology as a medium to effectively introduce the public to the values of Islamic education.

Students can be encouraged to participate in discussions addressing the ethical dimensions of STEM research and innovation, fostering an understanding of social responsibility in technological development. Beyond STEM skills, students should also be cultivated in terms of character and leadership guided by Islamic values, including the development of skills such as fair leadership, discretion, and collaboration.

Effective integration necessitates collaboration between religion teachers and STEM educators to design appropriate curricula and engage students in meaningful learning experiences. By amalgamating Islamic and STEM education, students can develop a comprehensive comprehension of the roles of technology and science in society, all while upholding their religious values. This approach cultivates graduates who are not only proficient in STEM disciplines but also committed to ethical and moral values, aligning with Indonesia's education objective of shaping well-rounded individuals.

In Indonesian education, achieving a balanced development across cognitive, affective, psychomotor, and religious domains is paramount. Religion is an integral component of personality development, as humans in this world live and worship God. Science learning involves exploring, examining, expressing, and understanding natural environmental phenomena, structures, and functions, which are then brought into the classroom as learning activities grounded in established scientific principles. This scientific activity is intrinsically linked to the reverence for the Creator's greatness in nurturing students' character (Abdulkadir Rahardjanto and Retno Susilowati 2018).

In light of these considerations, the integration of STEM with Islamic education assumes great significance. The sustainable implementation of this integration in higher education demands thorough analysis, and one strategic analysis tool employed is Strategic Assumption Surfacing and Testing (SAST).

2. Methodology

In order to address the prevailing issues, this research employs a qualitative descriptive approach. A qualitative methodology is instrumental in generating pertinent and quantifiable solutions (Rashid et al. 2019). Through Focus Group Discussions (FGD) and interviews with professionals and academics, this study endeavors to document and gather foundational premises pertaining to strategies for enhancing the integration of Science, Technology, Engineering, and Mathematics (STEM) within the context of Islamic education. This approach simplifies the identification of crucial assumptions that underpin plans, programs, or strategies.

Ten experts in the field were selected based on criteria encompassing expertise, accessibility, reputation, and experience. These experts were invited to complete the Strategic Assumption Surfacing and Testing (SAST) questionnaire. The selection of experts who possess domain knowledge adheres to the principles of objective-based sampling (Campbell 2020). Respondents were asked to provide their opinions, attitudes, or feelings regarding the discussed issue by employing a Likert scale ranging from 1 to 7 (ranging from "Not Important/Uncertain 1" to "Very Important/Very Certain 7").

Subsequently, the ranking results from the ten experts were used to determine the mode, which represents the most frequently appearing values. The level of importance was plotted on the X-axis, while the level of certainty was plotted on the Y-axis. The culmination of the SAST analysis results in the creation of a SAST quadrant graph and an assumption assessment graph.

3. Data Collection

Data were collected through Focus Group Discussions (FGDs) and interviews conducted with experts in their respective fields. The respondents included two teams of academic experts and eight individual academics. The outcomes of the FGDs and interactions with domain experts generated assumptions pertaining to strategies aimed at reinforcing the integration of Science, Technology, Engineering, and Mathematics (STEM) in Islamic education. The discussions yielded a total of 25 strategies, which were subsequently coded for clarity and presented in graphical form by a team of experts and academics.

Table 1 displays the strategic premises associated with variables relevant to enhancing the integration of Science, Technology, Engineering, and Mathematics (STEM) in Islamic education. Subsequently, pairwise comparisons were conducted among the elements, assuming that a solution to the existing problem had been identified. The relevance and confidence levels of each assumption were determined by examining the mode value of each respondent's assessment.

Table 1. Strategy Assumptions for Strengthening the Integration of Science, Technology, Engineering, and Mathematics in Islamic Education.

No	Assumptions
A1	There is a connection between Islamic knowledge and real life so that it is useful.
A2	There is a system that coordinates between Islamic and STEM clusters to make it easier to implement
A3	The importance of using technology in implementing Islamic knowledge to create integrative learning according to the 21st century education framework
A4	Islamic science requires an adaptive and flexible curriculum so that it is in accordance with the times
A5	Graduate competencies lead to digital skills to suit the demands of 21st century education

No	Assumptions
A6	In order to achieve learning, there needs to be interdisciplinary expertise to form a comprehensive/integrated mindset
A7	Intensify communication, information and education actions in the STEM field so that lecturers' knowledge increases
A8	Building an integration study center as a research and development center to improve science and technology
A9	Building and creating human resources with expertise in the STEM field by conducting training in every field of Islamic knowledge
A10	Universities play a role in strengthening the role of STEM integration into the Islamic sciences as quality control
A11	Understand how to structure STEM learning using learning guides/modules so you can implement it correctly
A12	Understand how to use the engineering design process to solve pedagogical problems
A13	Using the STEM framework as a way to understand and design integrated STEM learning
A14	There is socialization or refreshment regarding the integration of Islamic knowledge with STEM to provide a comprehensive understanding to academics
A15	Affirm and promote the obligation to integrate STEM by implementing a punishment system for those who do not so that implementation can be realized according to the guidelines
A16	Universities provide guidance and assistance to lecturers regarding the implementation of STEM integration to provide a common perception in its implementation
A17	Create clear and easy to understand regulations for lecturers in implementing STEM integration so that implementation is more systematically controlled
A18	Making the integration of STEM in Islamic science learning a value excellence in institutions
A19	Create STEM-based Islamic science teaching materials as an implementation guide so that implementation is directed
A20	Building a network between Islamic science lecturers in STEM integration so that integration connectivity can be mapped
A21	There is a mapping of each science study material within the STEM framework with the Islamic sciences so that integration is clearly visible
A22	Making the integration of STEM with Islamic knowledge as one of the options in the integration model in institutions stipulated in regulations so that implementation is systematic
A23	Through the integration of STEM with Islamic scientific knowledge, one can increase faith in Allah SWT
A24	Through the integration of STEM with Islamic scientific knowledge, one can increase faith in Allah SWT
A25	Learning is more meaningful through the construction of knowledge through the integration of STEM with Islamic scientific knowledge thereby increasing faith

4. Results and Discussion

To ascertain the level of importance and certainty associated with each assumption, the most frequently appearing value from each respondent's assessment of the assumptions depicted in the graph was determined. Details related to being "very important," "very certain," "very unimportant," and "very uncertain" were categorized into four quadrants. According to the aggregate assessment of respondents, ten strategic assumptions, including A1, A3, and A6, obtained a level of importance and certainty of seven (7:7) or resided in quadrant 1. This signifies that these strategic assumptions represent ideal conditions or absolute prerequisites for enhancing strategies aimed at bolstering the integration of Science, Technology, Engineering, and Mathematics (STEM) in Islamic education.

Conversely, strategic assumptions A5, A8, A16, A17, A20, and A21 attained an importance level of 7 and a certainty level of 6 (7:6), while assumptions A2, A4, A7, A9, A10, A11, A12, A13, A14, A15, A18, A19, A22, A23, A24, and A25 achieved a level of importance and certainty at 6:6. The placement of these 25 assumptions within each quadrant is illustrated in Figure 1.

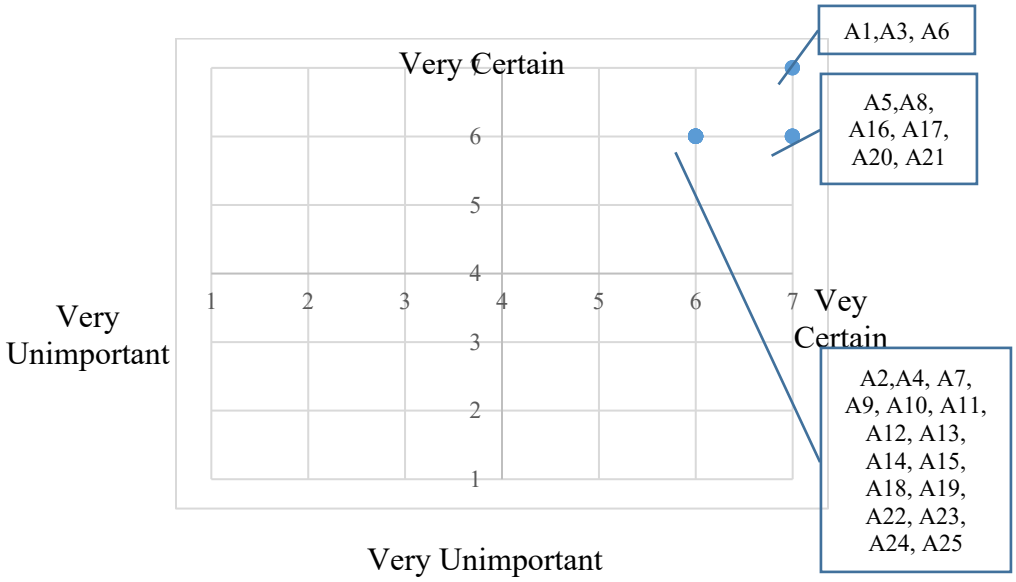

Figure 1. Graph of Strategic Assumptions for Enhancing Strategies to Strengthen the Integration of Science, Technology, Engineering, and Mathematics (STEM) in Islamic Education

Strategic assumptions with a value of (7:7) constitute the highest priority and must be implemented to achieve the research objectives. These assumptions include:

1. The assumption that there is a connection between Islamic science and real-life applications, making its usefulness tangible.
2. The significance of incorporating technology in the implementation of Islamic knowledge to foster integrative learning aligned with the educational framework of the 21st century.
3. The necessity for interdisciplinary expertise in achieving comprehensive and integrated mindsets in learning.

Additionally, there are strategic assumptions with an importance level of (7) and a certainty level of (6), located in quadrant 1, which represents the second-highest priority assumptions after those with a level of importance and certainty of (7:7). These two strategic assumptions encompass:

1. The cultivation of graduate competency with digital skills that align with the demands of 21st-century education.
2. The establishment of an integration study center as a hub for research and development to advance science and technology.

3. Universities providing guidance and support to lecturers regarding the implementation of STEM integration to establish a shared understanding of its implementation.
4. The creation of clear and easily understandable regulations for lecturers to ensure systematic control over STEM integration.
5. The establishment of a network among Islamic science lecturers involved in STEM integration to map integration connectivity.
6. The mapping of each science study material within the STEM framework to the Islamic science cluster to enhance the visibility of integration.

5. Conclusion

The application of the Strategic Assumption Surfacing and Testing (SAST) method in this research has successfully categorized pertinent strategic assumptions aimed at enhancing strategies for reinforcing the integration of Science, Technology, Engineering, and Mathematics (STEM) in Islamic education. A total of 25 strategic assumptions have been delineated, distributed across quadrant 1, as per this method. Consequently, decision-makers can consider these strategies for augmenting the integration of STEM in Islamic education based on the importance and certainty levels associated with each assumption.

Furthermore, this study has identified nine key strategic assumptions. Nevertheless, it is essential to acknowledge that this research faces limitations in determining the prioritization of these assumptions. Therefore, it is recommended that future research incorporates weighting and ranking mechanisms to select the most suitable strategic assumptions for proposing to policymakers. These efforts aim to enhance strategies for strengthening the integration of Science, Technology, Engineering, and Mathematics (STEM) in Islamic education at the Islamic University of Riau Province.

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