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## Humanizing STEM-Based Learning (Science, Technology, Engineering, and Mathematics) for the Transformation of Islamic Education in the 21<sup>st</sup> Century

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### Abstract \_

Development and progress over time always demands change and innovation, including in the education sector and Islamic education learning approaches. The aim of this research is to discuss theoretically and practical findings regarding integrated learning, namely Science, Technology, Engineering, Mathematics (STEM) learning innovations in Islamic education lessons. The method used in this research is a type of qualitative research with a literature review approach, reviewing and analyzing various literature sources related to the research topic you want to research. The research results show that Islamic education learning that is integrated with STEM-based learning can use learning approaches: (1) Problem Based Learning; (2) Project Based Learning; (3) Inquiry-Based Learning; (4) Game Based Learning; (5) Digital Based Learning; (6) Collaborative Learning; (7) Hands on Learning.

**Keywords:** *STEM Based Learning; Islamic education; 21st Century Education*

### Abstract

The development and progress of time always requires changes and innovations, including in the field of education and Islamic Education learning approach. The purpose of this research is to discuss theoretical and practical findings about integrated learning, namely Science, Technology, Engineering, Mathematics (STEM) learning innovation in Islamic Education. The method used in this research is a type of qualitative research with a literature review approach, examining and analyzing various sources of literature related to the research topic to be studied. The results showed that Islamic education learning that is integrated with STEM-based learning can use a learning approach: (1) Problem Based Learning; (2) Project Based Learning; (3) Inquiry-Based Learning; (4) Game Based Learning; (5) Digital Based Learning; (6) Collaborative Learning; (7) Hands on Learning.

**Keywords :** *STEM-based Learning; Islamic Education; 21st Century Education*



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## INTRODUCTION

Mastery of science and technology is an important key in facing global competition. Education has been developed in various approaches or methods to improve the quality of education. One approach that is considered effective is using a STEM-based learning approach.

It is not the strongest who wins, it is not the biggest who survives, but the one who is able to adapt who will emerge victorious. (Charles Darwin) Times continue to change and develop, with various problems that are increasingly complex and difficult to predict. Learning models and educational approaches need to adapt to the needs of the times. The curriculum that is created and designed, especially Islamic education learning, must be able to adapt and suit the demands of the times.

As is known, Islamic education learning has so far been limited to teaching in the form of symbols and memorization alone. Islamic education learning is carried out in a *stand-alone*, conventional manner, not integrated with elements of science, technology, engineering, art and mathematics.

This model is outdated, not applicable and places students as mere learning robots. Whether we admit it or not, learning with this approach will not be able to stimulate students' reasoning and critical powers; unable to change students' thinking paradigm from conceptual to contextual; and keeps students distant from existing reality. It is not surprising that they are not friendly with the environment in which they are located.

It is very important to change the paradigm of Islamic education where Islamic education learning can no longer stand alone, but must be manifested in every aspect of life. Teaching Islamic education must be able to adapt to the progress and developments of the times.

Today's Islamic religion must be able to incorporate science into religious education, and vice versa. This is in line with the spirit of Islamization of education which was *trendy* some time ago. The integration of science and technology is in line with the spirit of learning which is based on the concept of character education which is the identity of a nation.



Therefore, STEM ( *Science, Technology, Engineering, and Mathematics* ) education can be a solution to improve mastery of science and technology. STEM integration has been a field of interest since it was first introduced. This is because STEM integration can help students understand the concepts of science, technology, engineering and mathematics better. (Simbolon, 2019) The main focus of STEM education is to prepare future generations with the skills necessary to face the increasingly complex challenges of the future.

STEM is a new innovation in United States education developed by the National Science Foundation (NSF) in the 2000s. STEM education is increasing rapidly in Indonesia, especially through the SEAMEO Center for Qitep initiative in 2013. (Pratiwi, 2022) Since 2013, the SEAMEO Center for QITEP has introduced STEM education in Indonesia. According to Triyatna, the introduction activities are through teacher training, school principal training, and other policy discussions. (Doringin & Sapoetra, 2020)

STEM seeks to resolve two discrepancies ( *gaps* ) between school education and skills in the world of work. The first mismatch is the difference between the subjects taught in school and the skills required in the world of work, such as oral and written language deciphering, problem solving, project management, critical thinking, and interpersonal skills. Second, employment opportunities in STEM fields continue to grow rapidly while there are few students interested in STEM fields.

Meanwhile, STEM learning is a learning approach that integrates and modifies science, technology, engineering and mathematics education into a cohesive learning paradigm. (Roehrig et al., 2021) The goal of STEM learning is to provide students with a comprehensive understanding of a subject and its practical application in real-world scenarios. STEM learning aims to develop students' critical thinking, problem solving, and analytical skills, as well as their creativity and innovation. (Tan & Lee, 2022) The integration of STEM subjects into the curriculum is intended to prepare students for future careers in STEM fields and to respond to the increasing demand for STEM-literate individuals in the world of work. (Branscum et al., 2020)

Previous research related to Islamic education learning innovations is as follows: e-learning innovations in Islamic education can enable students to learn actively and creatively, (Lubis & Yusri, 2020) Islamic education learning innovations can be implemented through multi intelligences, (Nurhidayati, 2015 ) Islamic education learning innovation can be applied through contextual learning models in improving higher thinking, (Hidayat & Syahidin, 2019)



Islamic education learning innovation can be applied through blended cooperative learning in improving student learning outcomes, (Irsyadiah & Rifa'i, 2021) learning innovation Islamic education is more optimal by using visual learning media to help teachers explain Islamic education subject matter to students at school. (Maryam et al., 2020) Based on the explanation of previous research that Islamic education learning innovation is an updated learning style that is more fun, easier and able to encourage students to learn better, but from this research the author emphasizes his research on STEM learning innovation in educational learning Islam is considered very unique and interesting to discuss, because in STEM learning innovation there is a process of integrating general knowledge, science, religion and technology well.

## **RESEARCH METHODOLOGY**

The method used in this research is a type of qualitative research with a *literature review approach*. *Literature review* is a research method that is carried out by reviewing and analyzing various literature sources related to the research topic you want to research. (Andriani, 2022) The choice of this research method was because the researcher made every effort to carry out a synthetic analysis of Islamic education, which could then be integrated into a STEM ( *Science, Technology, Engineering, and Mathematics* ) based learning approach.

In conducting a *literature review*, researchers must select literature sources that are relevant to the research topic and then review and analyze these literature sources systematically and critically. *The literature review* method can provide a more comprehensive and in-depth picture of the research topic you want to research.

The steps used in *literature review research* include: (1) Topic identification; (2) Literature Search; (3) Literature Selection; (4) Literature Analysis; (5) Literature Synthesis; (6) Writing Reviews, and; (7) Evaluation and Editing. (Ridwan et al., 2021) (Anggreni & Services, 2022)

## **RESULTS AND DISCUSSION**

### **STEM-Based Learning Approach**

One of the new learning approaches that emerged in the Industrial Revolution Era 4.0 is the STEM approach, which is an acronym for Science, Technology, Engineering and Mathematics. STEM was founded in the United States (US) and is a problem-based learning approach that combines these four disciplines. STEM applies knowledge and skills simultaneously to solve cases.



This approach is defined as learning that combines four disciplines, namely Science, Technology, Engineering and Mathematics, with a focus on a learning process that explores two or more fields that actively involve students. (Izzati et al., 2019) In addition, Roberts and Bybee argue that the four fields of science integrated in STEM must function as a holistic unit. (Bybee, 2013) (Roberts, 2012)

It should be noted that the NSF (National Science Foundation) was the first to use the term "STEM". The basic definitions of each word are: *First* , Science: is a field of science that studies facts, phenomena and natural regularities. *Second* , Technology: created as innovation, change and modification of the natural environment that meets human needs and desires.

*Third* , Engineering: consists of determining the problem (asking), imagining, designing (planning), creating, and developing (improving). Engineering is a profession in which scientific and mathematical knowledge is acquired through study, experimentation, and practice or applied to operate or design problem-solving procedures to meet human needs. *Fourth* , Mathematics: is a branch of discipline that studies patterns or relationships. (Mulyani, 2019)

Meanwhile, the following is a table that shows the definition of STEM literacy in four related fields of study:

**Keterkaitan Empat Disiplin Ilmu STEM**

<i>Science</i>	Literasi ilmiah: kemampuan dalam menggunakan pengetahuan ilmiah dan proses untuk memahami dunia alam serta kemampuan untuk berpartisipasi dalam pengambilan keputusan untuk mempengaruhinya.
<i>Technology</i>	Literasi teknologi: pengetahuan bagaimana menggunakan teknologi, memahami bagaimana teknologi baru dikembangkan dan memiliki kemampuan untuk menganalisis bagaimana teknologi baru mempengaruhi individu, masyarakat, bangsa, dan dunia.
<i>Engineering</i>	Literasi desain: pemahaman tentang bagaimana teknologi dapat dikembangkan melalui proses rekayasa/desain menggunakan tema pelajaran berbasis proyek dengan cara mengintegrasikan dari beberapa mata pelajaran.
<i>Mathematic</i>	Literasi matematika: kemampuan dalam menganalisis alasan dan mengkomunikasikan ide secara efektif dan dari cara bersikap, merumuskan, dan menapsirkan solusi untuk masalah matematika dalam menerapkan berbagai situasi berbeda.

As explained by Torlakson, the four components of STEM are, Science ( *science* ) teaches students about the laws and concepts that apply in nature;



Technology is a *skill* or system used to organize society, organizations, knowledge or design as well as using artificial tools that make work easier; Engineering is *the* knowledge to operate or design procedures to solve problems; Mathematics teaches students about the laws *and* concepts that apply in nature. If all STEM components are combined, students will be able to solve problems more thoroughly or comprehensively. And if all these elements are included in the learning process, then the knowledge and learning experience will become more meaningful. (Torlakson, 2014)

### **STEM-Based Learning Orientation**

The term STEM is a slogan used for educational reform in the United States in the 21st Century, which means to increase the nation's competitiveness. 21st Century Education must motivate and inspire students to enter the fields of science and technology (fields of work that directly drive economic growth). 21st Century Learning must also improve students' ability to collaborate, solve problems, be creative, innovative, and design solutions to various problems. (Alirahman, 2021)

The goal of STEM education, according to Bybee, is for students to be STEM literate so they are expected to have:

1. Knowledge, attitudes and skills to identify questions and problems in life, explain natural phenomena, design and draw conclusions based on evidence regarding STEM-related issues
2. Understand the characteristic features of STEM disciplines as a form of knowledge, inquiry and design initiated by humans
3. Consciousness, as the STEM disciplines shape the material, intellectual and cultural environment
4. Desire to be involved in studying STEM-related issues as a constructive, caring and reflective citizen using STEM ideas. (Bybee, 2013)

Meanwhile, the objectives of STEM-based learning more specifically are as follows:

- a. Increasing Literacy in Science, Technology, Engineering and Mathematics
  - 1) Provides a deep understanding of the basic concepts of science, technology, engineering, and mathematics
  - 2) Improve reading, writing, and speaking skills in STEM contexts
- b. Development of Critical and Creative Thinking Skills



- 1) Encourage students to develop analytical and critical thinking skills in solving problems
- 2) Stimulate students' creativity in designing innovative solutions to STEM challenges
- c. Improved Collaboration and Communication Skills
  - 1) Assist students in collaborating in teams to complete STEM projects
  - 2) Improve communication skills, both oral and written, in scientific and technical contexts
- d. Empowering Students in Using Technology
  - 1) Provides practical experience in using the latest technology
  - 2) Teaches relevant programming and coding skills
- e. Project Based Learning
  - 1) Provide challenging and authentic projects to encourage understanding of concepts and their real-life application
  - 2) Provide opportunities for students to design, implement, and evaluate their own STEM projects
- f. Increased Interest and Participation in STEM Careers
  - 1) Arouse students' interest in careers in science, technology, engineering and mathematics
  - 2) Provides insight into the practical application of STEM concepts in a variety of professions
- g. Subject Integration
  - 1) Encourage integration between science, mathematics, technology and engineering subjects to create a holistic understanding
  - 2) Presenting learning content in a real world context (Alirahman, 2023)
- h. Digital Literacy Development
  - 1) Promote a strong understanding of digital literacy, including digital ethics and safety
  - 2) Teaching skills in using digital tools to access, evaluate and present information (Mulyani, 2019)

The STEM approach to learning has various benefits, including: (1) Improving 21st century skills, such as the ability to think critically, creatively, collaborate and problem solve (Locke, 2023) ; (2) Motivate students through project-based learning or problem solving, so that students can see their own progress, obtain feedback, and improve their skills and understanding; (3)



Increasing student engagement, creating a positive learning atmosphere, and encouraging creativity in solving STEM problems (Sevilla, 2021) ; (4) Strengthen social skills, teamwork, communication, and critical skills that are important in the professional world; (5) Preparing quality human resources in the future, so that they can contribute to creating innovation and solutions to real world problems.

Meanwhile, the following is an image that shows how important STEM is in the world of education:



Learning using a STEM approach is very important, because it provides training for students to be able to integrate every aspect at once. A learning process involving four aspects will form a more comprehensive knowledge of the subject being studied. In physics learning, STEM helps students to use technology and collect experiments that can prove scientific laws or concepts.

### STEM Humanization Achieves 21st Century Islamic Education

Islamic education is the process of preparing people through teaching, mentoring and training activities to absorb and implement the true meaning of Islamic teachings in their lives as individuals and as part of society to achieve a happy life and birth in this world and in the afterlife. Islamic education also includes the creation of an Islamic environment, familiarization, and modeling from teachers, parents, and the Islamic environment to provide a better influence on students' religious character.

The concept of Islamic education is very diverse, for example, Abdurrahman Al Nahlawi, quoted by Abdullah Idi and Toto Suharto, defines Islamic education as a process of individual and social structuring that can make





a person submissive and obedient while implementing Islam perfectly in individual and societal life. (Idi & Suharto, 2006) Al Abrasyi explains that Islamic education (using *the term* tarbiyah) is an effort to prepare humans to live perfectly and happily, love their homeland, be physically strong, have perfect morals, be orderly in their thoughts, be refined in their feelings, be proficient in his work, sweet speech both verbally and in writing. (Ramayulis, 2012)

Meanwhile, Zakiah Daradjat, et al, define Islamic education as an effort to form a Muslim personality in accordance with Islamic teachings. (Daradjat, 2012) In line with this, Ahmad D. Marimba in Sembodo Ardi Widodo, provides an understanding of Islamic education as physical and spiritual guidance based on Islamic religious laws leading to the formation of the main personality according to Islamic standards. (Widodo, 2007) Meanwhile, M. Arifin, provides a definition of Islamic education as an educational system that covers all aspects of life needed by God's servants, as Islam has become a guide for all aspects of human life, both *worldly* and *spiritual* . (Arifin, 2011)

Islamic education in relation to the National Education System (SISDIKNAS), as quoted by Samsul Nizar and Muhammad Syaifudin, can be interpreted broadly, including as follows:

1. Islamic education as a process of instilling Islamic values (Islamic Education)
2. Islamic education in the sense of field of study or subject (Islamic Religious Education/PAI)
3. Islamic education in the sense of institutions (Religious Education) such as Madrasas and Islamic Boarding Schools
4. Islamic education in the sense of all aspects of Islamic education (Nizar & Syaifudin, 2010)

Meanwhile, according to Azyumardi Azra, the aim of Islamic education is inseparable from the aim of human life in Islam, namely to create a person as a servant of Allah who is always devoted to Him, which in the social context of this person can be called *rahmatan lil 'alamin* , and can achieve a happy life. in this world and the hereafter. This is as stated by Allah in QS Adz-Dzariyat verse 56 and QS Ali Imran verse 102:

➤ QS Adz-Dzariyat verse 56:

وَمَا خَلَقْتُ الْجِنَّ وَالْإِنْسَ إِلَّا لِيَعْبُدُونِ

➤ QS Ali Imran verse 102:

وَلَا تَمُوتُنَّ إِلَّا وَأَنْتُمْ مُسْلِمُونَ God bless you



Muhammad As Said's conclusion regarding Majid Irsan Al Kailani's thoughts in formulating the objectives of Islamic education, refers to an understanding of the objectives of Islamic education as education that handles comprehensively and holistically the fundamental aspects of human life, in the form of the mind, soul and body.

Meanwhile, the scope of Islamic education includes harmony, harmony and balance between human relationships with Allah SWT, human relationships with fellow humans, thirdly, human relationships with themselves, as well as human relationships with other creatures and their environment. (Sanusi et al., 2022) The scope of Islamic education is also identical to aspects of Islamic religious teaching because the material contained therein is a combination that complements one another. (Rusdiana, 2014)

If seen from the perspective of the discussion, *the scope* of Islamic education which is generally implemented in schools includes the following aspects of knowledge:

- a. Al-Qur'an and Hadith: Al-Qur'an teaching is teaching that aims to enable students to read, write, memorize, understand the content and practice the contents of the Al-Qur'an. (Retnowati, 2019) (Sanusi et al., 2022)
- b. Aqidah, teaching of aqidah or faith means the process of teaching and learning about aspects of belief, in this case of course belief according to Islamic teachings, the essence of this teaching is about the pillars of faith which are widely developed. (Syafrianto, 2015)
- c. Morals, moral teaching is a form of teaching that leads to the formation of the soul, an individual's way of behaving in life, this teaching means the teaching and learning process in achieving the goal so that those taught have good and not bad morals. (Syafrianto, 2015)
- d. Fiqh, fiqh teaching is teaching whose content is to convey material about all forms of Islamic law which are based on the Al-Qur'an, Sunnah and other shar'i propositions. (Rusdiana, 2014)
- e. History of Islamic Culture and Civilization, the aim of teaching Islamic history is so that students can know about the growth and development of the Islamic religion from its beginnings to the present day so that they can know and love the religion of Islam, of course the spirit or wisdom and historical lessons that can be implemented in today's life and future. (Aslan, 2018)



Furthermore, from the ideal concepts both theoretically and practically that have been formulated in Islamic education, in fact Islamic education still has many problems and challenges in facing the era of globalization in the 21st century.

The reality of Islamic education is currently facing fundamental problems, namely: (a). *Problem of lack of vision* , (b). Educational practices that focus on individual piety and result in technological lag, (c). Epistemological problems that end with a dichotomy of science, (d). Problems with the tradition of deductive normative thinking, and (e) The use of models, methods and learning media that tend to be traditional. (Musrifah, 2019)

Another condition is that Islamic education today is facing various very large trends. According to Daniel Bell, as quoted by Abuddin Nata, that in the era of globalization the world situation is characterized by five tendencies as follows:

*First* , the tendency of economic integration which causes free competition in the world of education. *Second* , the trend of fragmentation has led to increased demands and expectations from society. *Third* , the tendency to use sophisticated technology , especially Communication and Information Technology (TKI). (Ulya, 2018)

*Fourth* , the tendency of *interdependence* , namely a situation where someone can fulfill their needs if they are helped by other people. *Fifth* , the tendency for the emergence of new colonization in the field of culture ( *new colonization in culture* ) which results in the mindset of the people who use education. (Hafsah et al., 2023)

So that in order to be able to solve these problems, Islamic education needs to make improvements and modern learning approaches in the era of globalization, because in the 21st century Islamic education is also required to be able to develop the 4C skill competencies of teachers and students, and the 4C that is meant is: *Critical Thinking and Problem Solving* (Ability to Think Critically and Solve Problems) *Creativity* (Creativity) *Communication Skills* (Ability to Communicate) *Collaboration* (Ability to Work Together).

A very possible choice of approach is to integrate Islamic education into STEM-based learning. Education with a STEM approach can be the key to creating the nation's next generation who are able to compete on the global stage. Therefore, STEM education needs to be a reference framework for the Islamic education process in Indonesia in the future. As stated in the Basic Framework and Structure of the 2013 Curriculum for Junior High School/Madrasah



Tsanawiyah Level (Kemdikbud, 2013), the 2013 curriculum aims to prepare Indonesian people to have the ability to live as individuals and citizens who are faithful, productive, creative, innovative and affective. and able to contribute to the life of society, nation, state and world civilization.

The stages of the STEM Model that can be integrated into Islamic education learning through a SAINTIFIC approach according to Muhammad Syukri Riyanto, et al are:

1) Observation steps ( *observe* )

Students are motivated to make observations of various phenomena/issues found in the daily life environment which are related to the scientific concepts in the learning being discussed.

2) Step new idea ( *new idea* )

Students observe and look for additional information about various phenomena or issues related to the science topic being discussed, after which students think of new ideas from the existing information. In this step students need skills and analysis and critical thinking.

3) *Innovation* steps \_

Students are asked to describe what things must be done so that the ideas that have been generated in the previous new idea step can be applied. (Riyanto et al., 2021)

4) *Creativity* steps \_

This step is the implementation of all suggestions and opinions resulting from discussions regarding ideas that can be applied.

5) Value steps ( *society* )

The final step that students must have from the ideas produced by students is in the form of values that can be useful for social life. (Riyanto et al., 2021)

The integrity of the two strategies that are combined and developed with the STEM model basically does not depart from the principles of the model concept itself. According to Joyce and Weil, there are four elements that must be present in a learning approach, namely: (a) *Syntax* (b) *The social system* (c) *Principles of reaction* , and (e) *Support system* . (Joyce, 2000) (Yondri et al., 2020) Learning models have SYNTAX (a certain sequence pattern) of a learning model is a pattern that describes the overall flow sequence of stages which is generally accompanied by a series of learning activities.

Furthermore, learning Islamic education in a STEM style means that the educational process must always emphasize several aspects in the learning class,



namely using *student centered learning techniques* : (1) asking questions and explaining problems; (2) develop and use models; (3) design and conduct research; (4) interpret and analyze data; (5) using mathematical and computational thinking; (6) make explanations and design solutions; (7) participate in argumentation activities based on existing evidence; (8) obtain information, provide evaluation and convey information. (Khairiyah, 2019) (Suryadi & Kurniati, 2021)

Meanwhile, the types of learning methods that can be explored in STEM-based Islamic education include:

1) *Problem Based Learning*

The problem-based learning method will place students exposed to real problems related to Islamic education material, thus requiring the application of STEM concepts in finding solutions. They work in groups to analyze emerging problems, develop strategies, and test solutions.

2) *Project Based Learning*

The project-based learning method leads students to be involved in projects that correlate with Islamic educational material, thus requiring the application of STEM concepts to achieve certain goals. They work in teams to plan, design, and execute projects involving research, prototypes, and presentations.

3) *Inquiry-Based Learning*

A discovery-based learning method where students are encouraged to ask questions that correlate with Islamic educational material, investigate phenomena, and discover STEM concepts through experimentation, research, and reflection. This method invites students to think critically, teaches research skills, and develops conceptual understanding.

4) *Game Based Learning*

This game-based learning method uses game elements and interactive simulations in Islamic education teaching materials, and to teach STEM concepts. Students engage in stimulating games, challenges, and scenarios for problem solving, collaboration, and implementation of STEM concepts.

5) *Digital Based Learning*

Digital-based learning methods utilize digital technology such as software, applications, simulations, or learning videos to present STEM concepts interactively and visually in Islamic education teaching materials. This is aimed at increasing student engagement and providing greater accessibility to the learning process.



6) *Collaborative Learning*

Collaboration-based learning methods direct students to work in groups to discuss, share knowledge, and collaborate in solving problems in Islamic education teaching materials. This method can help develop social skills, teamwork and mutual understanding.

7) *Hands on Learning*

This practice-based learning method uses practical activities such as experiments, experiments, or prototyping to help students understand and apply STEM concepts directly to Islamic education teaching materials. In this way, students are helped to develop deep understanding and practical skills.

## CONCLUSION

The transformation of Islamic education in the 21st century can be integrated through STEM-based humanization learning ( *Science, Technology, Engineering, and Mathematics* ), with Islamic education learning techniques that must emphasize several aspects in classroom learning, namely: (1) asking questions and explaining problems; (2) develop and use models; (3) design and carry out research, (4) interpret and analyze data; (5) using mathematical and computational thinking, (6) creating explanations and designing solutions; (7) Participate in argumentation activities based on existing evidence (8) obtain information, provide evaluations and convey information.

Meanwhile, the types of learning approaches that can be explored in STEM-based Islamic education include: (a) *Problem Based Learning*; (b) *Project Based Learning*; (c) *Inquiry-Based Learning*; (d) *Game Based Learning*; (e) *Digital Based Learning*; (f) *Collaborative Learning*; (g) *Hands on Learning* .

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