

# STE@M-Q EDUCATION: INNOVATION IN LEARNING

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Presented at the International Symposium on Research in Innovation and Sustainability 2019 (ISoRIS '19) 28 -29 August 2019, Penang, alaysia

**ABSTRACT:** *The mastery of Science and Technology is currently an important key in facing challenges in the future. Various challenges that arise include, among others, improving quality of life, equitable development, and the ability to develop human resources. For this reason, education plays an important role in preparing students who are strong and able to face future challenges. Various learning theories and approaches have been carried out. One of them is the STEM Education Model (Science, Technology, Engineering and Mathematic). But the quality of education in the context of academic achievement and character formation and the planting of religious values are still not proud. So that innovation is needed in learning. In this article, we try to review 14 research articles related to the use of the STEM model in Education. In this review it was found that although it was successful in improving academic aspects, it did not touch the religious aspect, which both aspects should be developed. In this paper a STEAM-Q based Education is proposed as a learning innovation that is expected to touch cognitive and mental aspects.*

**KEYWORDS:** STEM, STE@M-Q Education, Cognitive and Mental Aspects

## 1.0 INTRODUCTION

The quality of education in the context of academic achievement and character formation and the planting of religious values are still not proud. It was stated that Indonesia was ranked 57th out of a total of 65 countries in the world [1]. As for reading interest, according to the Most Litered Nation in the World study conducted by Central Connecticut State University in March 2016, Indonesia was declared ranked 60th out of 61 countries [2]. According to UNESCO, in 2017 Indonesia is ranked 108th out of 187 countries in the world. As many as 44% of the population completed secondary education and 11% of students failed to complete education or leave school [3].

Various approaches and learning models today are still focused on the success of the lessons themselves, stand alone, do not balance cognitive and spiritual aspects, as part of complete human development, including the STEM Education model [6-13]. This can lead to a lack of competence in students. Therefore, the purpose of our paper is to propose the development of the STEAM education model to the Islamic community, called the STE@M-Q Education model (Science, Technology, Arts, Mathematic-Quranic).

To do this, the learning framework will be developed from the Yakman model [25] where he found that “While studying the common factors of teaching and learning across the disciplines of S-T-E-M, I found it hard to not

include the influences of the arts disciplines”. Development of this model by adding Al-Quran to it. This addition is taken from the side of the verses of the Qur'an which are appropriate and related meanings. It is expected that learning models that are developed effectively, and internalize Islamic values in learning.

The function of Indonesian national education is to develop capabilities and form dignified national character and civilization in order to educate the nation's life, aiming at developing potential students to become human beings who believe and fear God Almighty, noble, healthy, knowledgeable, capable, creative , be independent, and become a democratic and responsible citizen. This requires a learning process that is not dichotomy between worldly affairs and ukhrowi. In relation to subjects, the learning process must integrate material with values in religion.

## 2.0 DISCUSSION

### 2.1 Definition of STEM

The STEM (Science, Technology, Engineering, and Mathematics) integration program in learning is a learning program that combines two or more fields of science contained in STEM-Science, Technology, Engineering / Engineering, and Mathematics [4]. The following table 1 outlines the definition of STEM literacy according to the National Governor's Association Center for Best Practices [5]

**Table 1. Definition of STEM Literacy According to the NGA**

Science	Scientific Literacy: The ability to use scientific knowledge and processes to understand the world and nature and the ability to participate in making decisions to influence it
Technology	Technology Literacy: Knowledge of how to use new technology, understand how new technologies are developed, and have the ability to analyze how new technologies affect individuals, communities, nations, and the world.
Engineering	Design Literacy: An understanding of how technology can be developed through an engineering / design process using the theme of project-based learning by integrating several different (interdisciplinary) subjects.
Mathematics	Mathematical Literacy: A collection in analyzing, reasoning, and communicating ideas effectively and from how to behave, formulate, solve, and interpret solutions to mathematical problems in applying different situations.

So in summary STEM is an integrative thematic learning strategy because it combines four fields in education, namely science, technology, engineering and mathematics. The STEM method, invites students to integrate subjects and correlate them with everyday life. The learning process involves seven main skills for 21st century students, namely collaboration, creative, critical thinking, computerization, cultural saving, and being independent in learning and career.

Many studies have been conducted on the application of STEM-based learning and it can be said that STEM can improve students' academic and non-academic achievements and be accepted as an effective learning method [6-13]

Amy Eguchi said that STEM learning can be improved with RoboCupJunior and can increase innovation and creativity among students who participate [7].

Kristin Lesseg [8] also states Navigating these factors of STEM school culture requires not only knowledge but also to draw on a professional orientation that encourages collaboration and risk-taking. Across the world, STEM receives tremendous attention in education reform efforts and in popular media [9]. Ani Ismayani (2016) concluded that the application of learning conducted had an effect on students' creative attitudes [10]. Jaka Afriyanta, et al. (2016) stated that students were happy with STEM PjBL learning and gained very memorable experiences following the learning stages thus giving rise to motivation and interest in learning [11]. Dewi (2017) proves that the application of STEM-based inquiry can improve students' creative thinking skills [12]. Regarding assessment in the implementation of STEM, Septiani and Anggita (2016) show that the performance assessment applied in the STEM approach to the material for preparing planting media is

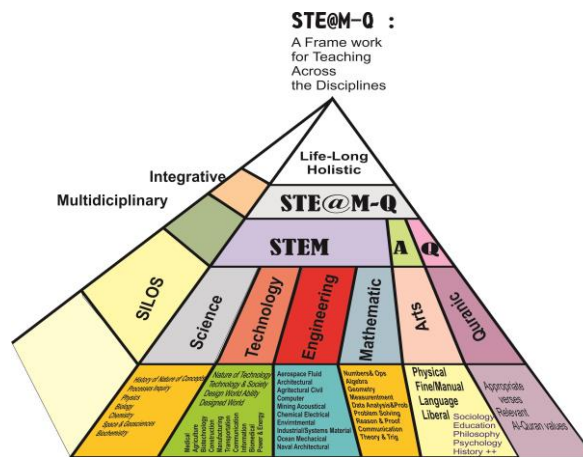
able to express students' science process skills [13]. In summary, of the 14 research results that were successfully reviewed [10-23], all succeeded in increasing creativity, motivation and interest, process skills, thinking skills, interest, problem solving, critical thinking, scientific literacy, collaboration, student perseverance.

However, from a number of studies on STEM that have been produced, it does not touch on the religious aspects (the religion they adhere to), whereas education must touch and develop two aspects, namely the cognitive and mental aspects, the aspects as part of a complete human development.

On the other hand, Dana L. Zeidler for example said that basically it is important for each student to be able to frame the STEM topic in a personal, thoughtful and meaningful context so as to allow for open inquiry, discourse, and evidence-based reasoning [6]. Likewise Lyn D. English (2016) and Kristin Leisseg, et all (2016) suggest that integrating various disciplines in the STEM community [8] [24].

**2.2 STE@M-Q Based Learning**

STE@M-Q based learning (Science Technology, Arts, Mathematic-Quranic) is learning that not only integrates disciplines from 4 branches of knowledge, namely Science, Technology, Engineering and Mathematics only, but also integrates them with art and religious values, in terms of these values are in Al-Quran. This is intended to mean that all the learning processes carried out can explore not only the value of knowledge, but also religious values. The process of extracting values in STE@M-Q is a development of STE@M by Yakman [25] which can be described in the following situations:









Picture 1. Framework For Teaching Across The Disciplines

STE@M-Q is a new framework which has evolved to support a new educational theory. STE@M-Q is based on STE@M education, which is an educational concept that is intentionally / integrately designed between subjects. However, when taught it can be one of the subjects to be dominant among other subjects. Specific content offered is also in accordance with Yakman [25], there are only a few different related Arts, where Yakman [25] includes Theology in it, while in the context of learning that tries to

explore Al-Quran, it is very different, so we separate into a separate section, namely the excavation of verses in the corresponding Al-Quran and the values of Al-Quran relating to learning material. In lesson study with 15 teachers in the "plan" stage, and a teacher model in the "do" stage with 32 students that we did, when doing a machine wave project, for example, the design of STE@M-Q which can be explored as shown in the following table:

**Table 2. Examples of Analysis of the determination of Learning Materials**

<p style="text-align: center;"><b>SCIENCE</b></p>  <ul style="list-style-type: none"> <li>• The peak is where the end of the toothpick is at the highest point</li> <li>• Waves are when the toothpick is in the lowest position</li> <li>• Amplitude is the distance between the peak and midpoint of the wave</li> </ul>	<p style="text-align: center;"><b>TECHNOLOGY</b></p>  <ul style="list-style-type: none"> <li>• Use of the internet in searching for references about waves, amplitude</li> <li>• Utilization of Applications about waves at <a href="https://play.google.com/store/apps/details?id=com.simplify.fissmp.bunyi&amp;hl=in">https://play.google.com/store/apps/details?id=com.simplify.fissmp.bunyi&amp;hl=in</a></li> </ul>	<p style="text-align: center;"><b>ENGINEERING</b></p>  <p>Techniques in designing and assembling tools</p>	<p style="text-align: center;"><b>MATHEMATICS</b></p>  <ul style="list-style-type: none"> <li>• Measuring the length of skewers and other ingredients</li> <li>• Sequence of Numbers</li> </ul>
<p style="text-align: center;"><b>ARTS</b></p>  <ul style="list-style-type: none"> <li>• Attractive wave design</li> <li>• Colorful in the Plastisin</li> </ul>		<p style="text-align: center;"><b>QURANIC</b></p>  <ul style="list-style-type: none"> <li>• Regularity (QS Fathir:41, QS Almkuminun : 71)</li> <li>• Be grateful for waves</li> <li>• Patience (QS Asyuro : 32-33)</li> </ul>	

Determination of the project must of course be adjusted to the basic competencies and learning objectives of the class concerned, especially for the subjects in STE@M-Q.

**3.0 CONCLUSION**

The phenomenon related to the low quality of education shows that there is still a need for the world of education to always improve itself. Therefore, changes, innovations, and reforms are needed in how to teach students from the use of the old paradigm to become a new paradigm. Building content mastery must be done through the process of providing skills (Skills), which are based on attitudes, characters, and good habits. We must remember that the end of an educational process is basically instilling personality. STE@M-Q based learning is one of the alternative learning potentials used to build 21st century skills. STE@M-Q based learning can be packaged in cooperative learning models, PBL, PjBL, and other learning models. We know that Indonesia has a grand design in character education since our ancestors, namely spiritual and emotional development, intellectual development, sports (physical and kinesthetic development), and feeling (affective and creative development). With STE@M-Q learning, the goal of Indonesian national education is that Indonesian human development can be fully achieved.

**ACKNOWLEDGEMENTS**

We would like to thank Universiti Teknikal Malaysia Melaka and UNIBA Surakarta, Indonesia for its support

**REFERENCES**

[1]. <https://www.oecd.org/pisa/pisa-2015-results-in-focus.pdf>  
 [2]. <http://webcapp.ccsu.edu/?news=1767&data>  
 [3]. <http://ejournal.upi.edu/index.php/manajerial/article/download/9481/5867>  
 [4]. Laboy-Rush, D. (2011). Integrated STEM education through project-based learning. *Boston, MA: Learning.com.*

[5]. [https://classic.nga.org/cms/center/issues/education/ste\\_m](https://classic.nga.org/cms/center/issues/education/ste_m)  
 [6]. Zeidler, D. L. (2016). STEM education: A deficit framework for the twenty first century? A sociocultural socioscientific response. *Cultural Studies of Science Education, 11*(1), 11-26.  
 [7]. Eguchi, A. (2016). RoboCupJunior for promoting STEM education, 21st century skills, and technological advancement through robotics competition. *Robotics and Autonomous Systems, 75*, 692-699.  
 [8]. Lesseig, K., Firestone, J., Morrison, J., Slavitt, D., & Holmlund, T. (2019). An analysis of cultural influences on STEM schools: Similarities and differences across K-12 contexts. *International Journal of Science and Mathematics Education, 17*(3), 449-466.  
 [9]. Holmlund, T. D., Lesseig, K., & Slavitt, D. (2018). Making sense of “STEM education” in K-12 contexts. *International journal of STEM education, 5*(1), 32.  
 [10]. Ismayani, A. (2016). Pengaruh penerapan STEM project-based learning terhadap kreativitas matematis siswa SMK. *Indonesian Digital Journal of Mathematics and Education, 3*(4), 264-272.  
 [11]. Afriana, J., Permanasari, A., & Fitriani, A. (2016). Penerapan project based learning terintegrasi STEM untuk meningkatkan literasi sains siswa ditinjau dari gender. *Jurnal Inovasi Pendidikan IPA, 2*(2), 202-212.  
 [12]. Dewi, H. R. (2017, August). Peningkatan ketrampilan berfikir kreatif siswa melalui penerapan inkuiri terbimbing berbasis STEM. In *Prosiding SNPF (Seminar Nasional Pendidikan Fisika)*(pp. 47-53).  
 [13]. Septiani, A. (2016). Penerapan Asesmen Kinerja dalam Pendekatan Stem (Sains Teknologi Engineering Matematika) untuk Mengungkap Keterampilan Proses Sains.

- [14]. Utami, T. N., Jatmiko, A., & Suherman, S. (2018). Pengembangan Modul Matematika dengan Pendekatan Science, Technology, Engineering, And Mathematics (STEM) pada Materi Segiempat. *Desimal: Jurnal Matematika*, 1(2), 165-172.
- [15]. Lestari, I. F. (2016). *Penerapan Model Pembelajaran Berbasis Pengalaman Dengan Pendekatan Science, Technology, Engineering, And Mathematics (Stem) Untuk Meningkatkan Kemampuan Pemecahan Masalah Dan Keterampilan Berpikir Kritis Siswa SMA* (Doctoral dissertation, Universitas Pendidikan Indonesia).
- [16]. Khaeroningtyas, N., Permanasari, A., & Hamidah, I. (2016). Stem learning in material of temperature and its change to improve scientific literacy of junior high school. *Jurnal Pendidikan IPA Indonesia*, 5(1), 94-100.
- [17]. Aldila, C. (2017). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Stem Untuk Menumbuhkan Berfikir Kreatif Siswa Pada Materi Elastisitas Dan Hukum Hooke.
- [18]. Sugianto, S. D., Ahied, M., Hadi, W. P., & Wulandari, A. Y. R. (2018). Pengembangan Modul IPA Berbasis Proyek Terintegrasi STEM pada Materi Tekanan. *Natural Science Education Research*, 1(1), 28-39.
- [19]. Rustaman, N. Y., Afianti, E., & Maryati, S. (2018, May). STEM based learning to facilitate middle school students' conceptual change, creativity and collaboration in organization of living system topic. In *Journal of Physics: Conference Series* (Vol. 1013, No. 1, p. 012021). IOP Publishing.
- [20]. Zamista, A. A. (2018). Increasing Persistence of Collage Students in Science Technology Engineering and Mathematic (STEM). *Curricula: Journal Of Teaching and Learning*, 3(1).
- [21]. Pertiwi, R. S. (2017). Pengembangan Lembar Kerja Siswa Dengan Pendekatan Stem (Science, Technology, Engineering, Mathematics) Untuk Melatih Keterampilan Berpikir Kreatif Siswa Pada Materi Fluida Statis.
- [22]. Pangesti, K. I., Yulianti, D., & Sugianto, S. (2017). Bahan Ajar Berbasis STEM (Science, Technology, Engineering, and Mathematics) untuk Meningkatkan Penguasaan Konsep Siswa SMA. *UPEJ Unnes Physics Education Journal*, 6(3), 53-58.
- [23]. Lestari, D. A. B., Astuti, B., & Darsono, T. (2018). Implementasi LKS Dengan Pendekatan STEM (Science, Technology, Engineering, And Mathematics) Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa. *Jurnal Pendidikan Fisika dan Teknologi*, 4(2), 202-207.
- [24]. English, L. D. (2016). STEM education K-12: Perspectives on integration. *International Journal of STEM Education*, 3(1), 3.
- [25]. [https://steamedu.com/wp-content/uploads/2016/01/What is the Point of STE AM A Brief Overv.pdf](https://steamedu.com/wp-content/uploads/2016/01/What-is-the-Point-of-STEM-AM-A-Brief-Overv.pdf)