

Integration of STEM Education in Malaysia and Why to STEAM

Suraya Bahrum, Norsalawati Wahid, Nasir Ibrahim

Faculty of Art, Computing and Creative Industries, Sultan Idris Education University
Perak, Malaysia

DOI: 10.6007/IJARBSS/v7-i6/3027 URL: <http://dx.doi.org/10.6007/IJARBSS/v7-i6/3027>

Abstract

STEM education and political priorities in the US and is rated as one way to ensure global competitiveness. Integrated approach to STEM school level gaining popularity in developed countries like the United States, South Korea, China and Australia. However, much of the debate and suggested that the study of art combined with appropriate discipline of science, technology, engineering and mathematics change STEM to STEAM. STEAM paradigm also emphasizes the importance of STEM education, but also stressed that the art has the ability to open up new ways of seeing, thinking and learning. Whereas current developments in Malaysia has started to show a deep interest and efforts on behalf of the Malaysian government to implement the STEM approach. This article discusses the development of STEM to STEAM education in the United States and the efforts made in Malaysia have begun to use this approach. This study is a qualitative study using literature review. This article proposes combining elements of art into the disciplines in STEM to STEAM in order to strengthen the STEM education, also suggest that the main thing to keep in mind to implement STEM education is to increase the interest of students and teachers' awareness of STEM education. This step involves a new approach to learning and strengthen the curriculum, teacher training and discussions with all interested parties (stakeholders) in order to make STEM education comprehensive and inclusive.

Keywords: Integrated Approach, Steam Education, STEM Education, Awareness.

Introduction

Malaysia need to strengthen STEM education in order to achieve a developed nation that is able to face the challenges and demands of STEM-driven economy by 2020 (Ministry of Education, 2013). By definition, STEM education means "pedagogical applications based design and engineering technology for teaching content and practice in science and mathematics education with the content and practice of educational technology and engineering with simultaneous". STEM education, including approaches that explore teaching and learning between two or more areas of STEM subjects (Sanders, 2009). Among the first steps to strengthen STEM education is through the Malaysia Education Blueprint (2013 - 2025), namely to increase the interest of students and teachers awareness of STEM education.

STEM term began in the early 90s in the United States in the policies of the US government (Koehler, Binns, & Bloom 2016) The challenge is to make sure every citizen of the United States is willing to pursue Science, Technology, Engineering Mathematics (STEM) and finally be able to work in careers related to STEM fields such as scientists, engineers, mathematicians, and technologists. At first, the term SMET (*science, mathematics, engineering, & technology*) used, but has been changed to STEM by the National Science Foundation (NSF) to simplify and consolidate the terms of its meaning (National Academy of Science, 2007). Since STEM ideas presented, now it has various definitions (Roehrig, Moore, Wang, & Park, 2012). Bryan, Moore, Johnson and Roehrig (2016). ". Based on this definition, it can be known that the goal of integration is to integrating STEM Science, Technology, Engineering, and Mathematics in the teaching and learning process. The four subjects as defined by the National Research Council, US:

- Science is the study of the natural world, including the laws of nature associated with physics, chemistry, and biology and the treatment or applications of facts, principles, concepts, or conventions associated with these disciplines.
- Technology comprises the entire system of people and organization, knowledge, processes and devices that go into creating and operating technological artifacts, as well as the artifacts themselves.
- Engineering is body of knowledge about the design and creation of products and a process for solving problems. Engineering utilizes concept in sciences and mathematics and technological tools.
- Mathematics is study of patterns and relationships among quantities, numbers, and shapes. Mathematics includes theoretical mathematics and apply mathematics.

STEM Integration elaborate definition, Moore, Johnson, Peters-Burton, and Guzey (2016) details the six core STEM integration, namely:

1. Using meaningful learning context and relate to student real life.
2. Challenge students potential using design approach Engineering to develop critical and creative thinking through activities that be related.
3. Student aided design technology can learn from failure in designing solutions in engineering design with existing design.
4. Implementing teaching and learning that is integrated with science and mathematics and subjects relevant like Literature, Humanities, and Social Studies.
5. Implementing teaching and learning activities that are student-centered so that students are actively involved in teaching and learning
6. Train students to collaborate and communicate in conducting educational activities.

According to the fourth core of STEM integration that is integrated with science and mathematics as well as the relevant subjects such as Literature, Humanities, and Social Studies, the starting point of the core of this study tried to propose the STEM integration with Visual Art

Education. This will change the acronym STEM to STEAM: an acronym for Science, Technology, Engineering, Arts and Mathematics.

Parallel phenomenon that occurs now, the decline involvement and student achievement in STEM Education. According to Andrews, Bufford, Bank, and Curry (2014) STEM learning in the United States has experienced a decline compared with the performance of students from China. In addition, the students' interest in STEM subjects have also fallen drastically behind the explosive growth of science and innovation. According to National Assessment of Educational Progress report (NAEP) in 2013 there were more than 70 per cent of Grade 8 students in the United States are not proficient in math. While in Malaysia, STEM educational attainment based on the TIMSS and PISA found not encouraging. Malaysia has been in the position of the bottom two-thirds of the entire country involved (Andrews et al, 2014). This requires improvement of STEM either by integrating with relevant subjects such as Literature, Humanities, and Social Studies.

A research study conducted by McGrath & Brown (2005) suggests that visual art has a real potential to improve cognition in 'STEM' education. While the main findings of the study Henriksen (2011) shows the established teaching art merge to bring more motivation, engagement and impact on STEM-based learning. These studies describe the improvement of the discipline in the 'STEM' to integrate art, where it makes students more holistic when using the right brain and left brain. The result will make students more creative, have critical thinking and ability to solve problems, communicate, and collaborate. This is an opportunity to change the emphasis of learning from passive knowledge receiver to active, creative students in designing and implementing activities.

World problems and challenges of the 21st century demanded that the solutions to the problems facing the world community as tsunamis, floods, earthquakes, collapsed buildings, fires, or even the food supply crisis. These issues are in fact extremely complex because of the need to involve many stakeholders who have expertise and interest. For example, a forest fire is a serious and cause haze and floods that hit the states of the East Coast of Malaysia at the end of 2014 the last to claim the scientists to investigate the causes of fire and the flood, engineers also needed for the reconstruction of houses that are able to withstand the pressure of the flooding water, technology experts who are able to create and supply equipment to repair damaged homes and facilities, as well as designers of their shape technology tools or even design a suitable home. Likewise, a mathematician who can estimate the amount of financial support that is necessary for any victims. Clearly, the problems of today's world is much more complex and requires the cooperation of many parties. This is where the importance of the integration of STEM education and art so that students can start building expertise to help themselves collectively in social responsibility. However, the question of the integration of STEM education is, whether the latest developments concerning the integration of STEM in Malaysia? How about a paradigm shift from STEM to STEAM in this country? Are efforts to implement STEM Integration in Malaysia? The question answered this question will

try to make revisions and review government documents related STEM Integration. Therefore, this article is written to give views on the development of STEM integration at global level and also in Malaysia, submitted his views to implement the Integrated Arts in STEM disciplines in a holistic and inclusive in the Malaysian context.

STEM integration at the International Level

Introducing the new document, Next Generation Science Standards (NGSS) in 2013 makes this year is very important for STEM education in the United States. NGSS is a standard that is used for the implementation of the Integrated STEM in the United States. NGSS is a document that builds on the previous document, A Framework for K-12 science education: Practices, crosscutting concepts, and core ideas (National Research Council, 2012). However, the fundamental issue is, what is the reason that led to the introduction of this NGSS? Where does the United States in the assessment Program for International Student Assessment (PISA) 2012 by The Organization for Economic Cooperation and Development (OECD)? Mathematics with a score of 481 (the OECD average is 494), Science score of 497 (the OECD average is 501) and reading score of 498 (the OECD average is 496), the United States was ranked 36th (OECD, 2012). This information is certainly shocking, but that's the reality. International assessments is one of the main reasons why the researchers called for reforms in the rise STEM teaching and learning of science and mathematics at school level in the United States. These reforms include the introduction of NGSS document to give new impetus to the teaching and learning of Science and Mathematics. NGSS is generally concerned with the integration of Science and Mathematics Engineering and Technology through the eight elements of Science and Engineering Practice (NRC, 2012).

Malaysia in the International Performance Assessment and Policy Issues

Malaysian student performance in the PISA assessment in 2015 showed an increase in scores in all three domains. Malaysia scored Mathematics 421 (the OECD average is 494), Science score of 420 (the OECD average is 501) and reading literacy score of 398 (the OECD average is 496) (OECD, 2015). Although all scores of Malaysia was below the OECD average but Malaysia recorded a higher position than in PISA 2012. This success proves that the efforts undertaken by the Ministry of Education (MOE) somewhat successfull. Ministry of Education (2013) has announced the introduction of the document in the Malaysia Education Blueprint (2013-2025). Interestingly, the term STEM is used for the first time officially by the Ministry of Education (MOE) in this document. An important element in this document is the introduction of the Secondary School Standard Curriculum (KSSM) and the revision KSSR 2011, from this year, 2017. Accordingly, the national school curriculum for primary and secondary schools have been seen again after going through a full cycle of implementation in the school system. The concept of the new curriculum for secondary schools has been approved by the Central Curriculum Committee on October 26, 2010 to be implemented in stages starting in Grade 1 level and is known as the Secondary School Standard Curriculum (KSSM). Education Planning Committee also decided to start KSSM in 2017, after the expiry of the first cohort KSSR. KSSM phased implementation stage begins with students from Form 1 in 2017 also took into account the

wishes of the blueprint sketched aspirations of students to meet national needs. Curriculum transformation refers to efforts to improve the learning program to improve student outcomes to achieve six student aspirations namely knowledge, thinking skills, leadership skills, bilingual proficiency, ethics and spirituality and national identity as recommended in the Malaysian Education Blueprint (MEB) 2013 - 2025. this transformation is performed on content, pedagogy and assessment as follows:

- Content restructured and improved to ensure students are provided with the knowledge, skills and values that are relevant to the current needs for the challenges of the 21st century.
- Pedagogical emphasis on learning in depth approach to teaching and learning based on higher order thinking skills (HOTS). Focus is given to the inquiry-based learning, problem solving, contextual learning, collaborative learning, project-based learning and STEM approach.
- Assessment is carried out continuously to ensure the progress and achievement of student learning. Assessment in teaching and learning is conducted in the form of summative and formative. Teachers assess the extent to which students master the learning standards with reference to the prescribed performance standards. Development and actual achievement level of students recorded and reported descriptively to students and parents.

STEM integration in Malaysia

KSSM and KSSR revision in 2017 is still new and many important steps that must be taken to ensure the smooth implementation of the curriculum. The curriculum has been put STEM agenda approach as a core element in the construction and implementation. Pedagogical emphasis in teaching in-depth approach to teaching and learning based on higher order thinking skills (HOTS). Focus is given to the inquiry-based learning, problem solving, contextual learning, collaborative learning, project-based learning and all this is in line with the approach of STEM. Given that the Malaysian government has started to show interest in STEM approach to the school level, then the government should ensure the implementation of the curriculum that meet the characteristics of a clear STEM integration.

A question about the characteristics of integration should refer back to the definition of STEM integration developed by the researchers in this field. Features presented by researchers at the ideally already quite good, but the main issue is at the stage of implementation of the curriculum, whether implementation of this curriculum successfully executed ?. In the context of the United States, the integration of STEM also be a big issue because of the constraints of concrete. Among the major constraint is the professional training for teachers, student teachers, and implementing policies. The teachers of science and mathematics in the United States less exposed to science-related fields of engineering (Roehrig, et al., 2012). With a lack of knowledge and skills in the field of engineering, medical science and mathematics teaching can not effectively use the engineering design as desired by researchers in the US STEM integration

and NGSS document itself. Then, the call to intensify professional training of STEM integration has been made for teachers of science and mathematics are taught in the schools of the United States (Johnson & Sondergeld, 2016). The same challenges faced by Malaysia in implementing this approach STEM integration. In the event the teachers less exposure to this approach because it is very new, the professional training in the integration of STEM education in Malaysia should be strengthened, improved, and monitored to establish a competent teacher in knowledge, skills, and attitudes in the context of the integration of STEM. Thus, the Blueprint 2013-2025 has now become an important document for all interested parties (stakeholders) in the field of education in Malaysia.

Studies on STEM education in Malaysia too have begun a major issue among a team of educationist from Universiti Pendidikan Sultan Idris (UPSI) 's Faculty of Education and Human Development, led by Professor Emeritus Datuk Dr. Aminah Ayob and including Associate Professor Dr Ong Eng Teck and Associate Professor Dr Md Nasir Ibrahim, has asserted that an effective STEM education will equip children with STEM competencies from an early age which will then build upon each other and can be used with real world application (2015), Muhammad Abd Hadi (2015) also suggest that education programs and professional development of teachers must apply more elements of Design Engineering, Scientific Investigation, Reasoning and Thinking Mathematics, and 21st Century skills. While Lilia Halim (2012) via a module EncsiT been integrating STEM and science education using project-based learning that the level of science process skills in students is increasing. While the findings of Abdul Hadi and fellow researchers from the IPG Kampus Ipoh found acceptance and involvement in the implementation of STEM education through Focused Innovation Persuasion (IPT) among primary school pupils who successfully enhance (2015). Based on these studies and grants issued by the government towards the development of STEM education in Malaysia, indicating serious efforts of government and researchers toward the development of STEM education in Malaysia.

STEM to STEAM changes in the United States

The STEM acronym emerged in the 1990's through NSF driven initiatives to group science, technology, engineering, and math together (Sanders, 2009). STEM became popularized through emphasis from policy makers. The language supporting STEM education is typically framed as a means of remaining internationally competitive. The addition of the arts to STEM is a more recent phenomenon. According to McDougall (2012) STEM jobs are growing approximately three times as fast as non-STEM occupations in United States, but poor retention figures shows that many students are not successful in their attempts to pursue a STEM degree. Only 43% of students that enter a four-year institution with a declared STEM majors actually graduate with a STEM degree (Holdren, 2013). Students have different learning styles and studies in neuroscience shows that human beings have the ability to learn through visual, auditory, and kinesthetic cues. Artistic inquiry promotes rigor and creativity while also enabling an instructor to teach in multiple ways, which in turn creates more neural pathways and a higher probability of retaining knowledge (Asbury & Rich, 2008; Jeffers, 2009; Land, 2013). In

addition to improving learning, the core content, arts integration can be engaging and bring joy to learning. “Whether drawing with free-form gestures or playing improvisational theater games, artists jump start creative work through activity that is fun, unrestrained, subversive, whimsical and free of a specific goal” (Brown & Tepper, p. 13, 2012). This type of process-oriented thinking is common and is conducive to creativity. Art and artists are able to create and contemplate serious pieces while maintaining a level of playfulness (Brown & Tepper, 2012). Therefore as we enter the second decade of the 21st century, we must initiate a curricular vision that meets a new spectrum of vital interests. If creativity, collaboration, communication, and critical thinking all touted as hallmark skills for 21st century success are to be cultivated, we need to ensure that STEM subjects are drawn closer to the arts.

STEAM term is an acronym for Science, Technology, Engineering, Arts and Mathematics. There is some evidence that Georgette Yakman first used the term in 2006 when she was a master's graduate student at Virginia Polytechnic and State University's Integrated Science-Technology-Engineering-Mathematics Education program (ISTEMed). At that point she defines STEAM thus Sciences. The STEAM Congressional Caucus, which stands for Science, Technology, Engineering, Arts and Mathematics, was established in January 2013. The Caucus aims “ to change the vocabulary of educations to recognize the benefits of both the arts and sciences and their intersections to the country’s future generations.

A working definition from the Office of Congresswoman Suzanne Bonamici:

“ STEAM: the integration of arts and design principles, concepts, and techniques into STEM instruction and learning, achieved through the use of arts integration curriculums, collaboration with qualified teaching artist, community-based arts organizations, and arts teachers employed by LEAs (Local Education Agencies), and other teaching methods that use the arts to facilitate and effectively carry out STEM instructions and learning.”

This is also used by Steam Connect, who defines STEAM as :

“The +a in STE(+a)M integrates arts with STEM (Science, Technology, Engineering, and Mathematics) educations sparking the interplay between left-brain convergent thinking and right-brain divergent thinking. In a rapidly changing world, we all must become well-rounded global citizens who have the imagination and skills to conquer new challenges. STEAM is the catalyst for this”

STEAM born for holistic development of students including in terms of knowledge, skills and values. STEAM students comprehensively establish not only skilled in one discipline but across disciplines, namely inter-disciplinary fields. STEAM is a paradigm shift from traditional educational philosophy that is based on the public examinations to current requirements that focus on the appreciation of art in addition to the learning process. Adding "A" serves to benefit the students and bring creativity and learning through experience in the STEM landscape. Visual Art is no longer just a way to edit the culture into the classroom but with STEM making it parallel to real life and relate to their everyday experience. Art can translate concepts from various disciplines. In Visual learners learn to paint views of the city that includes the perspectives. Ideas learned through perspective can help students to better understand the development of geometric concepts in mathematics (Meghan, 2014) In the field of crafts, the

production of Batik Pelangi which has a mixture of colors in the resulting dye requires students to understand the concept of molecules and materials. Structural motifs in songket production also involves the measurement of mathematics. Similarly, in the production of models, for example the vehicle model it involved technology and engineering to design and so on.

Conclusion

The paradigm is still very new in Malaysia but the educational philosophy of the new millennium that occur outside the country of introducing STEAM awareness of the importance of visual art STEM developments in Malaysia. The process of teaching and learning in schools should be transformed and given new impetus. In the latest curriculum KSSM 2017 and KSSR revision, STEM integration approach is gaining attention and in Malaysia have begun to be implemented gradually in the core to the curriculum more value integrating various fields of science and practice.

The curriculum has a big impact on the education system as teachers would have to teach the syllabus in accordance with the national curriculum. With the education system in Malaysia which has a centralized nature (centralized), curricula, teaching and learning, as well as all necessary assessments aligned to form a proper education at all levels. Changes to the curriculum of course impact on teaching and learning and assessment in national examinations. Therefore, after the implementation of the new curriculum, the Ministry of Education recommended from time to time to see the needs of schools, teachers, students, parents, and members of the community and the parties concerned (stakeholders) during the implementation of Integrated STEM in KSSM 2017's , The process of communication and discussion are important to give a clear picture of the new curriculum and get feedback for improvement in the future to create an inclusive education system for all levels of Malaysian society.

Acknowledgement

The first author acknowledges the continuous support, guidance and encouraging feedback of her supervisors in the research process also thanks to the , the Ministry of Education and the School Administrator for the full cooperation in this study.

Corresponding Author

Suraya Binti Bahrum,
Faculty of Art, Computing and Creative Industry,
Universiti Pendidikan Sultan Idris, 35900, Tanjong Malim, Perak, Malaysia,
E-mail: surayabahrum@yahoo.com

References

Bequette, M. & Bequette, J. (2011). STEM plus arts make STEAM? Effective integration of aesthetic-based problem solving across topic areas. *STEM Colloquium*. Minnesota

Brown, A. S., & Tepper, S. J. (2012). Placing the arts at the heart of the creative campus. New York, NY: Association of Performing Arts Presenters.

Bryan, L. A., Moore, T. J., Johnson, C. C., & Roehrig, G. H. (2016). Integrated STEM education. In C. C. Johnson, E. E. Peters-Burton, & T. J. Moore (Eds.), *STEM road map: A framework for integrated STEM education* (pp. 23-37). NY: Routledge Taylor & Francis Group.

Bunyamin, M. A. H., & Finley, F. (2016). STEM Education in Malaysia: Reviewing the Current Physics Curriculum. The paper has been accepted for presentation at the International Conference of the Association for Science Teacher International Conference of Association for Science Teacher Education (ASTE), 7-9 January 2016 di Nevada, Amerika Syarikat.

Jayarajah, K., Saat, R. M., & Rauf, R. A. A. (2014). A review of science, technology, engineering & mathematics (STEM) education research from 1999-2013: A Malaysian perspective. *Eurasia Journal of Mathematics, Science & Technology Education*, 10(3), 155–163.

Henriksen, D. (2014) "Full STEAM Ahead: Creativity in Excellent STEM Teaching Practices," *The STEAM Journal*: Vol. 1: Iss. 2, Article 15. DOI: 10.5642/steam.20140102.15

Johnson, C. C., & Sondergeld, T. A. (2016). Effective STEM professional development. In C. C. Johnson, E. E. Peters-Burton, & T. J. Moore (Eds.), *STEM road map: A framework for integrated STEM education* (pp. 203-210). NY: Routledge Taylor & Francis Group.

Kementerian Pendidikan Malaysia (2013). *Pelan Pembangunan Pendidikan Malaysia 2013-2025*. Putrajaya: Kementerian Pendidikan Malaysia.

Koehler, C., Binns, I. C., & Bloom, M. A. (2016). The emergence of STEM. In C. C.

Johnson, E. E. Peters-Burton, & T. J. Moore (Eds.), *STEM road map: A framework for integrated STEM education* (pp. 13-22). NY: Routledge Taylor & Francis Group

Maeda, J. (2013). STEM + Art = STEAM. *STEAM Journal*, 1(1).

Mishra, P., Henriksen, D., & The Deep-Play Research Group (2012). On being (in)disciplined. *Tech Trends* 56(6), 18-21.

National Academy of Science (NAS): Committee of Science, Engineering, and Public Policy (2007). *Rising above the gathering storm: Energizing and employing America for a brighter economic future*. Washington, DC: National Academies Press.

National Research Council (NRC). (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: The National Academies Press.

Reps Bonamici and Schock Announce Bipartisan Congressional STEAM Caucus (February 14, 2013). Retrieved from. <http://bonamici.house.gov/press-release/rebs-bonamiciand-schock-announce-bipartisan-congressional-steam-caucus>

OECD. (2012). *Program for International Student Assessment results (PISA) from PISA 2012: Country note- United States*. Retrieved from <http://www.oecd.org/pisa/keyfindings/PISA-2012-results-US.pdf>

OECD. (2015). *Program for International Student Assessment results (PISA) from PISA 2015: Country note- United States*. Retrieved from <http://www.oecd.org/pisa/keyfindings/PISA-2015-results-US.pdf>

Roehrig, G. H., Moore J., T., Wang, H.-H., & Park, M. S. (2012). Is adding the E enough? Investigating the impact of K-12 engineering standards on the implementation of STEM integration. *School Science and Mathematics*, 112(1), 31–44.

Sanders, M. (2009). STEM, STEM Education, STEMmania. *The Technology Teacher*, December/January, 20-26.