A review of Arts element to enhancing STEAM education in Malaysia

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Abstract

Many countries have conducted many research in the last few years to improve their students' achievement through STEAM (science, technology, engineering, and mathematics) education. Malaysia also focuses on STEM and has stated STEM in the Malaysian Education Blueprint (2013-2015) to strengthen the science subjects in our country. However, the main issue related to STEM education in Malaysia is students' lack of interest in science subjects. The factors that course the students not interested in STEM are students' anxieties and difficulties in getting good grades in STEM, declining PISA performance, and teachers' teaching approach. Many studies that show integrating arts in STEM, which is known as STEAM education, is a critical education model for enhancing STEM. The United States, Korea, and New Zealand had already implemented the model in their education system. This review aims to introduce the STEAM framework and its importance for students and teachers. This study is very important because it will explain what STEAM education is and find out the importance of STEAM so that the Ministry of Education can implement a new approach to STEM. This is a qualitative study that employs a literature review to examine the findings, discussions, and recommendations of collected STEM/STEAM research works from 2006 to 2021. This review discusses STEAM has a positive impact on students' achievement, cognitive development, creativity, and ability in problem-solving as well as students' interest in science and teachers' pedagogy. STEAM education is still new in Malaysia. Therefore, in the future policymakers will need to develop a curriculum, professional development for teachers, and materials to ensure that STEAM can be implemented successfully in Malaysia.

Introduction

In recent years, many countries have conducted research to improve STEM (science, technology, engineering, and mathematics) education in order to improve student achievement. STEM education has received significant official and institutional backing in the United States and the European Union (Corlu & Aydin, 2016). Malaysia is now emphasizing the importance of STEM education. To strengthen science topics, the Malaysian government has declared STEM education as a priority in the Malaysia Education Blueprint (2013-2025). During the 2017 KSSM and KSSR curriculum modifications, STEM was incorporated into the formulation and implementation of new curricula. STEM approaches including high-order thinking abilities, inquiry-based learning, problem-solving, contextual learning, collaborative learning, and project-based learning are applied in the classroom in secondary and primary schools. Despite the attention that has been given to STEM education, it is still an ongoing debate about students' lack of interest in STEM. Research by Yang (2010) found that only five percent of students in the United States of undergraduate level pursue their studies in science-related programs.When children entered secondary school in England, their interest in science topics began to wane (Barmby et al., 2008). In Malaysia, according to Faizatul (2020), only 19% of 44700 Pentaksiran Tingkatan Tiga (PT3) candidates were joining the science stream in form four. The Ministry of Education (2019) science stream students in the year 2018 were decreased from 48% in 2012 to 44% in 2018. Currently, the target to achieve ration 60:40 in the science stream is still far from the target.

According to Faizatul (2020), the reason for students' lack of interest in STEM was because they were anxious due to the perception that it was too difficult to get good grades in STEM subjects such as physic, chemistry, and Addition Mathematics. As Amelia et al. (2019) so eloquently put it, the diminishing number of academics in the science stream is due to fear and a lack of faith in STEM-related subjects. This is because they believe the science stream has a more demanding syllabus than the opposite stream. If the current trend continues, Malaysia will face a scarcity of STEM workers in the future (Abdullah et al., 2017). According to Ring (2017), students have the notion that pursuing postsecondary education is tough if they pick STEM-related fields. Negative attitudes about STEM have been a deterrent to kids pursuing STEM careers (Sin,2013).

Similarly, PISA results in 2018 have become a significant factor in the gradual decline of science stream pupils. According to (Barrett et al., 2015), STEM learning in the United States has declined in comparison to Chinese scholars' performance. Furthermore, despite the rapid rise of science and innovation, student interest in STEM topics has declined dramatically. According to the National Assessment of Educational Progress (NAEP), around 70% of Grade 8 pupils in the United States were not proficient in mathematics in 2018. Malaysia's PISA results in STEM are similarly not encouraging. . Malaysia's PISA results in STEM are similarly not encouraging. In Malaysia, PISA scores in STEM are similarly not encouraging. Malaysia had been in the bottom two-thirds of the list of all participating countries. Malaysian students get 440 points on average in Mathematics, compared to 489 points in OECD countries. Similarly, Malaysian students earn 438 points in science, compared to an OECD average of 489 points. According to Suraya Bahrum et al., (2017), student's interest in STEM has waned, and their STEM achievement is very low.

Teachers have a critical role in the success of STEM education combined with other subjects. One of the factors for students' lack of interest in the STEM field is because of teachers are not exposed to multidiscipline teaching methods (Mohamad Hisyam, 2019). Teachers lack exposure and training in integrated STEM teaching approach so that STEM has left many teachers with outdated knowledge in science and mathematics (Rahman et.al, 2017). When requested to teach STEM in the classroom, teachers, according to Wei (2020), are less confident and concerned. This is due to the fact that they have never received professional training in teaching STEM subjects. As a result, the teaching quality of teachers in regards to

STEM education was judged to be moderate. As can be observed, teachers' attitudes, methodology, and preparation in STEM education were all significant variables in students' interest in STEM. Besides that, Kim (2018) stated that teachers' workload had caused ineffective teaching performance among science teachers. Teachers do not have enough time to teach using 21st-century skills such as problem-solving, collaborative learning, or project-based learning. They need to prepare students for exams so all the teachers are preferring to use the traditional approach in teaching (Titik Rahayu,2018). The traditional teaching approach will affect students' interest in STEM.

STEM is seen as the means to achieve economic growth; policymakers and researchers have expressed concerns about the issues discussed. As a result, this study will introduce arts in STEM which is known as STEAM education, and the importance of STEAM that can help the Ministry of Education to increase students' interest in science subjects and improve teacher teaching skills.

Methodology

This study examines the findings of STEM education research publications as well as current literature from 2006 to 2021. Using a content analysis technique, it analyses and synthesizes the findings, conclusions, discussions, and ideas of accumulated research works connected to STEM/STEAM education. This study will help students better comprehend the STEAM framework and will act as a guide for the creation of a tutorial programme in Malaysia.

Integrating Arts in STEM

Programmers, system engineers, IT professionals, biotechnologies, project leaders, and other occupations related to high technology are in high demand in today's digital society and economy. Many countries recognize the value of the arts. Recognizing that "humanities design and creativity are critical underpinnings of effective mathematicians, scientists, and engineers," Canada and Australia established the Humanities Design and Creativity Initiative (Herro et.al., 2018). The United States and Korea want to boost students' interest, engagement, motivation, and value in STEM education by incorporating aesthetic elements (Moomaw,2012). Arts play a vital role in the development of informed and well-rounded citizens. For young children, early exposure to STEAM offers various benefits. Integrating and engaging learning experiences boost students' enthusiasm in learning To interact with pupils in STEM education, Malaysian education requires a STEAM learning approach. STEM integrated with the arts gives the variety and unpredictability required for new product development and design (Oner et al., 2016)

In terms of schooling, including the arts into STEM can help students develop their problem-solving skills while also revealing their creativity, resulting in their producing artistic products from a holistic and positive perspective. Houet (2020) Arts are vital to STEM because STEAM can educate citizens capable of discovering and investigating links among STEM subjects and other areas, such as activities in life, to deal with the issues of the twenty-first century. There are major downsides in communication, cooperation, innovation, and important thinking benefits, according to Ayvaci & Ayaydin (2017) and Gulhan & Sahin (2018). Students may also be more prepared to learn by exploring and experimenting, and by combining traditional STEM with the arts, they may be able to maximize interaction with their surroundings. STEAM could be a way to take benefit of STEM while also incorporating these guidelines into and through the humanities. STEAM elevates STEM by allowing students to relate their learning to principles and standards, providing them access to the entire learning palette. Limitations are replaced by amazement, critique, inquiry, and innovation in STEAM.

STEAM education

Science, Technology, Engineering, Arts, and Math (STEEAM) are acronyms for Science, Technology, Engineering, Arts, and Math. Georgette Yakman may have been a founder of STEAM when she was a master's student in Virginia Polytechnic and State University's Integrated Science-Technology-Engineering-Mathematics Education programme in 2006. (ISTEMed). The STEAM Congressional Caucus, which stands for Science, Technology, Engineering, Arts, and Mathematics, was created in January 2013. The Caucus' mission is to "change educational vocabulary to reflect the benefits of both the humanities and sciences, as well as their intersections, to future generations of Americans."

Yakman (2008) STEAM is based on STEM education, which is a relatively new paradigm for teaching across disciplines to help more students comprehend the systems and relationships that combine hard sciences, technology, engineering, and mathematics to help address problems in a quickly changing world. The STEAM framework tries to help educators teach subjects in a way that is more connected to one another. Within the already well-established sphere of education, STEAM-style teaching is frequently fun and meaningfully offered in further engaging and deeply embedding methods. Students require a functional literacy that includes a breadth of first-discipline literacy, as well as the capacity to transfer knowledge with higher-order thinking between disciplines (DeBoer,1991:Yakman,2008). The STEAM ideology revolves around the idea that STEAM stands for Science, Technology, Engineering, and the Humanities, all of which are backed by Mathematical aspects (Yakman,2008). the definitions and classifications of STEAM elements that follow:

Science : " What exists naturally and the way it's affected?"

“Physics, Biology, Chemistry, Geosciences, Space Science & Biochemistry”

Technology: "What is human-made ?"

“Nature of Technology, Technology, and Society, Design, Abilities for a Technological World, The Designed World (including Medical, Agriculture & Biotechnology, Construction, Manufacturing, Information and Communication,
Transportation, Power & Energy”

Engineering: "The use of creativity and logic, based in mathematics and science, utilizing technology as a linking agent to create contributions to the world." "Aerospace, Architectural, Agricultural, Chemical, Civil, Computer, Electrical, Environmental, Fluid, Industrial/Systems, Materials, Mining, Naval Architectural, Nuclear, Ocean (ASEE, 2008)"

Mathematics: "Numbers and Operations, Algebra, Geometry, Measurement, Data Analysis &

Probability, Problem Solving, Reasoning & Proof, Communication, (including

Trigonometry, Calculus & Theory)" (NCTM,1989)

Arts : "How society develops, impacts, is communicated and understood with its attitudes

and customs in the past, present, and future."

"Physical, Fine, Manual, Language & Liberal (including Sociology, Education,

Politics, Philosophy, Theology, Psychology, History & more"

Yakman (2008) develops a framework for organizing and assessing, depending on these characteristics, the interactive nature of both the practice and study of formal fields of science, technology, engineering, mathematics, and the arts

Concepts of the STEAM framework (Yakman, 2006)

Top of Pyramid

"At the top of the pyramid is a universal level. This correlates to the concept of holistic education. People will learn to adapt to their environment. The first level is also known as life-long education."

Integrated Level

"The integrated level is students integrated all the fields and a basic overview in their lesson. Use thematic concepts to show students during this level, so all fields are often related within the lesson. This level is most relevant to grade school and secondary school education."

Mutidisiplinary level

"The third level of the pyramid is multidisciplinary. it's at this level where students can get a scope of specifically chosen fields and a concentrated overview of how they inter-relate actually. A superb thanks to teaching about natural inter-relations in practice is to show reality base/authentic units."

Discipline-Specific Level

"The fourth level of the pyramid is labeled the discipline-specific level. This level is where the specific divisions of each silo should be given an overview. This is the level at which to explore what areas of expertise a person wishes to acquire a career and hobby. Since this is very appropriate for young adults and most relevant to secondary education."

Content-Specific Level

"The fifth level of the pyramid is the content-specific level. Specific content areas are studied in detail, where professional development happens and students delve into the tighter realm of the specific content areas of their choice. Areas can be studied alone or in specifically grouped clusters from within their silos or from across the fields"

Yakman argues that learning the contextual learning is a STEAM strategy in which students are invited to comprehend events that occur in their immediate environment. (Ridwan et.al 2017) STEAM educations encourage students to explore, solving problems with their abilities, collaboration, and communications with others when they involve with the learning processes.

A working definition from the Office of Congresswoman (Bonamici.S, 2014):

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 artists, community-based arts organizations, and art teachers employed by LEAs (Local Education Agencies), and other teaching methods that use the arts to facilitate an effectively carry out STEM instruction and learning."

Julia Andrew (2020) STEAM characteristics can be concluded as:

1. STEAM is an integrated learning method that necessitates a deliberate link between standards, assessments, and course design/implementation.
2. True STEAM experiences entail teaching and assessing two or more standards from Science, Technology, Engineering, Math, and the Arts through each other.
3. The STEAM approach is built on inquiry, collaboration, and a focus on process-based learning.
4. An true STEAM project must utilise and leverage the integrity of the arts itself..
5. Intentional connections-students can demonstrate and apply their talents; 5 STEAM outcomes: Inquiry-based learning is built on questions, problem-solving, and the process of learning. Integrity- the substance of the arts has been carefully chosen and is being taught with honesty; Collaboration, Creativity, Critical Thinking, and Communication are 21st century skills; Equitable Assessment is a measurement of growth.

Julia Andrew is a character in the film Julia Andrew (2020) The STEAM education framework represents a paradigm shift from old educational philosophy, which was centered on mono disciplinarity, to modern requirements, which emphasize multidisciplinary. Integrating the arts into STEM benefits students by fostering creativity and learning via hands-on experience inside the STEM environment. Importance of STEAM

Impacting students' achievement

STEAM is an approach to positively impacting student performance. Brouillette, L& Graham, N.J (2016) Physical science learning in high poverty elementary schools in an urban district in grades 3 to 5 is influenced by STEAM lessons. According to the findings, students who got just nine hours of STEAM training boosted their science achievement. Ahmad et al., (2021) STEAM have a favorable impact on learning outcomes, with students' average grades increasing significantly before and after participating in STEAM classes. Park, Kim, and Lee (2018) In STEAM-based faux engineering programs, 3D modelling and printing have been utilized to improve student learning results and attitudes about technology.. Students achieve high scores in the engineering courses and feel confident with the courses. Kim& Bolgel, 2017; Quigly & Herro, 2017; Thunberg, Salmi & Bugner, 2018, Yakman & Lee, 2012 The STEAM approach has been proved in the research to have favorable effects on academic attainment and motivation. Students feel motivated in the learning process because they learn by doing such as experiments and projects that they will know the process and apply the learning concepts in the activities. By this, students will understand what they learn and they can get a good achievement in their examination.

Positive impact in cognitive development

Connecting STEAM and literacy can help youngsters develop their cognitive skills, enhance their literacy and numeracy skills, and reflect on their work in meaningful ways. Several studies and technological products relating to the function of art in STEM have been acknowledged, according to Swaminathan & Schellenberg (2015). According to Swaminathan's research, learning the arts can aid students in improving cognitive skills such as spatial reasoning, abstract thinking, divergent thinking, self-creativity, openness to experience, and curiosity In technology items, an electronic display screen that uses a combination of red, blue, and green dots to produce all of the different hues is utilized .As a result, by incorporating a STEAM approach into formal education, pupils will benefit from a positive impact on cognitive development beginning at a young age.

According to Barbre (2017), incorporating STEAM courses into VR instruction improves students' abstract notions, learning outcomes, and practical competence. This is because when students working in group discussions, they do the experiment and use the concepts that they had to learn in solving problem activity. From the activity, they will apply the knowledge in a real situation. Kang (2019) Both cognitive and affective learning will be influenced by STEAM education. The experience in elementary school shown that the effect could last a long time.. Students will get the experiences when they are doing the activities by themselves. They will remember the facts and they also learn about how to communicate with others in the class. Besides cognitive development, Through, student-centered learning, STEAM education can also help students develop their communication and cooperation abilities. These abilities are required in both elementary and secondary school (Colegrove 2017). STEAM activities will help students communicate and collaborate by delivering a meaningful learning experience by tackling a problem creatively or applying it to a real-world setting (Spyropoulou, C, 2020). People can acquire self-confidence and self-esteem through STEAM education.

Improve students' creativity and ability in problem-solving

STEAM education encourages students to be creative and efficient in problem-solving. They are trained to dominate 21st-century skills such as critical thinking to find out solutions to problems, creativity, collaboration to work with others, and communication to convey ideas. All these skills are important in the world of work. Herro, Jagques & Quigly (2018) STEAM aims to mix art with science, technology, engineering, and mathematics in order to improve students' problem-solving skills, as well as to demonstrate their creativity and ensure that they can develop artistic objects from a holistic and positive perspective.

Yakman (2008) broadens the scope of STEAM by incorporating arts into STEM, arguing that aesthetics and arts should not be overlooked in new approaches. When pupils are requested to draw something, for example, they must look more attentively at the objects and scrutinize them more thoroughly in order to notice the lines and shapes of what they are dissipating. As a result, they learn to notice even minor variations. While learning spatial thinking, students develop the ability to see a three-dimensional space by looking at a two-dimensional drawing. It is a skill that engineers, architects, and scientists must learn, and it also helps pupils understand difficult subjects.

STEAM learning approach can improve students' creative thinking skills. Students will develop their creative thinking skills when they involve in project-based activities (Ahmad et al., 2021). Project-based -learning such as design game, build model or product encourage students' creative ability. According to Liao (2016), the STEAM education approach supports experiential learning, creativity, problem-solving skills, and argue that STEAM is interrelated, students are encouraged to take risks, think critically, and find creative solutions to the problem. Learning approaches in STEAM education such as experiencing learning can train students to think creatively in solving problems.

Increasing students' interest in science(Kang, 2019)

STEAM activities such as project-based learning, designing, gaming, and so on can attract students toward science. Those who took part in STEAM lessons, according to Hong (2018), had a stronger "science preference" than students who did not. They demonstrate higher degrees of inability to lead, cognitive strategy, learning motivation, and problem-solving motivation. Students had a lot of fun learning during Zoi Karageorgian's (2019) mobile programming and using a smartphone as a QR reader for 360-degree capture and editing exercises. It was a driving force for me to tutor others, conduct substantial research, and be very active. The students had a great time in class and came up with a lot of great ideas. Kajima (2021) stated that there was an improvement in youths' interest in engineering when they participated in the STEAM workshop. STEAM design thinking workshop increased participants' confidence in engineering so that their interest in science increased. Quiqley et.al (2017) STEAM learning emerged as a response to the need to increase students' interest and skills in the STEAM. Students actively do their hands-on activities and they enjoyed the activities. According to Jamil et al. (2018), STEAM courses can improve students' motivation, attitude, and specific course success, as well as help students think about and integrate the connection between knowledge and practical engineering. The students expressed an interest in student-centered design activities and discussions about many aspects of a problem. Students' interest will increase when the STEAM approach implements in education because it provides students with an authentic learning experience that includes tasks, with real-world contexts, ill-defined problems, complex or multistep questions, multiple ways to approach a problem, integrate across the discipline, and have failed and interactions built into assignment itself.

Improve teachers' pedagogy

Teachers will benefit from using a STEAM approach to improve their teaching methods. Teachers will be able to conduct their teaching in a variety of ways using student-centered learning methodologies such as project-based learning, process-based learning, and experiential learning. Secondary teachers' perspectives revealed inter, trans, and cross-disciplinary learning impacted by teacher cooperation, dialogue, and classroom organization that supports critical and creative thinking, according to Harris and Bruin (2018). STEAM solutions, according to Segarra et al. (2018), are a useful complement to traditional teaching and training. More creative teaching activities and interests, such as gaming, gardening, dance, or crafts, might be added to the curriculum.

Oner et.al (2016) the study stated that teachers who used Project-based learning will make the lesson more creative and active. Students were happy and interested when they were doing their project. The results showed that students were motivated in the lesson. Adding the arts in STEM also provides more options for the teachers to present STEM concepts to children, especially at the elementary and early childhood levels. Providing meaningful hands-on STEAM experiences for children positively impact their perceptions and dispositions towards STEAM (Spyropoulou, C et.al 2020). Teachers may use various methods in teaching such as story-telling, drama, or outdoor learning activities for children to learn.

STEAM education is a flexible teaching model. Teachers may use their creativity to teach students to reach positive outcomes. Promote learning experiences allow students to explore, question, research, discover, and exercise innovative building skills (Colker. et. al.,2014) From the literature, STEAM education can improve teachers' pedagogy and increase the education qualities. Teachers also have more opportunities to communicate with teachers and students during teaching activities. Moreover, a collaboration between interdisciplinary teachers helps relieve some of the pressure of developing lessons in isolation, thereby providing an atmosphere of creativity and innovation within the teachers' community (Doniger,2018).

Conclusion and Discussion

There are many benefits for students from early exposure to STEAM. Integrated and exciting learning experiences improve students' interest in learning. Malaysian education needs a STEAM learning model to interact with students' interest in STEM education. Arts is a new educational element that can be applied in Malaysia to enhancing STEM education. Integrating multi-discipline in teaching will produce multi abilities students. Students become more creative, able to solve problems, improve their communication skills and be more collaborative. All these skills are important for our education system and the future to implement in their working fields. Students' interest in science will increase when implement STEAM in learning activities. Increase the interest in STEM can help Malaysia to achieve the Ministry of Education's target which the ministry needs 60% science stream students in 2025.

To make sure that STEAM education can be implemented in Malaysia, the stakeholders need to focus on the development of diverse educational material and programs that promote STEAM educations. Ministry of Education must be ready to develop a STEAM program such as utilizing the up-to-date product, an integration-based program in science and art, and a design-based program to promoting future jobs. On the other hand, teachers and researchers can work together to develop a variety of high-quality teaching materials such as apps, modules, and teaching programs that suit our curriculum.

Teachers' understanding of STEAM rose dramatically, and they developed more favorable attitudes about STEM, according to research, enhancing their self-efficacy and confidence in teaching STEAM so that it can be implemented effectively in the classroom. Systematic training must provide to teachers so that teachers understand the concepts of STEAM education and the know-how to apply STEAM into their lessons. Teachers need to mastered STEAM pedagogy; they have to prepare to teach interdisciplinary knowledge and skills, as well as effective outcomes, which are expected before STEAM education implement in the Malaysian education system.

More studies are required to encourage the integration of STEAM into the curriculum in our countries. Teachers' STEAM teaching capacity could be strengthened by professional development with elements of collaborative or classroom implementation. Further research on effective STEAM professional development program design principles are necessary and STEAM implementation in the classroom. Therefore, the Ministry of Education needs to prepare the curriculum, professional development, and learning materials before STEAM can implement completely in Malaysia.

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