Journal of Electronics, Computer Networking and Applied Mathematics
ISSN: 2799-1156
Vol: 02, No. 03, April – May 2022
http://journal.hmjournals.com/index.php/JECNAM
DOI: https://doi.org/10.55529/jecnam.23.38.47

Application of Stem in the Mastery of Mathematics Learning in Primary School

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Received: 29 January 2022 **Accepted:** 16 April 2022 **Published:** 20 May 2022

Abstract: Science, Technology, Engineering and Mathematics (STEM) is an important agenda in the Malaysian Education Development Plan (PPPM) 2013-2025. Mathematics teachers play an important role in teaching and learning in the classroom. This study is a needs analysis study in the first phase of Design and Development Research (DDR). The purpose of this need's analysis study is to identify the need for the development of STEM application models in Mathematics mastery in primary schools. The study was conducted qualitatively using the interview method. Informants such as mathematicians, STEM experts, model development experts and primary school mathematics resource teachers were interviewed. All these experts were selected by purposive sampling and met the set criteria. Interview data were analyzed using thematic techniques, namely transcription, coding and themes verbatim. The findings of this study indicate that there is a need for researchers to develop STEM application models in mathematics mastery. Therefore, researchers suggest that further research is needed to make a study to discuss the impact and importance of STEM applications in mathematics learning mastery in primary schools.

Keywords: Mathematics, STEM, Application Implications, Mastery, Learning.

1. INTRODUCTION

The Malaysian Education Development Plan 2013-2025 (PPPM) has outlined approaches and improvements that aim to improve the education system in Malaysia in order to compete with the international education system and improve the quality of education in Malaysia (Adam & Halim 2019). To achieve this objective, MoE has identified 11 shifts that can bring about changes in the education system in Malaysia. The first transition in this framework has stated the need to provide equal access to quality education of international standards. Improving the quality of Science, Technology, Engineering, and Mathematics (STEM) education is one of the indicators in the first transition (Wyatt Dalton, 2019).
According to Abdullah et al. (2018), the integration of STEM in mathematics teaching offers the best opportunity for students to understand mathematical concepts more contextually and

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holistically. STEM education also removes traditional barriers by integrating them into the teaching and learning of mathematics (Noleine Fitzallen, 2015). In this context, the experience of STEM integration in mathematics teaching will indirectly increase students' involvement, confidence, curiosity and understanding of integrated STEM disciplines. In addition, according to a policy report by the Children's STEM Working Group (2017), STEM integration activities in the mathematics teaching process can provide positive opportunities for primary school children in fostering the attitude and belief of young students in their ability to succeed in the STEM field . Therefore, a study related to the application of STEM in mathematics learning in primary schools is necessary to develop a conceptual framework in the mastery of mathematics learning in primary schools that can be used as a guide for teachers to better integrate STEM.

Therefore, through the desire of the Malaysian Ministry of Education to reach international education standards by 2025, the application of STEM education has become one of the initiatives emphasized in the Malaysian Education Development Plan (2013-2025). According to Carlisle & Weaver (2018), increasing the flow of STEM education channels is the best way to motivate children to increase their interest in science and mathematics. Through the integration of STEM education, students can find answers to real-life problems and explore new things. Many developed countries such as America, Australia and Canada have begun to introduce in the mastery of learning mathematics. Fernández-Cézar (2020) says "in the mastery of learning mathematics is an approach that aims to teach the discipline as an integrated whole and includes the entire process from early childhood to higher education".

According to Hassan (2018), in the mastery of mathematics learning aims to increase students' imagination and develop solutions to challenges by applying their mathematical and scientific knowledge in technology design, based on learning problems and authentic scientific research. Therefore, compared to traditional rigid formal education in early childhood education, mastery in mathematics learning offers resources and opportunities for younger students to explore, investigate, and develop their own knowledge as active learners. Johnson (2020) claims that countries such as the United Kingdom, Germany, Ireland and Finland have acknowledged the mastery of learning mathematics as a priority in their education system.

Khotimah (2021) suggests several ways for the application of STEM in the mastery of mathematics learning that includes hands-on experience and active involvement such as project-based learning and learning games. Furthermore, Kong & Mohd Effendi (2020) claim that mathematics teachers need to develop their knowledge in STEM with the concept of Mathematics. This is because mathematics teachers play an important role in ensuring mastery of mathematics learning. Regardless of the approach used, efforts are still taken to develop a suitable curriculum for the integration of STEM education in mathematics education (Kuschel et al. 2020).

Background of the Study

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JADUAL 1. Pelaksanaan STEM berdasarkan Pelan Pembangunan Pendidikan 2013-2025

Gelombang 1 (2013-2015)	Gelombang 2 (2016-2020)	Gelombang 3 (2021-2025)
• Mengukuhkan kualiti Pendidikan STEM melalui pengukuhan kurikulum, pengujian dan latihan guru dan penggunaan model pembelajaran pelbagai mod (blended learning).	• Menarik minat dan kesedaran masyarakat tentang STEM melalui kempen dan kerjasama. • Semakan semula Kurikulum Standard Sekolah Menengah (KSSM) dan Kurikulum Standard Sekolah Rendah (KSSR) dilaksanakan. • Menaik taraf makmal sains sedia ada di sekolah rendah dan menengah. Kementerian juga bercadang memperluaskan program kesedaran STEM kepada murid sekolah rendah serta bercadang menggunakan pendekatan tidak formal untuk mengukuhkan minat dalam pendidikan dan kerjaya dalam bidang STEM.	• STEM akan dianjak ke arah kecemerlangan melalui peningkatan keluwesan operasi (Panduan Pelaksanaan Sains, Teknologi, Kejuruteraan dan Matematik) dalam pengajaran dan pembelajaran (PdPc).

JADUAL 2. Transisi peralihan daripada KBSM kepada KSSM

Kohort	Tingkatan 1	Tingkatan 2	Tingkatan 3	Tingkatan 4	Tingka tan 5
2017	KSSM	KBSM	KBSM	KBSM	KBSM
2018	KSSM	KSSM	KBSM	KBSM	KBSM
2019	KSSM	KSSM	KSSM	KBSM	KBSM
2020	KSSM	KSSM	KSSM	KSSM	KBSM
2021	KSSM	KSSM	KSSM	KSSM	KSSM

The application of STEM in the mastery of mathematics learning is a type of mathematics curriculum integration. The concept of mathematics curriculum integration is complex and challenging because subject integration puts different subject areas together. The idea of curriculum integration comes from the awareness of educators that the problems of the world cannot be separated which become the isolation of disciplines taught in schools (Beane, 1995; Czerniak et al., 1999; Jacobs, 1989). In most cases, people need skills that cross disciplinary lines. Even with this view, researchers and educators have yet to reach consensus on a clear definition and conceptualization of curriculum integration (Czerniak et al., 1999; Huntley, 1998). Research studies are often unclear about the terminology that has been used to describe integration (Beane, 1995; Czerniak et al., 1999; Drake, 1998; Lederman & Niess, 1997). Two words that are often used in the literature to describe the integration of the mathematics curriculum are "multidisciplinary" and "interdisciplinary". "Most research studies try to distinguish the two by focusing on the path and level of integration.

In this study, the researcher tried to obtain the current understanding and definition of integrated STEM in mathematics education in order to gain a deeper understanding. Various definitions of STEM application in the mastery of mathematics learning. Most definitions revolve around the manipulation of STEM ideas in the teaching and learning process. For example, Sanders (2009) defined integrated STEM education as "an approach that explores teaching and learning between two or more STEM subject areas,. Moore et al. (2014) added that interdisciplinary integration is "based on connections between subjects and real-world problems , "and more specifically applies, "The efforts of educators to participate in engineering design as a method to develop technologies that require meaningful learning and the application of mathematics and / or science". In addition to teaching two or more STEM domains, Kelley and Knowles (2016) further characterize integrated STEM in mathematics

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teaching as "linked to STEM practice in authentic contexts for the purpose of connecting mathematics subjects to enhance student learning".

Stohlmann et al. (2012) suggested that the application of STEM in the mastery of mathematics learning is an effort to combine various classes into one class, but it is not necessary to involve all four STEM disciplines. This explanation is not easy, because one question that is commonly asked is whether all four STEM disciplines need to be united to be considered integrated STEM in mathematics teaching. Another definition includes a broader "vision" of what good integrated STEM education is in mathematics instruction beyond disciplinary integration. For example, the Dayton Regional STEM Center (2011) has promoted a principles-based framework for defining quality STEM and based an integrated STEM education on 10 components.

At the STEM Academy, the Department of Energy created and offered the following definition to its participants: "STEM education is the use of science, technology, engineering, mathematics, and their related practices, to create a student-centered learning environment where students investigate and engineering problem solving, and building evidence-based explanations of world phenomena (Kelley and Knowles, 2016). The application of STEM in the mastery of mathematics learning encourages creativity and innovation while developing critical thinking, collaboration, and communication skills as students search for explanations about the natural world to improve the built world". This is a common conceptualization in the Application of STEM in the mastery of mathematics learning that is offered to all participants who study at this time. Breiner, Harkness, Johnson, and Kohler (2012) defined the practice of STEM Application in the mastery of mathematics learning as a transition from traditional classroom lectures to pedagogical implementation involving inquiry and problem-based learning approaches.

In their literature review, Briener et al. (2012) suggest that others define the Application of STEM in the mastery of mathematics learning as a complete curriculum in learning and teaching sessions that include mathematical concepts in a way that most closely reflects the practice of professionals currently working in the STEM field in an effort to graduate more students who are ready to work in STEM professions. Moore et al. (2014a) defined the Application of STEM in the mastery of mathematics learning as, "efforts by educators to have students participate in meaningful mathematical application and solution activities".

Purpose of the Study

STEM is a field of study at school and a field of study at the tertiary level. Examples of STEM subject areas are Science, Chemistry, Mathematics, Fundamentals of Sustainability, Technical Communication Graphics, and Computer Science. Examples of STEM courses at the tertiary level are Mechanical Engineering, Medicine, Bio-chemistry and Computing & Information Systems. In addition, Technical and Vocational Education and Training (TVET) which is also a STEM component will have high added value in industrial sectors such as oil and gas, aviation and shipping engineering and green technology.

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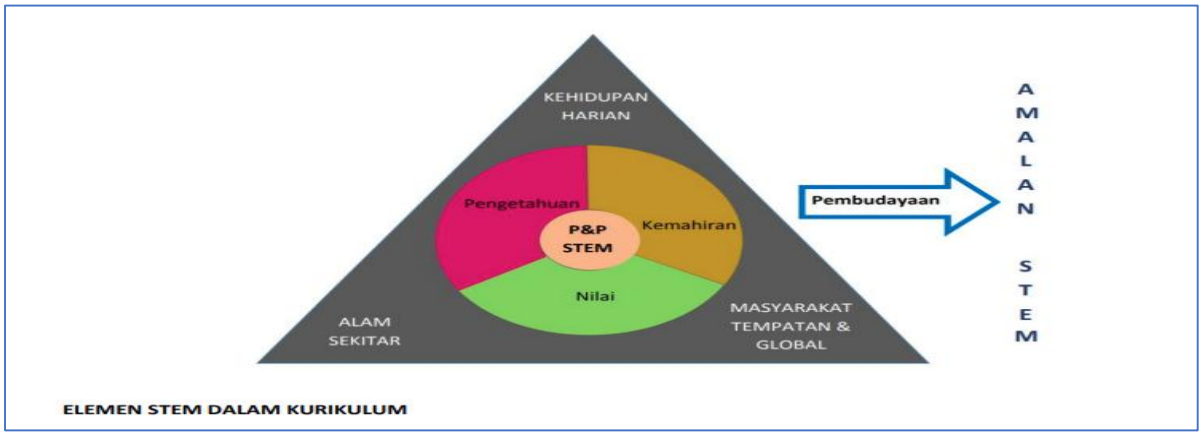
Therefore, in the school system, STEM is a p&p approach that involves the application of STEM knowledge, skills and values to solve problems in the context of daily life, society and the environment as shown in the diagram below. This approach encourages students to ask questions and explore the environment through inquiry and solve problems related to the real world towards cultivating STEM practices.



STEM skills are competencies and competencies to explore, solve problems, design and produce products. These skills can be acquired through activities, projects or assignments that are required in the curriculum of all STEM subjects. STEM skills consist of Process Skills and Technical Skills. Process Skills are skills used in the process of learning and applying knowledge in solving problems. Process Skills involve science process skills, mathematical process skills, design skills and computational thinking skills. Technical skills are psychomotor skills that include manipulative skills, management skills and the handling of materials, tools and machines in a correct and safe manner.

So the main purpose of the researcher is to ensure that all these skills can be experienced by students at the primary school level. Therefore, as a mathematics teacher, the first step planned is to introduce the application of STEM in Mathematics Learning in Primary Schools.

Literature Review

Design and Development Research (DDR) was used in this study. The study aims to introduce the application of STEM in Mathematics Learning in Primary Schools. Richey and Klein (2007) explained that a study that uses the DDR method is an orderly and systematic process, namely the needs analysis phase, the design and development phase and the evaluation phase that involves testing the usability of the model.

Saedah et al. (2013) stated that DDR is a research approach that can provide validity and reliability of data and information that is useful to researchers in the field of learning technology and curriculum development. Empirical data collected using DDR helps in the development of new theories that contribute to improvements in technology learning. DDR refers to a systematic research process that covers the development of education-related

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products/models/modules. The strength found in this DDR-based research approach is very systematic, and it is able to guide every researcher in developing their studies on the condition that every method used must comply with the prescribed procedures (Mohd Ridhuan & Nurul Rabihah, 2020).

In this study, needs analysis is the first phase in DDR, the researcher uses a qualitative approach using a semi-structured interview protocol with a number of experts, namely mathematics experts, STEM experts, model development experts and mathematics resource teachers. A needs analysis was made to get a direct expert view on the need to introduce STEM Application in Mathematics Learning in Primary Schools. An interview protocol was developed based on the themes identified through the literature review. Before the interview was conducted, the validity of language, content and qualitative experts was carried out against the interview protocol. Face-to-face interviews allow the researcher to obtain information related to the informant's view and a deeper study and help the researcher control the discussion (Cohen et al., 2018; Cresswell & Creswell, 2018). Informants in the field of education who have experience of more than five years in the current field can be classified as experts (Berliner, 2004; Akbari & Yazdanmehr, 2014. The selection of informants using sampling aims to meet the criteria set and obtained from different institutions.

Leading databases such as SCOPUS and ERIC were used in the search for articles for the research conducted. The keywords "STEM Maths education learning" and "STEM Maths education learning approach" are used to search for related articles using English and Malay. The keyword is to find articles related to learning related to mathematics STEM education and learning STEM approaches in education.

2. DISCUSSION

Based on the verbatim transcription analysis done, informants have agreed that there is a need for STEM Application in Mathematics Learning in Primary Schools.

Demographics of study informants

A total of 10 informants have more than 10 years of experience in the field of mathematics education, STEM and model development. The demographics of the informants are shown in Table 1.0.

Table 1: Informant Demographics

Aspect	**Categories**	**Numbers**
Experience in Education	<10 years	0
	11-15 years	3
	21-30 years	5
	16-20 years	1
	>30 years	1
Expertise field	Staff at Pusat STEM Negara	2

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	Mathematics Professor in University Model developers at IPG Mathematics Lecturer at IPG Mathematics Resource Teacher	2 2 2 2
Place of working	Putrajaya Pahang Selangor	3 2 5

Based on Table 1.0, it was found that a total of ten informants involved in this research interview are experts who have experience in education for more than 10 years. All informants in this interview are from different locations, namely Putrajaya, Pahang and Selangor.

All informants who have been interviewed have expertise in certain fields, namely mathematics, STEM and model development. However, all informants from different institutions/schools, namely mathematics experts, STEM experts, model development experts and primary school mathematics resource teachers.

After the interviews were analyzed, it was found that the informants agreed that there is a need for STEM Application in Mathematics Learning in Primary Schools.

Some insightful views are presented below;
"Of course this effort should be done immediately... In this era of globalization, STEM elements have become an important concept in everyday life, it is appropriate that this application should be done at the primary school level..." (Informant 1)

"It is very necessary...so that students and teachers adapt to modern technology that is becoming more prevalent. A skill that is easy and easy for students to understand'. (Informant 2)

"I strongly support you, as we move on intomany advance things, its best to educate our younger generation with multi skills. STEM Yes!!!. I'm glad with your idea" (Informant 3)

"In this era, even more so with these GEN Y students, it is really important to apply STEM in learning mathematics. It makes it easier for teachers and also students'. (Informant 4)

"I think I totally welcome this idea. It will be more fun for the kids to do their maths assignments as many think maths is tough but its easy in a way". (Informant 5).

Informants have given thoughtful opinions by stating their respective reasons. As an expert in this field, Informant is aware of the Application of STEM in Mathematics Learning in Primary Schools. More condemning because the informant said about the Five categories of STEM approaches found from previous studies, namely multi-mode learning, inquiry-based learning, problem-based learning, project-based learning and cooperative learning.

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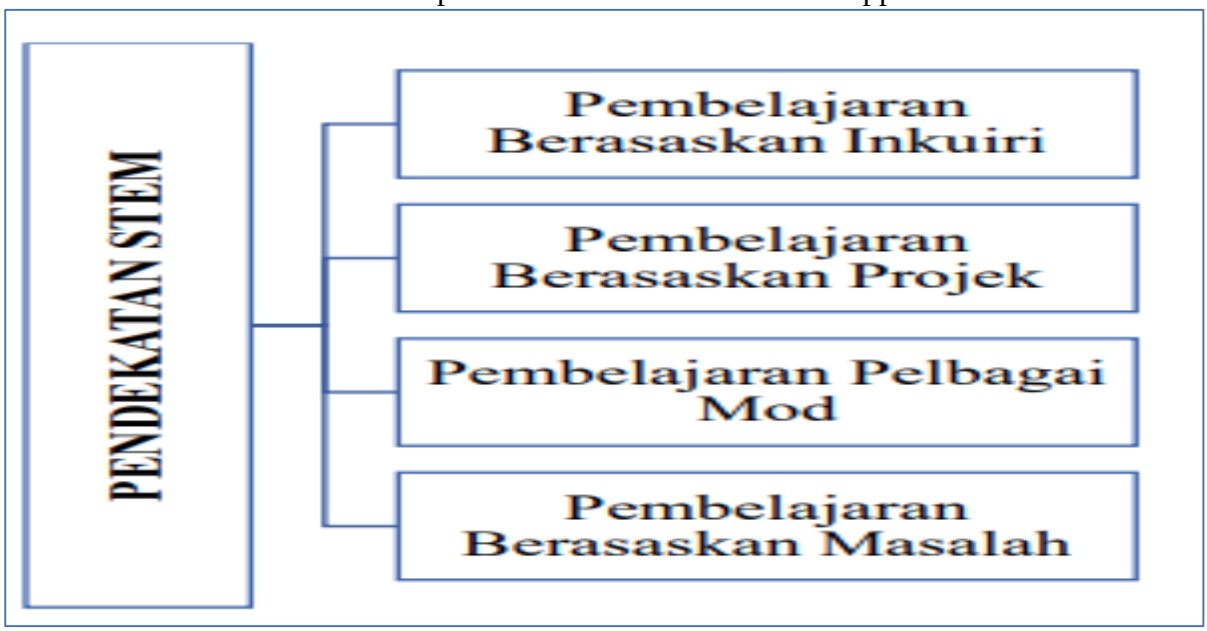
All five of these modes can be used to realize the researcher's study which is the Application of STEM in Mathematics Learning in Primary Schools.

Table 2: Conceptual Framework of the STEM Approach



Through the findings of this interview, it can be concluded that the informants as a whole agree that the Application of STEM in Mathematics Learning in Primary Schools is for their use and as a teaching guide for teachers to facilitate teaching and learning. Their statements are guided by their experiences as math experts, STEM experts, model development experts and math resource teachers in primary schools. Saedah et al. (2020) explained that the study in the needs analysis phase was conducted to identify the needs in building the new innovation proposed in the study. The information from the first phase will be part of the basis in designing the model or whatever final product is the target. This finding is in line with the findings of previous researchers (Dare et al., 2019; Muhammad Nasiru et al., 2018; Ostler, 2012) who stated that model development is very important as a guide for teachers to apply STEM in Mathematics Learning in Primary Schools.

3. CONCLUSION

Based on the research that has been conducted, it can be concluded that the requirements analysis phase needs to be implemented as the first step in the design and development study (DDR). Through needs analysis, the informants as a whole agreed that applying STEM in Mathematics Learning in Primary Schools as a guide for teachers in teaching and learning to produce holistic students, not only excellent in mathematics, but also excellent from the technological aspect of creativity for facing the challenges of globalization in line with the focus on STEM in the context of Teaching and Facilitation (Malaysia Education Blueprint 2013**).**

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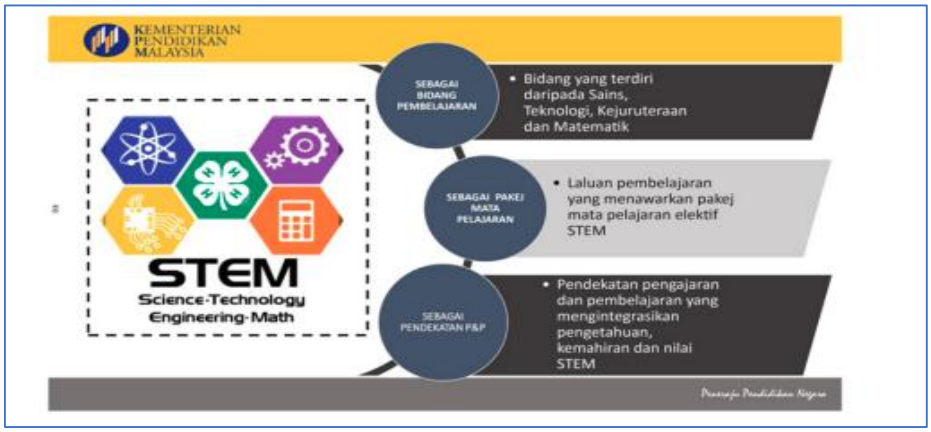

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