INTEGRATING STEM EDUCATION THROUGH PROJECT-BASED 
INQUIRY LEARNING IN TOPIC SPACE AMONG YEAR ONE 
CHILDREN

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ABSTRACT
This research aims to investigate the effect of integrating STEM education through Project-based Inquiry Learning (PIL) and the used of the STEM modules which consists of three projects on topic Space in Year One Mathematics Syllabus in Kurikulum Standard Sekolah Rendah (KSSR) of Malaysia. STEM education in primary school focuses on introduce and awareness of students about the importance of STEM education. The projects in STEM modules are covering the different ethnic cultures in Malaysia. The modules are designed using the four phases in PIL. Concepts and the explanation of STEM education on each project are emphasized and provided in the modules so the teachers able to carry out the projects by using the modules. By using the modules in primary Mathematics, the students and teachers will be more understand on how to integrating the Mathematics' concepts in STEM education.

Keywords: STEM education, Project-based Inquiry Learning, Kurikulum Standard Sekolah Rendah (KSSR), Space

Introduction
Given the context of rising international education standards and the aspiration of better preparing Malaysia’s children for the needs of the 21st century, the Government of Malaysia has conceptualised the Malaysia Education Blueprint 2013-2025 which embodies 11 strategic and operational shifts. In Shift 1, it is emphasised that the quality of Science, Technology, Engineering, and Mathematics (STEM) Education will be enhanced.

STEM is an acronym for Science, Technology, Engineering, and Mathematics. Despite that, Sneideman (2013) believes that STEM is a philosophy or a way of thinking where several subjects namely Science, Mathematics, Engineering and Technology are integrated into one education areas considered more appropriate and relevant to be taught in schools especially, because of it emphasizes practical aspects and reality. In this way children learn Science and Mathematics in real, realistic and meaningful contexts through technology applications and inventions. Learning this way is more fun, involves hands-on and gives you a continuous experience stimulate children to think and solve problems.

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:
i. 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.

ii. 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.

iii. 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.

iv. 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:

i. Using meaningful learning context and relate to student real life.

ii. Challenge students potential using design approach Engineering to develop critical and creative thinking through activities that be related.

iii. Student aided design technology can learn from failure in designing solutions in engineering design with existing design.

iv. Implementing teaching and learning that is integrated with science and mathematics and subjects relevant like Literature, Humanities, and Social Studies.

v. Implementing teaching and learning activities that are student-centered so that students are actively involved in teaching and learning

vi. Train students to collaborate and communicate in conducting educational activities.

To enhance the quality of education in Malaysia, the Ministry of Education (MOE) had developed and launched the Malaysia Education Blueprint 2013-2025 (PPPM) which aims to transform the education system in Malaysia in order to compete with the growing international education system. To achieve this objective, the MOE has identified 11 shifts that can result in changes in the education system in Malaysia. The first shift in this blueprint has stated: Provide Equal Access to Quality Education of an International Standard. One of the benchmark in the first shift is to strengthen quality of Science, Technology, Engineering and Mathematics (STEM) education.

In order to produce the educated citizens and meet the needs of 21st century skills, STEM education is an important interdisciplinary subjects which fulfilled the needs. Each individual must know and understand the basic concepts of STEM. STEM education has given the best opportunities for students to understand the world in a holistic manner. According to Hays Blaine Lantz, Jr. (2009), STEM education offers students one of the best opportunity to make sense of the world holistically, rather than in bits and pieces. STEM education removes the traditional barriers erected between the four disciplines, by integrating them into one cohesive teaching and learning paradigm.

To equip the students with the skills needed to face the challenges of a changing global with the application of STEM, the MOE is responsible for ensure an increasing in the ratio of students who wish to pursue scientific and technical fields. In the PPPM 2013-2025, the MOE has stated the five factors that cause the decline and the quality of student outcomes in STEM education:

i. Lack of awareness in STEM education.

ii. STEM subjects considered difficult.

iii. A solid curriculum content.

iv. Less consistent in the quality of teaching and learning.

v. Old and inadequate infrastructure.

These factors or problems must be overcome so that the desire of MOE in PPPM 2013-2025 can be achieved. Suhaidah, Mangao and Nur Jahan (2014) has designed a conceptual framework for the development of STEM education in Malaysia. In this framework, it divided the development of STEM education into six phases, which in from early childhood to industry or community. In this paper, we focused on the second phase which is on the primary or elementary school, the focus is helping the students to make the connection or build the foundation in STEM education.
In the primary or elementary school, the STEM education focuses on the introduction and gives the awareness to students about the importance of STEM education. In other words, it gives a draft idea of the integration for the four fields in STEM education. Initial step to introduce STEM education is to provide the standards-based learning which based on the problem-solving and inquiry-learning method in real situations to link up the four subjects in STEM education. In other words, the goal of STEM education is designed based in the inquiry-learning by used the thinking skills in science and technology to solve the everyday real life problems.

The purpose of this research is to enhance the integration of STEM education in Mathematics Kurikulum Standard Sekolah Rendah (KSSR) through inquiry based approach which the activities focus on project-based learning or using the Inquiry-Based Learning Project (PIP).

**Project-based Inquiry Learning (PIL)**

Inquiry-Based Learning Project (PIL) is the method that emphasizes on the sciences skills and attitude, high order thinking skills, creative problem solving, design and construction of the object-based technology and encourages the children to communicate and work in teams (Aminah et al., 2015). There are four phases in PIL, namely Inquiry, Exploration, Experimentation, and Reflection (Fig. 1) (Ong et al., 2016).

In the Inquiry Phase, students ask questions about what they want to know and with the guidance of teachers, the students may decide the issues or topics they want investigated. In the Exploration phase, students are looking the information about issues or topics that have been identified. Search information by using various methods, such as internet, video, nature walk, visit, study science books, and so on. The students develop the new knowledge and strengthen the existing knowledge on the subject they studied or had been exploring. After receiving all the necessary information, the students will determine the suitable materials for the projects.

In the Experimentation phase, students build or develop their inventions or ideas by create the model according what they had planned in the Exploration phase. Students demonstrate the product and answer questions that they ask in the first phase. In the Reflection phase, students reflect on the learning process which they had gone through and give a view of the product or invention that they have produced. In this phase, students also will be ask to give the opinion on the interest, awareness, appreciation and what they want to do next.

These four phases in PIL are adapted and modified from the implementation of STEM education in the PERMATA curriculum. The aim of modified PIL is hoped that it can be implemented into the Malaysia's primary school curriculum.

PIL is the method should use in teaching STEM education which can be represented in “Fig.1”. The inquiry is the initial phase to stimulate the curiosity of students. 3E in the PIL is Exploring, Experiment and Experience and 3C in the PIL are Collaborate, Create and Communicate.

![Fig. 1: Inquiry-Based Learning Project (PIP) method](image)

**STEM Modules**

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. Because of that, development of STEM education is an
important agenda for the transformation of education system and prepare the students in Malaysia to meet the challenges of the 21st century. It is expected to help teachers to enhance their knowledge and development of STEM education, in this research a STEM modules using the PIP method based on the ADDIE Module has designed.

STEM modules in this research has been characterized by using variety traditional culture of Malaysia. Projects in the STEM modules chose the traditional culture in Malaysia because Malaysia is a country made up from different races and ethnic such as Malay, Chinese, Indian and other which practices different and unique traditional cultural. In the modules, students not only understand the STEM concepts involved, at the same time the students also can understand the tradition of different races in Malaysia.

In this module, three projects that use PIL methods have been designed. The skills in these five projects are integrating the knowledge of science, technology, engineering and mathematics while producing products. These three projects have been focus on the topic of space in Revised KSSR Year 1 Mathematics Syllabus. These three projects are:

<table>
<thead>
<tr>
<th>No</th>
<th>Project</th>
<th>STEM Concept Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chinese Lantern (Tanglung)</td>
<td>Shape and size of the lantern, the amount of materials that needed such as colour paper, burning, light and design of lantern.</td>
</tr>
<tr>
<td>2</td>
<td>Kolams Art</td>
<td>Measure, shape, size, symmetry and how to stick the rice or sands on the paper and the design of kolams.</td>
</tr>
<tr>
<td>3</td>
<td>Batik</td>
<td>Measure, shape, symmetry, materials, colour and pattern.</td>
</tr>
</tbody>
</table>

Chinese Lantern (Tanglung)

The art of Chinese lantern making began in the Han Dynasty (206 B.C. to 220 A.D.). This was a significant period of time for science and invention and the handcrafted arts took on purpose for beauty as well as practical needs of day-to-day life. Originally lanterns were simply for lighting. Over time, however, Chinese lanterns evolved into art forms. Today, Chinese Lanterns are a cherished part of festivals and celebrations. As Buddhism flourished in China, lanterns were lit at the Imperial Palace and temples in a show of respect for Buddha.

Original lantern construction varied according to purpose. Palace lanterns were made of the finest silk or glass over the best wood. The traditional red lanterns, recognized around the world, used red gauze stretched over bamboo. Shadow-picture lanterns used a paper wheel inside which turned when heated, creating moving pictures outside of the lantern. Today, these rayon, medicine bottle, and porcelain lanterns are fabricated of modern materials and technology. Our lanterns are brilliantly lit up
with colored bulbs, enlivened by music and sound effects, and visual moving parts. You'll discover larger-than-life imaginative shapes, and an entirely new experience.

The Lantern Festival is one of China’s most traditional celebrations and falls on the 15th day of the first lunar month—typically February or March (on the Gregorian calendar). Varieties of lanterns are hung in the streets and children make their own to show off in village parades. Other traditions include posting riddles on the lanterns for people to decipher. The dragon or lion dance often accompany the festivities and delicious rice dumplings are eaten on the day.

Kolams Art

Kolams are a symbol of auspiciousness. It is Hindu belief that that the geometrical patterns & designs applied with rice flour at the entrance to a home, invites Goddess lakshmi into the household, and drives away the evil spirits. It is mostly a South Indian tradition, practiced widely in Tamilnadu. Kolams are also applied daily in the pooja room near the lamps. There are specific kolams attributed to the various deities.

Traditionally, the women wash the path in front of the house. (Cowdung is used to clean up the ground, though this practice is no longer in vogue in the cities, mainly because cowdung is not easily available and most entrance path are now laid in cement or tiles.) Finely ground rice powder is then used to apply kolams. This practice is followed in the evenings also. The reason for using rice flour is that we are providing food for the ants & other small insects. In these days finely ground white stone powder is used, for this is easier to apply & also the kolams are brighter and well finished. Even if ground stone powder is used, one could mix rice flour in it.

The month of margazhi (middle December) is a gala time for all kolam lovers in the cities and villages. Women start applying huge beautiful kolams very early in the morning undaunted by the chill morning dew. They start learning kolams and make preparations overnight testing the kolam on paper so that they can do a perfect job the next morning. There is a healthy competition in each street, each trying to outdo the others. The current trend is to create colourful rangolis (rang - colour in Hindi) applying colour powders to fill up the white outlines.

Batik

Malaysian Batik is batik textile art of Malaysia, especially on the east coast of Malaysia (Kelantan, Terengganu and Pahang). The most popular motifs are leaves and flowers. Malaysian batik depicting humans or animals are rare because Islam norms forbid animal images as decoration. However, the butterfly theme is a common exception.

The Malaysian batik is also famous for its geometrical designs, such as spirals. The method of Malaysian batik making is also quite different from those of Indonesian Javanese batik, the pattern is larger and simpler, it seldom or never uses canting to create intricate patterns and rely heavily on brush painting method to apply colours on fabrics. The colours also tend to be lighter and more vibrant than deep coloured Javanese batik.

In line with the 1Malaysia concept, the Malaysian government is now endorsing Malaysian batik as a national dress to every level of the general population, by having local designers to create new batik designs which reflect the 1Malaysia idea.

Results and Discussions

This STEM modules had been carried out during Program Celik Minda STEM and during visiting from delegates of Universitas Negeri Yogyakarta (UNY). During the activity, the facilitators guide the students on how to make a project. The facilitator used the instructions in the module to do the project. While the students are making the project, facilitator asked the students questions about the shape, size and colour. The questions asked by facilitator as below:

a. What do you know about kolams/Batik?
b. How to make a pattern of kolams/Batik symmetry?
c. When can we find the kolams/Batik?
These questions are asked in the Inquiry Phase, the purpose asked these questions is to cause the curiosity among the students. From the curiosity, the students are interested to find out more about the kolams art. In the same time, the facilitator’s guides the students followed the four phases in PIL and let the students understand the integrated STEM knowledge in this project.

From the responses from the students, noticed that the students are enjoying themselves while making the kolams. they had employment the hands-on and minds-on while making the kolams. The kolams art in this project not only because it featured in conjunction with Deepavali celebration but it also consist of STEM knowledge, such as how to made a symmetry kolams, and what is the design can used for kolams.

Besides that, findings also supported by the following transcripts from the interview data:-

**Kolams:**
Yes, it’s very interesting. (Student A)
Colorful. (Student B)
This project can be done in my class. (Student C)

**Batik:**
Yes, I enjoy making the batik. (Student A)
I like to make batik. (Student B)
Yes, I want to make batik again. (Student C)
Yes, I like the colours of batik. (Student D)

**Conclusions**

Purpose of this study is to improve the integration of STEM education in KSSR Mathematics through PIP. STEM is a teaching and learning approach that involves the application of knowledge, skills and values of STEM to solve the real life problem in the context of daily life, society and the environment. This approach encourages students to ask questions and explore the environment through inquiry and solve the issues related to the real world situation to cultivate the practice of STEM.

By using the STEM modules based on the PIP, the teacher will be more confidence and able to carry out the STEM education in school. To achieve the goals of PPPM 2013-2015 of MOE, the teacher themselves must change their mind and accept the challenges of the teaching and learning in this new era so they can produce the students fulfilled the need of 21st century.

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**REFERENCES**


Ong Eng Tek, Aminah Ayob, Md Nasir Ibrahim, Mazlini Adnan, Jameyah Shariff & Noriah Ishak. (2016). The Effectiveness of an In-Service Training of Early Childhood Teachers on STEM
Integration through Project-Based Inquiry Learning (PIL). Journal of Turkish Science Education, 13(Special Issue), 44-58.


Appendices

Fig.3 : STEM Module

Fig.4 : Program Celik Minda STEM (Batik)
Fig. 5: Visiting from delegates of Universitas Negeri Yogyakarta (UNY) (Kolams art)

Fig. 6: Visiting from delegates of Universitas Negeri Gorontalo, Indonesia (Chinese Lantern) (Tanglung)