The Effect of An Integrated-STEM Water Rocket Module (SEMARAK) on STEM Elements Application Among Form Four Students

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Abstract
The organisation of water rocket activity is synonymous with any STEM-based activity worldwide. The fun-filled activity can impart multiple science and mathematics concepts and integrate all four STEM disciplines. However, the current practice of water rocket activity that relies heavily on flight performance does not reflect the ideal STEM practice. This issue prompted the development of an integrated-STEM water rocket module, so-called SEMARAK (SElangkah Menuju Angkasa Raya Kita). SEMARAK is a water rocket module containing activities, rubrics and resources that adhere to the current KSSM (Kurikulum Standard Sekolah Menengah) syllabus. The SEMARAK's effect on STEM knowledge, skill and value was investigated by a case study. The case study involved monitoring the work progress and responses from a group of 32 Form Four students. Findings showed that SEMARAK resulted in a positive effect on the application of STEM elements among the students. The study signifies the benefits of incorporating the STEM elements in a water rocket activity which focuses on the learning process rather than just the terminal assessment in a competition setting.

Keywords: Integrated-STEM, Water Rocket, STEM Elements, SEMARAK

Introduction
The water rocket is one of the most popular activities to be held in conjunction with any Science, Technology, Engineering, and Mathematics (STEM) education initiatives. Launching a water rocket under different conditions triggers inquiry among students, specifically in learning forces and motion (Meyer& Bartos, 2014). The ability of water rocket activity to integrate all four STEM disciplines while enhancing students' learning experience has further solidified the prominence of STEM education activity (Hortman, 2017).

STEM as a teaching and learning (STEM T&L) approach involves students applying STEM elements within the context of daily life, society and environment (Bahagian Pembangunan Kurikulum, 2016). The approach encourages students to mentally and physically engaged in the problem solving related to the real-world context toward the cultivation of STEM practices. STEM T&L should have the following initiatives: (1) raise students awareness towards real-world problems; (2) engage students in productive group work; (3) involve students in an open-inquiry scenario;

(4) assist students in the application of STEM knowledge; (5) provide opportunities for students to improve their proposed solution; (6) involve students in applying their design skill; and (7) acquire students to give justification to their various solution (Bahagian Pembangunan Kurikulum, 2016). The fulfilment of these features is vital to learn a STEM subject in schools effectively.

Any water rocket activity can quickly allow students to apply the STEM elements while fulfilling all the features of STEM T&L approach. However, in a common practice of water rocket activity, the students' learning outcome is justified by the terminal achievement of the rocket performance, not the on the students' performance (Omri *et al*., 2018; Planetarium Negara, 2018). Examples of such terminal assessment are (1) how precise the rocket falls on a target and (2) how long the rocket flies in the air. This practice is not ideal since good learning outcomes should focus on the development of competence and task mastery (Lam *et al.*, 2004). Learning via competition should be structured in the environment to enrich students with the experiences and skills they will need in their future careers (Kristensen *et al*., 2015).

Learning via competition can be detrimental instead of beneficial *(Kristensen et al*., 2015; Lam *et al*., 2004). In a competition-based water rocket activity in which the flight performance is the success indicator, the students tend to focus on the goal instead of the process. In this context, the process involves applying STEM knowledge, skills and values. Most students might take the application as insignificant, in comparison with the water rocket performance. Eventually, this phenomenon contributed to the disconnect between water rocket activity and STEM elements application among students. On the one hand, the student can win a water rocket activity competition without understanding its underlying STEM concepts. On the other hand, the student who did not achieve the goal will have a lousy self-evaluation after the failure (Lam *et al*., 2004).

Therefore, there is a need to revolutionise the implementation of water rocket activity. Whether the activity is competition-based or not, an ideal water rocket activity should always consider the work process alongside the flight performance. The process includes the planning stage of the construction until the final rocket launch. The student's application of STEM knowledge, skills and values are taken into account to determine the student's performance in a water rocket activity. Therefore, a comprehensive evaluation method is required to assess the application of the desired STEM elements. This method recognises, rewards and enhances the student's STEM elements application in the water rocket activity.

An ideal water rocket activity should also compliment the STEM knowledge content that the students have learnt and will learn in school. As the organisation of any project-based learning (such as water rocket activity) can be time-consuming, most teachers would avoid themselves from carrying such activity (Tonge & Mahamod, 2020). Most STEM teachers would instead stick to the traditional teaching method such as assignment and drilling of the STEM concept because it can quickly cover the desired content (David, 2015; Ling Chia & Maat, 2018; Zhao *et al*., 2014). Hence, a water rocket activity should have the ability to direct the student towards achieving various learning standards featured in the current *Kurikulum Standard*

Sekolah Rendah (KSSR) and *Kurikulum Standard Sekolah Menengah* (KSSM) in the Malaysian context. This inclusion will provide some assurance for the STEM teachers to implement a project-based learning strategy while explicitly fulfilling specific learning standards.

Also, an ideal water rocket activity should represent the integrated-STEM practice featuring all four STEM disciplines. The water rocket activity is a suitable medium for the integrated-STEM because it can provide the real-world context (Moore & Smith, 2014; Wei & Chen, 2020), the opportunity for the students to be creative and innovative (Bunyamin, 2017) and the chance to improve comprehensive abilities (Wei & Chen, 2020). The integrated-STEM practice could improve students interest and performance in mathematics and science if carefully designed in the activity (Stohlmann *et al*., 2012). Cross-cutting STEM concepts from science and mathematics subjects can be widely covered in the activity. The engineering and technology elements that fit well with the science and mathematics concepts can be incorporated through the integrated-STEM.

Implementing the three ideal practices for water rocket activity might be easier said than done. The current reality might be far from the ideal. In terms of assessment and evaluation, the readily available STEM instruments are limited (Amadio, 2015; Margot & Kettler, 2019); let alone for water rocket activity. The evaluation of all three STEM elements would require three different instruments. This requirement can be a daunting task for a teacher to figure out for themselves. Similarly, organising a water rocket activity that compliments the current KSSM syllabus requires countless hours of study, planning and preparation. The task will become even more complicated if the integrated-STEM practice is being put into the picture.

Therefore, considering how complicated an ideal water rocket activity for STEM T&L can be, there should be a readily-available guide on how the activity can be carried out. To date, there are already several guides in the form of books, modules and manuals on water rocket activity that are available; such as water rocket guides by de Podesta, (2007); Ishii, (2006); Omri *et al*., (2018); Shearer & Vogt, (2011); and Vogt *et al.,* (2014). However, none of these resources does fulfil all the three ideals of water rocket activity. For one, the learning outcomes set for the resource are not of the Malaysian KSSM learning standards and do not adhere to the outlined STEM T&L approach.

Hence, the need to mitigate this issue has prompted the development of a T&L resource that strives to fulfil an ideal water rocket activity requirement. The resource will be able to bridge the disconnection between water rocket activity and the application of STEM elements among students. However, to achieve such aspiration, the development should be carried out through a proper way. A properly developed module should undergo a series of procedures that comprise validity and reliability evaluation and the effectiveness evaluation; as showcased in this paper. Therefore a self-contained module known as SEMARAK (an abbreviation from Malays, SElangkat Menuju Angkasa RAya Kita means A Step Toward Ours Space) was written using the Malay language. SEMARAK went through the validation and reliability procedures in a developmental research design. The research process was reported elsewhere (Mohd Hafiz, 2020a; Mohd Hafiz & Ayop, 2020). This paper focused on the effect of SEMARAK on the application of STEM knowledge, skill and value among students.

Methodology

SEMARAK was designed to be used for non-formal afterschool learning. Three prominent learning strategies for effective STEM learning were utilised. The strategies are the engineering design process (EDP), project-based learning (PjBL) and inquiry-based learning. EDP was made as to the module's primary strategy. It helps plan and organise the modules' activities and make sure that the elements from the engineering discipline are visible to students (Mohd Hafiz & Ayop, 2019). The Engineering Design Process Model developed by the Massachusetts Department of Education (2006) was chosen as the EDP model for the module. The expert validated and field-tested SEMARAK module was compiled in the form of a booklet. Figure 1 shows the components of SEMARAK. The booklet was sent to and catalogued in Malaysia National Library (Mohd Hafiz, 2020a). The complementary website support students learning and teacher's instruction (Mohd Hafiz, 2020b).

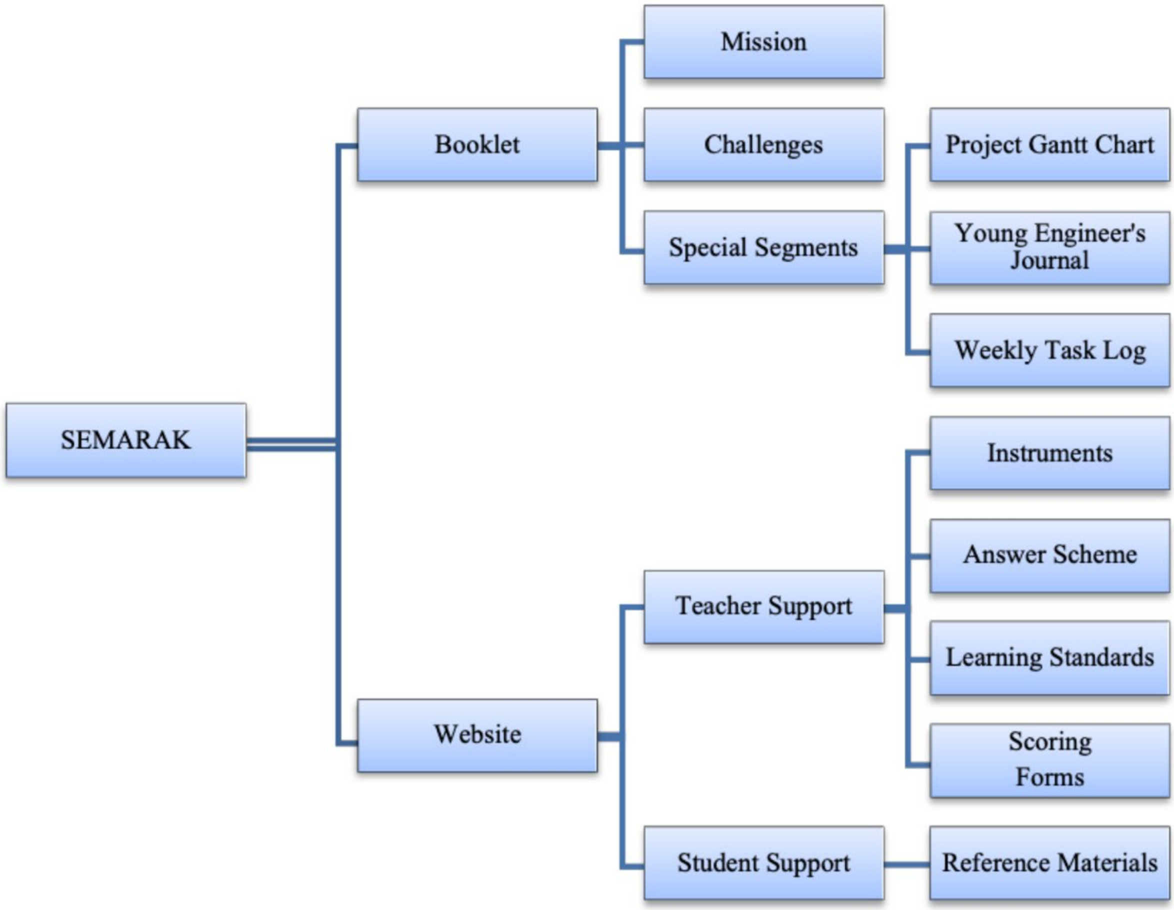

Figure 1: SEMARAK components

SEMARAK was developed for Form Four students. Form Four students were chosen because they are in the transition level between lower secondary and tertiary levels. The focus of STEM education at this level is to enforce STEM Skills (Kurikulum, 2016). The case of the study is a group of students from a school in Kuala Lumpur. They are the first cohort who took the KSSM Science revision 2017. The school organises a water rocket competition every year. The school administrator welcomed this study to enrich their students' hands-on experience and exhibited an interest in knowing the effect of SEMARAK, which is not a competition-based activity but focuses on the process of applying STEM elements.

The case study was conducted on 32 Form Four students with one STEM teacher on duty, from another school in Kuala Lumpur. The selection of participants was carried out using volunteer sampling (Mohsin, 2016). The 32 students were later divided into eight subgroups of four members. As SEMARAK incorporates role-playing in its' implementation, each subgroup member needs to carry out a role play as a different type of engineer in a subgroup known as a company.

The time allocated for the overall implementation of the module was eight hours. These eight hours was later broken down to four 2-hours sessions. The fieldwork of this case study took four weeks to complete. Students engaged with SEMARAK activity on average, three hours weekly. The effect of SEMARAK was evaluated on the application of three STEM elements among the students: knowledge, skill and value.

STEM knowledge covers all the learning standards in STEM subjects in school, such as Science and Mathematics. It is impossible to learn all the learning standards in the SEMARAK. The same goes to STEM skills and values, which are many to cover. Therefore, SEMARAK targeted on specific STEM elements. The scope of STEM elements in this study was clearly defined in the early stage of SEMARAK development. A need assessment was conducted among 90 STEM education teachers from all over Malaysia. Table 1 listed defined STEM elements requested by teachers to be embedded in SEMARAK.

Table 1 : SEMARAK STEM elements

STEM Element	Selected dimension	Definition
Knowledge	Science concept: 1. Force 2. Linear Motion 3. Pressure Mathematics concept: 1. Ratio and Proportions 2. Trigonometry 3. Mathematical Reasoning	STEM knowledge is an idea, concept, principle, theory and understanding in the STEM field that has been drafted in all STEM-related subjects (Curriculum Development Division Ministry of Education Malaysia, 2016). In this study, STEM knowledge refers to the most selected concepts in science/physics and mathematics subjects in the need assessment for a water rocket activity.
Skill	Design Skill	STEM skills competencies to discover, solve problems, design, and develop a product (Curriculum Development Division Ministry of Education Malaysia, 2016). In this study, STEM skill refers specifically to students' design skill based on the criteria

		listed in the Design Skill Rubric either through displayed behaviour, writing, oral communication or water rocket constructed. Design Skill was the skill selected by most of the STEM teacher respondents in the need assessment.
Value	Creativity & Innovation	STEM values are the positive attitude or guideline that should be abided by any STEM student (Curriculum Development Division Ministry of Education Malaysia, 2016). In this study, STEM value refers specifically to students' creativity and Innovation based on the criteria listed in the Creativity & Innovation Rubric either thru displayed behaviour, writing, oral communication, presentation video/ E-Brochure crafted or water rocket constructed. Creativity & Innovation is the most selected value in the need assessment.

The module's effect was studied closely by monitoring the progress of each subgroup representatives (N=8). The representatives were selected randomly within the subgroup. The effect of SEMARAK on the application of STEM knowledge is evaluated using students' written responses. Their responses toward 24 activities known as Missions and Challenges were collected and qualitatively analysed. Table 2 shows a list of those activities. These activities were carefully designed to align with the learning standards in the STEM knowledge defined in Table 1.

Table 2: Activities featured in SEMARAK

Mission
Mission 1: To Evaluate Existing Rocket Performance
Mission 2: To Identify Rocket's Problems
Mission 3: To Investigate The Rocket's Problem
Mission 4: To Determine The Best Rocket Characteristic
Mission 5: To Create The Initial Design Sketch
Mission 6: To Select a Rocket Design
Mission 7: To Manage SEMARAK Project's Budget
Mission 8: To Design a Rocket's Prototype
Mission 9: To Build the Rocket's Prototype
Mission 10: To Test the Rocket's Prototype
Mission 11: To Evaluate the Performance of the Rocket's Prototype
Mission 12: To Redesign the Rocket
Challenge
Challenge 1: Rocket Structure
Challenge 2: Best Practices To Launch and Build a Rocket

Challenge 3: The Effect of Forces on Rocket's Motion
Challenge 4: Forces Acting on a Rocket
Challenge 5: Pressure Inside a Rocket
Challenge 6: Ratio, Rate and Proportions for a Rocket
Challenge 7: Rocket's Stability
Challenge 8: Mathematical Statements about a Rocket
Challenge 9: Mathematical Arguments about a rocket
Challenge 10: Linear Motion of a Rocket
Challenge 11: Linear Motion Graphs of a Rocket
Challenge 12: To report the performance of SEMARAK's Project

Meanwhile, STEM skill and value were measured using the Design Skill Rubric and the Creativity & Innovation Rubric, respectively (Frank & Strong, 2010; PBLWorks Buck Institute for Education, 2020). Attributes measurement using rubric involved measuring by observing displayed attributes, written work, and the water rocket model constructed. The STEM teacher-in-charge rated the score based on the descriptors enlisted in each construct of the rubric. In addition, weekly journal entries (Young Engineer's Journal) and semi-structured interview feedbacks were also analysed to support the finding.

Results and Discussion

STEM Knowledge

The SEMARAK effect on STEM knowledge was considered present if students reflect their application of any targeted concepts in SEMARAK (see Table 1). All subgroup were able to apply the science concept of force. Figure 2 shows such an example of response for the justification given on page 2 in SEMARAK booklet; Mission 4. Students were required to do a web search in this Mission and discuss why specific geometrical shapes are favourable to design a targeted water rocket. The given response indicated the application of the concept of force. There is a mention of stability (unequal force) and drag (friction). It is worth noting that SEMARAK was designed for students to work collaboratively to complete given missions with minimum supervision from their teachers. Their responses in each activity were the outcomes from their discussion.

Ciri Roket Untuk Mencapai Objektif	Justifikasi Sains/ Logik
Jisim roket : Rendah	Lebih rendah jisim roket, lebih tinggi pecutan roket (F=ma)
Kepanjangan roket : 30 inci (max) 210 cm	menjamin kestabilan roket
Bentuk kon roket : runcing/tajam	mengurangkan rintangan angin dan roket meluncur jauh
Bentuk sirip: bentuk elips	menjaga keseimbangan roket
Ketebalan sirip: 3 cm	semakin tebal sirip, semakin meningkat jisim sirip

Rocket Characteristics to achieve Objectives	Logic / Scientific Justification
Rocket mass: low	Lower rocket mass, higher rocket acceleration (F = ma)
Rocket length: 30 inch (maximum) 210 cm	To ensure rocket stability
Rocket cone shape: tapered/sharp	To reduce wind resistance and rocket fly further
Fin shape: elliptical shape	To maintain rocket stability
Fin thickness: 3 cm	Higher fin thickness, higher fin mass

Figure 2: A response example in Mission 4 (top) and its translation (below). Highlighted texts are student's written response.

The application of the mathematical concept of ratio and proportions was also evident. In Mission 10: Testing Rocket's Prototype page 65, the amount of water used to launch the water rocket was approximately 500 ml. The volume was obtained from the calculation using ratio and proportions in the prior Challenge. In page 37 Challenge 6: Rate, Ratio and Proportions, the students were required to calculate the water volume for a 1.5 litres bottle for the given ratio of water-to-air as shown in Figure 3. The calculated volume of water for 1:3 was 516.67 ml. All subgroups were able to use the calculated volume in their actual water rocket to accomplish Mission 10.

JADUAL ISIPADU PENGISIAN AIR UNTUK ROKET AIR 1.5 LITER

Nisbah		Kadar Pengisian	Faktor Pengisian (%)	Isipadu Air (ml)
Isipadu Penuh : 1550 ml				
Air	Udara			
1	1	1/2	50.00	775.00
1	2	1/3	33.33	516.67
2	1	2/3	66.67	1033.33
1	3	1/4	25.00	387.50
3	1	3/4	75.00	1162.50
1	4	1/5	20.00	310.00
2	3	2/5	40.00	620.00
3	2	3/5	60.00	930.00
4	1	4/5	80.00	1240.00

WATER FILLING VOLUME TABLE FOR WATER ROCKET 1.5 LITER

Isipadu Penuh L 1550 ml				
Ratio		Filling rate	Filling factor (%)	Water volume (ml)
Water	Air			

Figure 3: A response example in Challenge 6 (left) and its translation (right). The red box shows the values required for students to accomplish Mission 10.

In addition to responses written in the SEMARAK module, feedbacks obtained from both the semi-structured interview and Young Engineer's Journal entry also indicated a positive effect. The interview was performed after the completion of all Missions and Challenges in SEMARAK. All subgroups could relate the concepts they have learnt in SEMARAK, indicating application and acquisition of STEM knowledge. Most frequent expressed STEM concepts were linear motion, force, and trigonometry. These concepts are the targeted STEM knowledge defined in Table 1. This result showed that SEMARAK successfully embedded learning standards in an informal water rocket activity. The following translated transcripts support the application of STEM knowledge:

Activities in SEMARAK involve calculation in Mathematics, Physics and Science. For instance, the calculation of height, velocity, distance, time and force.

(Subgroup 2)

I too can apply the knowledge of trigonometry in measuring the height of the rocket and all the measurement.

(Subgroup 3)

There is much connection between what we have learned in class with the activities in SEMARAK. For example, there are a lot of Physics. It is the same; the linear motion and the linear graph. It links with SEMARAK.

(Subgroup 6)

Similarly, the feedback obtained from the Young Engineer's Journal (YEJ) entry also indicates a positive effect. YEJ is a record at the end of each Mission for students reflect what they have learned and acquired. Table 3. shows an example of subgroups' feedback related to the STEM knowledge extracted.

Table 3: Indication of STEM knowledge application written by students in YEJ.

Subgroup	Entry 1	Entry 2	Entry 3
1	*Parts of rocket*	*Concept of implication, mathematical statement and sequence pattern*	*Determine velocity and acceleration using the Tracker Application*
2	*Suitable pressure for a rocket launch* *Good characteristics for a water rocket*	*Linear motion formula* *Centre of Mass (CM) and Centre of Pressure (CP) of the water rocket*	*Linear graph* *How to use the Tracker Application*
3	*The requirement for a good water rocket flight (Able to travel further)*	*The best water rocket fin design*	*Linear motion graph*

STEM Skill

The effect SEMARAK towards STEM skill was established primarily using the data obtained using Design Skill Rubric. Table 4 tabulated scores rated by the STEM teacher-in-charge for the eight subgroups.

Table 4:. Design Skill Rubric score

Construct / Participant	Score							
	G1	G2	G3	G4	G5	G6	G7	G8
1- State problem definition	5	5	5	4	5	4	4	5
2- Produce conceptual design	6	5	6	5	6	5	5	6
3- Produce preliminary design	5	5	5	5	4	4	4	5
4- Produce detailed design	4	4	4	3	4	3	3	5
5- Carry out design validation	6	5	6	5	6	5	5	6
6- Implement the product completion	5	5	5	4	4	4	4	5
7- Carry out the overall design process	6	6	6	5	5	5	5	6
Total Score (max. 42)	**37**	**35**	**37**	**31**	**34**	**30**	**30**	**38**
Percentage (%)	**88**	**83**	**88**	**73**	**80**	**71**	**71**	**90**

The data shows that five out of eight subgroups achieved at least 80% of the total marks for STEM skill showing the expert level of skill. The maximum and minimum score for each construct is six and zero, respectively. A score of five or six is considered an expert for each construct (Frank & Strong, 2010). All subgroups were at expert level for second and seventh constructs. Students showed an excellent ability to produce a conceptual design, with a good sense of evaluating the construction cost and coming up with an alternative design. For instance, the students could practice smart finance management (Mission 7: To manage SEMARAK Project's Finance), which required them to incorporate used materials instead of buying. Students practised cyclic process in designing to get their own best water rocket.

Furthermore, the students can quickly develop an alternative to suit the current materials they had. For construct 4, only one subgroup manage to achieve the expert level. Other subgroups did not produce a neat and scaled drawing even though their constructed water rocket model possesses all the best rocket characteristics. All of the subgroups were at expert level for construct 5. For construct 6, four subgroups did not manage to prepare their water rocket e-brochure within the specified time.

To further comprehend the effect of SEMARAK towards STEM skill application, the feedback obtained from the semi-structured interview and YEJ were also considered. Any feedback indicating an application of the constructs in the Design Skill Rubric was considered a positive effect. It was found that SEMARAK posed a moderate effect on STEM skill among students. The available feedback revolved around designing a water rocket model that can fulfil intended flight goals; to fall on the target, and stay on the air longer with a parachute. The observable STEM skill is supported by the following translated transcripts from the interview:-

The design skill that (I have gained) is to construct a suitable water rocket that possesses stability features and strength during SEMARAK activity implementation.

(Subgroup 2)

I can now shape my rocket and construct a round shape parachute, as well as managing material cost.

(Subgroup 7)

I have gained the design skill from SEMARAK; now, I can utilise the aerodynamic design using the parabolic design or hemisphere. I also learned to make a hole in the middle of the parachute top to create balance in the parachute.

(Subgroup 3)

Feedbacks obtained from the YEJ Journal entry also indicated a moderate positive effect. Some of the feedbacks on STEM skill was either left blank or not a criterion related to the design skill. Table 5. shows an example of students feedbacks on the STEM skill extracted from the journal.

Table 5:. Indication of STEM skill application written by students in YEJ

Subgroup	Entry 1	Entry 2	Entry 3
6	Not stated	Conduct the stability test for water rocket	Apply mathematics concept in daily life (Not a criteria of design skill)
7	Not stated	Constructing a water rocket that involves cutting and patching	Not stated
8	Measuring water rocket manipulatives accurately	Not stated	Not stated

The most probable cause of this moderate effect in interview and YEJ might be the ambiguity surrounding the definition of STEM. STEM skill has been challenging to be defined as skills do not exist in isolation and difficult to identify (Siekmann & Korbel, 2016). Furthermore, this finding might indicate that the student might not be aware of STEM skill that they applied and acquired during SEMARAK activity. To conclude, SEMARAK was able to give a positive effect on STEM skill among students. The mod of score is 5 indicated an expert level of the design skill.

STEM Value

The effect SEMARAK towards STEM value was established primarily using the data obtained using a criterion scoring rubric. Creativity & Innovation Rubric consists of seven constructs. Four constructs are based on the subgroups' work process, and another three were based on their constructed water rocket. However, for this study, only six out of the seven constructs were evaluated. The fourth construct was not evaluated because several subgroups could not prepare their water rocket e-brochure. Students are required to use computers to produce their own e-Brochure. The school's computer lab was not accessible at the time of the study because the related SEMARAK's Mission was not carried out within the lab administrator's fixed lab schedule. This situation might limit the implementation of SEMARAK or another learning module, which depends on computers' use. Table 6. shows the score rated by the STEM teacher-in-charge for the eight subgroups.

Table 6: Creativity & Innovation Rubric score.

Construct / Participant	Score							
	G1	G2	G3	G4	G5	G6	G7	G8
1 - Define the creativity challenge	3	4	4	3	4	3	3	4
2 - Identify sources of information	3	3	2	2	3	2	3	3
3 - Generate and select ideas	4	3	3	3	3	3	3	4
4 - Present work to target audience	-	-	-	-	-	-	-	-
5 - Product constructed is original	4	4	4	4	4	4	4	4
6 - Product constructed is valuable	4	4	3	3	3	3	3	3
7 - Product constructed is stylish	4	4	4	2	4	3	4	4
Total Score (Maximum 24)	**20**	**22**	**20**	**17**	**21**	**18**	**20**	**22**
Percentage (%)	**83**	**92**	**83**	**71**	**88**	**75**	**83**	**92**

Six out of eight subgroups achieved 80% of the total marks for STEM value application. Similar to Design Skill Rubric, the maximum and minimum score for each construct is six and zero, respectively. The subgroup that managed to obtain three marks is rated at the standard level of Creativity and Innovation (PBLWorks Buck Institute for Education, 2020). The median and mode of the score distribution are three out of a maximum of six. This result indicated that the students could achieve the standard level of Creativity & Innovation in their work. The exhibited STEM value's most consistent construct across all subgroups was the fifth construct. None of the water rocket design was similar. Furthermore, they came up with a combination of rocket components they have developed from the ground up thru the engineering design process (EDP). Hence, none of the design was similar, and the design was beyond their teacher's expectation.

Similarly, to further comprehend the effect of SEMARAK on the STEM value application, the feedback obtained from the semi-structured interview and journal were analysed. The feedback from both the interview transcripts and journal entry showed several responses that can be cross-linked to the STEM value. The STEM value theme is supported by the following translated transcripts from the interview data:-

Among the exciting feature in SEMARAK is in the construction of the rocket itself. The materials used are from reusable and inexpensive resources to build a water rocket model that is almost similar to a real rocket.

(Subgroup 3)

In terms of creativity, I can construct suitable shapes (for water rocket parts) from the combination of various choices of shapes. In terms of Innovation, after this programme, I can construct a more robust water rocket model.

(Subgroup 5)

I gained the skill to construct a parachute water rocket that the nosecone can break into two parts so that the parachute will come out from it.

(Subgroup 8)

The feedbacks obtained from the YEJ entry indicated a positive effect on the STEM value application. Some feedbacks on was either left blank or not a criterion related to Creativity & Innovation. However, the rubric result was sufficient to confirm that students engaged in SEMARAK exhibit STEM value at the standard level. Table 7 shows examples of students' written responses on the STEM skill extracted from the journal.

Table 7:. Indication of STEM value application written by students in YEJ.

Subgroup	Entry 1	Entry 2	Entry 3
3	Work collaboratively as a group (Not a criteria of creativity & Innovation)	Being patient and never give up (Not a criteria of creativity & Innovation)	The need to be hardworking (Not a criteria of creativity & Innovation)
4	Not stated	Not stated	Not stated
5	How to solve problems related to rocket	Not stated	Not stated

Conclusion

Water rocket activity itself is highly beneficial for STEM education. A proper learning resource is warranted to ensure STEM elements are optimally applied and practised by students (Yu *et al*., 2010). Therefore, SEMARAK was developed considering STEM elements application and EDP strategy in a role-playing situation. SEMARAK was developed to maximise the potential of water rocket activity by bridging the current disconnection between the activity and applying STEM elements. The bridging is created thru an adherence to the STEM teaching & learning approach outlined by the

Malaysian Ministry of Education (Bahagian Pembangunan Kurikulum, 2016), current curriculum and global STEM education trends. It can be concluded that SEMARAK gave positive effects on the student in terms of applying STEM elements. The positive effects observed in the reported case study show that SEMARAK can benefit students to apply STEM elements more than just by winning a water rocket competition.

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