Encouraging STEM Interest Among High School Students in Rural Area of Sabah: A BOTANIstNJA Module Integrated with Problem-Based Learning Case

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ABSTRACT Due to declining number of students enrolled in Science, Technology, Engineering and Mathematics education (STEM) subjects, the Ministry of Education has introduced STEM packages option for Form 4 students starting January 2020. Nevertheless, it is important to cultivate the learning interest towards STEM subjects starting from the lower form. In this study, an integrated problem-based learning Biology module called BOTANIstNJA was implemented to Form 1 and 2 of a secondary school in a rural area to gauge their interest in learning STEM subject. Total of 79 students participated in this case study related to plants, simple plant specimen activity and early career exposure as a Botanist. Three perspectives: teaching, learning, and communications skills were evaluated through questionnaires and analysed by means of frequency distribution. All students expressed "strongly agree" at 78.5%, 57.0%, and 51.9%, respectively. This result suggests the effectiveness of the integrated problem-based learning module to stimulate students' interest and shall be continued to encourage them in taking the STEM package.

KEYWORDS: Biology, BOTANIstNJA Module, Problem-based learning, STEM, Sabah
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INTRODUCTION

It has long been an aspirational goal of Malaysia to become a developed nation with economic prosperity through the implementation of Science, Technology, Engineering and Mathematics education (STEM). The nourishment of STEM education thus has been progressively cultivated towards secondary school students, starting from Form 1. This is important to foster their critical thinking skills while having a great interest in STEM subjects before entering tertiary education or university. However, the declining interest in STEM, exacerbated by the current decline in the students' enrolment in STEM subjects, is causing grave concerns. In 2019, only 44% of students registered for the STEM subjects, compared to that of 49% in 2012 (Malik, 2019). On average, this is a decrease of 6,000 students per year (Malik, 2019). A continuous slump of this number will give a negative long-term impact on the number of experts in STEM fields (Ismail *et al*., 2019). Thus, various agencies have made concerted efforts even from high school level to prevent such unwanted consequences. For example, robotic competition (Jiea *et al*., 2019) and National STEM Movement (Idris, 2018).

Recently, the Ministry of Education has announced a fixed STEM package for Form 4 students starting from January 2020 (Senin, 2019). The STEM package mainly includes three options where students are required to enroll in: (1) all pure science courses - Physics, Chemistry, Biology and Additional Mathematics; (2) any two pure science and mathematics courses and/or at least one elective subject of applied STEM science and technology or non-elective STEM subject; (3) at least two elective STEM subjects in applied science and technology or any one vocational subject (Mata Pelajaran Vokasional). This package corresponds with the transition of the Kurikulum Bersepadu

Sekolah Menengah (KBSM) to the Kurikulum Standard Sekolah Menengah (KSSM), where KSSM is designed to develop students' capabilities to meet the 21st century skills, such as critical, creative, and innovative thinking, as well as leadership for them to compete globally (Teo, 2019). On the other hand, the fixed packages will cater the students to connect with tertiary education entry requirement and student's preferred career path (Abdul Rahim, 2019). Figure 1 illustrates the relationship between STEM package with tertiary education courses.

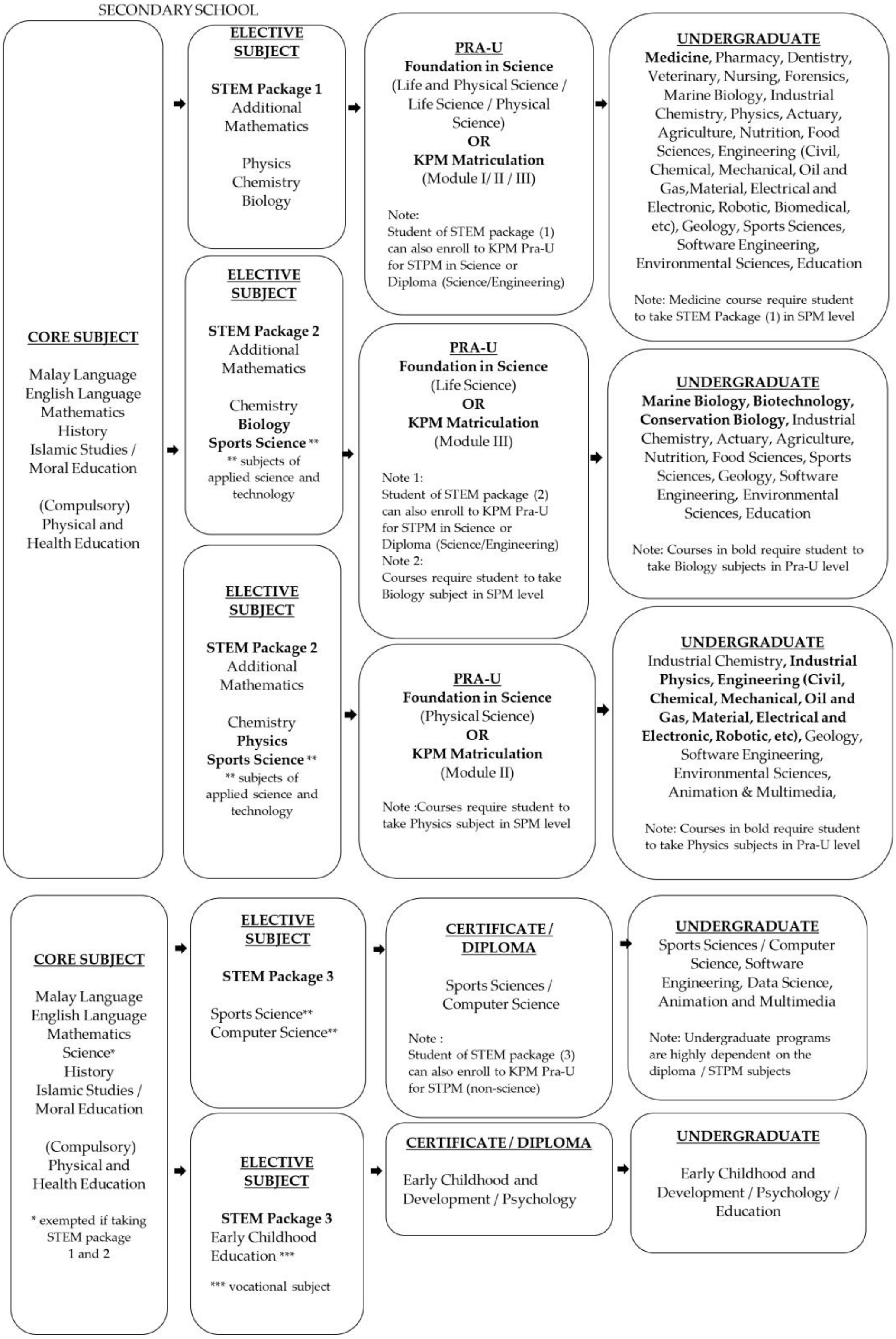

Figure 1. Example of relationship between STEM package with tertiary education courses

The announced STEM packages and related tertiary education may provide a systematic and flexible path for students to foresee their career future in STEM fields. However, given by the active participation from the government in improving the education system, it is important to nurture the students' interest in learning the STEM subjects, especially from Form 1. In this regard, the basic Science subject must be taught in a more enriching and interesting manner to keep the students' enthusiasm alive (Jayarajah *et al*., 2014). Here, one of the strategies is to engage the students through active learning. This can be achieved through problem-based learning (PBL). PBL is a well-known active learning strategy that can facilitate two extremes in learning: low-level and high-level learning. Low-level applies to basic concepts, while high-level learning requires knowledge application practice. By having active participation of students and their teachers at both levels, any given problems will indirectly stimulate their learning interest, thus assist the students to recognize the value of scientific knowledge to seek solutions. On the other hand, a module can be integrated into PBL to increase its effectiveness. Module is a learning material that enables the students to attempt drills and revision (Amin *et al*., 2020) independently while systematically allows them to comprehend the subject (Mohd Najid *et al*., 2019). In addition, the students will learn to sense the responsibility of learning. Therefore, a pedagogy through integrated PBL module can be promising to realize students' interest towards STEM. In this study, an integrated PBL Biology module called BOTANI[st]NJA was implemented towards Form 1 and Form 2 students in order to gauge their interest in STEM education.

METHODOLOGY

BOTANI[st]NJA module was conducted at SMK Usukan, Kota Belud, which is a part of rural area located around 60 kilometre away from Kota Kinabalu, Sabah. The BOTANI[st]NJA was designed by the Biology lecturers of Preparatory Centre for Science and Technology (PPST), Universiti Malaysia Sabah (UMS). The topic was mostly about plants where students were introduced to a Botanist as a potential career in plant studies. Prior to the module implementation, 79 of combined Form 1 and Form 2 students were divided into 15 groups, each accompanied by a facilitator. The module was executed in a systematic order as summarised in Figure 2. A special BOTANI[st]NJA badge was awarded to any of the groups producing neat specimen organization and correct identification. During the session, facilitator encouraged the students to ask question and actively engage with the problems.

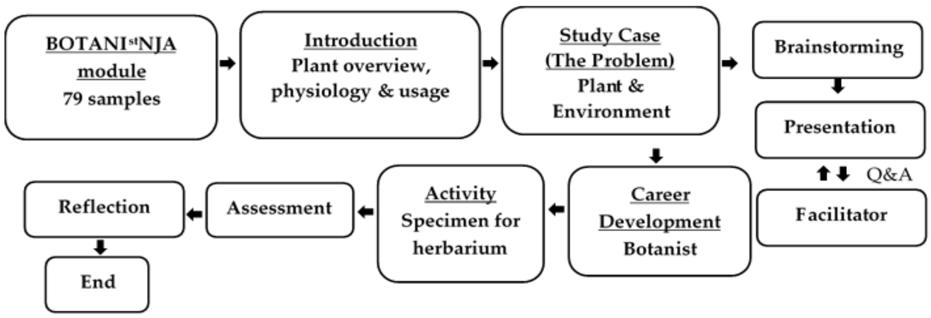

Figure 2. Methodology for BOTANI[st]NJA module.

At the end of the session, students were given a constructed questionnaire in order to gauge the effectiveness of the integrated PBL Biology module. The questionnaire (Figure 3) was structured and adapted from Luo *et al*., (2017), where students were required to answer nine questions in a six-point Likert Scale. Ascending scale represents strongly disagree (SD), disagree (D), moderately disagree (MD), moderately agree (MA), agree (A), and strongly agree (SA). Finally, data were analyzed by means of frequency distribution and descriptive statistics using Statistical Package for Social Science (SPSS) version 24.

No	Statements	SD 1	D 2	MD 3	MA 4	A 5	SA 6
Q1	The interaction between warrior and students was active	1	2	3	4	5	6
Q2	The warrior offered discussion opportunity	1	2	3	4	5	6
Q3	This module improves my learning effectively	1	2	3	4	5	6
Q4	This module motivated me to learn	1	2	3	4	5	6
Q5	This module sharpens my expression and communication skills	1	2	3	4	5	6
Q6	This module enhanced my confidence in speaking public	1	2	3	4	5	6
Q7	This module developed my self-directed learning skill	1	2	3	4	5	6
Q8	This module enhanced interaction and collaboration skills	1	2	3	4	5	6
Q9	This module increase my interest on science knowledge	1	2	3	4	5	6

Figure 3. The questionnaire according to Luo *et al*., (2017).

RESULT AND DISCUSSION

The questionnaire feedback and answer counts are summarised in Figure 4. In all given questions, 79 students have answered high counts of number 5 and 6, indicating a majority of agreement and/or motivation towards respective skill criteria in the questions. Descriptive statistics and frequency distribution for three categories response are summarised in Table 1 to 4, respectively. Further, three categories of perspectives are summarised through specific questions in order to evaluate the students' perceptions under BOTANIstNJA. The three categories are teaching ability of the facilitator (Q1 and Q2 in Table 2), learning (Q3, Q4, Q7 and Q9 in Table 3), and communication skills of the students (Q5, Q6 and Q8 in Table 4).

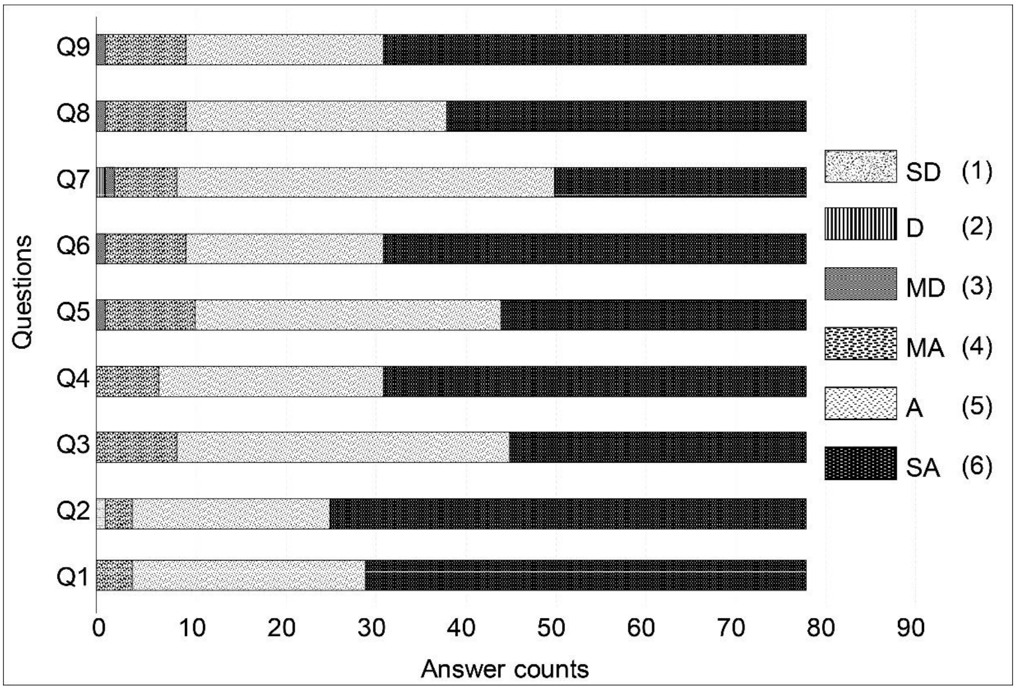

Figure 4. Answer counts for Q1-Q9 in Biology subject.

Table 1. Descriptive statistics for teaching, learning and communication effects

Categories feedback	N Statistic	Mean Statistic	Std. Deviation Statistic	Skewness		Kurtosis	
				Statistic	Std. Error	Statistic	Std. Error
Teaching	79	5.5759	0.53761	-1.581	0.271	2.871	0.535
Learning	79	5.3671	0.48509	-1.155	0.271	1.623	0.535
Communication	79	5.3671	0.56638	-0.822	0.271	-0.029	0.535

Table 2. Frequency distribution of teaching effect (Q1 and Q2).

Satisfaction	Mean range	Frequency	Frequency %	Cumulative %
Somewhat agree	3.50 – 4.49	3	3.8	3.8
Strongly agree	5.50+	62	78.5	100.0
Total		**79**	**100.0**	

Table 3. Frequency distribution of learning effect (Q3, Q4, Q7 and Q9)

Satisfaction	Mean range	Frequency	Frequency %	Cumulative %
Somewhat agree	3.50 – 4.49	4	5.1	5.1
Agree	4.50 – 5.49	30	38.0	43.0
Strongly agree	5.50+	45	57.0	100.0
Total		**79**	**100.0**	

Table 4. Frequency distribution of communication skills (Q5, Q6 and Q8)

Satisfaction	Mean range	Frequency	Frequency %	Cumulative %
Somewhat agree	3.50 – 4.49	7	8.9	8.9
Agree	4.50 – 5.49	31	39.2	48.1
Strongly agree	5.50+	41	51.9	100.0
Total		**79**	**100.0**	

Based on the descriptive statistics (Table 1), the teaching perspective has the highest mean score of 5.58, compared to 5.37 in learning and communication perspectives. In frequency distribution of each students' perception (Table 2 – 4), mean ranges were fixed at 3.50 – 4.49, 4.50 – 5.49, and 5.50+ for satisfaction level of "moderately agree", "agree", and "strongly agree". The students have never been exposed to similar type of learning as BOTANIstNJA. Compared with teacher-centered approach in conventional learning, the BOTANIstNJA encouraged student-centered learning, where the tutor facilitated the group discussion without providing easy answers. Interestingly, 78.5% of students "strongly agree" (Table 2) with this teaching approach. This result might be reflected by the responsibility given to the students to take charge of their own learning, which was guided by the facilitators. In the solution's finding process, the students gathered information from printed handouts, Science textbooks, and raw leaves samples taken from outside the classroom.

Subsequently, through active thinking and discussion, the students appreciated the BOTANIstNJA by answering high frequency of "agree" (38.0%) and "strongly agree" (57.0%) for learning perspective (Table 3). These values indicated the underlying interest for learning within the students. The source of interest is profoundly driven by the students cognitively appraised situation, where rather through theoretical, they were able to actively participate in the group and find motivation to solve the problems (Treesna Wulansari *et al*., 2018). On the other hand, to spark motivation and enthusiasm in students for STEM, they were introduced to a Botanist career in order to create a cheerful prospective mood to their learning experience. As for communication effect, the students expressed "agree" (39.2%) and "strongly agree" (51.9%) (Table 4) for their developed communication skills. Prior to actively utilizing the information resources, the given problems triggered a group discussion. The benefits of this process are twofold: it helps the students to become independent learners and encourages an effective group discussion with their peers in solving the problems (Husain, 2011). The PBL provides students with a degree of interaction for peer learning, peer teaching, and group presentation (Abdullah *et al*., 2010). In particular, the students' knowledge about leaves structure has improved through a well-facilitated group discussion during the herbarium labelling activity. Apart from good participation and full commitment from everyone who was involved, the BOTANIstNJA facilitators also assisted the students by imparting knowledge on herbarium (Figure 5). In this study, the BOTANIstNJA has demonstrated its feasibility for gauging learning interest towards STEM subjects within Form 1 and 2 students. This approach shall be continued to encourage them taking the STEM packages. Eventually, a consistent increase of students enrolled in the STEM packages will enrich the number of STEM experts in Malaysia.

Figure 5: Simple herbarium of BOTANIstNJA activity from SMK Usukan, Kota Belud

Limitation of Study

The data provided was only represented by one selected rural school. The accuracy of module effectiveness needs to be further proven by involving more schools in the future. In order to maintain the module's quality, human-factor biased must be waxed. Facilitators or lecturers in charge must be given equal training and clear instructions when they conduct the module's activities. Obviously, expanding the usage of this module by involving more samples or schools in the future is the only way to strengthen all findings related to its impact and effectiveness in stimulating student's interest towards STEM.

CONCLUSION

An integrated problem-based learning Biology module (BOTANIstNJA) was implemented to Form 1 and 2 of SMK Usukan, Kota Belud to gauge the students' interest in learning STEM subjects. The students were given problems related to plants and assessed an activity with herbarium labelling. Three perspectives: teaching, learning, and communications skills were evaluated through questionnaires. Based on the frequency distribution and descriptive statistics, all students expressed their improvement in all perspectives. This result suggests the effectiveness of the integrated problem-based learning module to stimulate students' interest in learning STEM subjects.

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