Undergraduates' Interest Towards Learning Genetics Concepts Through Integrated STEM Problem Based Learning Approach

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Abstract

Scientific and innovative society can be produced by giving priorities in Science, Technology, Engineering, and Mathematics (STEM) as emphasized by Malaysian Higher Education Blueprint (2015-2025). STEM need to be implemented at higher education because universities need to produce competent graduates to support economy growth and sustainable development. Learning STEM through Problem Based Learning might allow the undergraduates to become more enthusiastic when problem-based instruction is incorporated with STEM by implementing teamwork and problem-solving techniques to engage the first-year undergraduates fully with the learning. This study was conducted to investigate whether Integrated STEM Problem Based Learning Module could enhance and retain the interest towards genetics concepts among first-year undergraduates. Topics in genetics was considered difficult not only to teach but also to learn. In this research, to overcome the genetic concepts learning difficulties, genetic related topics were chosen to introduce STEM through problem-based learning approach, which might help first-year undergraduates to acquire deep genetic content knowledge. This is very vital for the first-year undergraduates, as the knowledge gained in their first semester will be applied in the upcoming courses in their entire undergraduates' programs of study. A Pre-Experimental research design with one group-posttest design was applied. A total of 50 participants who are first-year undergraduates from Faculty of Biology from one of the public universities in Malaysia were involved. The Genetics Interest Questionnaire used to study if the STEM Problem Based Learning Module could enhance and retain the interest towards genetics concepts. The research has proven that Integrated STEM through problem-based learning approach could enhance and retains the interest in learning genetics concepts among first-year undergraduates.

Keywords: STEM, genetics concepts, undergraduates, interest.

INTRODUCTION

The importance of implementing integrated STEM approach at higher education has been stressed in numerous reports, including in the President's Council of Advisors on Science and Technology Engage to Excel report (Olson & Riordan, 2012), American Association for the Advancement of Science Vision and Change report (American Association for the Advancement of

Science, 2011) and the National Research Council Discipline Based Education Research report (National Research Council, 2012). It had suggested that STEM education can be improved through a diversification of teaching and learning methods. Apart from diversification, it had urged the need to fundamentally shift the entire undergraduate's education paradigm from instruction-centered or teacher-centered to learning-centered or student-centered (Barr & Tagg, 1995).According to Baharom and Palaniandy (2013), due to the complexity of biology related courses at undergraduate level, new approach is needed to teach and learn contents in biology related courses in an exciting way. To a naive undergraduate, they may feel it is too laborious and irrelevant if no attempts were done to solve their problem. Baharom and Palaniandy (2013) stated that if teaching and learning remained teacher-centered, exam oriented and painstaking memorization of facts and concepts in biology related courses it will dwindle enrolment to the science courses at the higher education level.

Undergraduates need to master the genetics knowledge as the knowledge from this course will be used as fundamental to other courses in biology (Banet & Ayuso, 2000; Tsui & Treagust, 2004). Apart from its importance, genetics course was studied because Kılıç, Taber, and Winter bottom (2016) stated topics in genetics was considered one of the most important and difficult to teach and learn. Study by Altunoğlu and Sekar (2015), Haambokoma (2007), Bahar, Johnstone, and Hansell (1999), and John stone and Mahmoud (1980) concluded that genetic has been identified as the most problematic topics in learning biology even though it is considered as basic topic. In this research, to overcome the genetic concepts learning difficulties, genetic related topics were chosen to introduce STEM through problem-based learning approach, which might help first-year undergraduates to acquire deep genetic content knowledge. This is very vital for the first-year undergraduates, as the knowledge gained in their first semester will be applied in the upcoming courses in their entire undergraduates" programs of study.

Genetic concepts were the selection to study because if the concepts in genetics taught are not related to undergraduates' everyday lives, they may fail to use the made quately when they face real-world problem. Therefore, their knowledge may remain in the form of isolated knowledge. Effective learning requires them to apply newly acquired concepts or skills to different contexts (Cimer, 2007; Gallagher, 2000). Thus, through this research it might allow first-year undergraduates to use their knowledge or skills they gained from this research to solve the problems in undergraduates faced in their everyday lives. However, several studies showed that as students go to higher education level, their interests towards science tend to decline (Bae, 2015; Dawson, 2000). This statement rings to be true when this research also discovered from preliminary interview data that undergraduates felt less interest in learning genetics concepts and difficult to know its value without interest. Therefore, through this research it might help first-year undergraduates to gain interest while learning genetics concepts and at the end appreciate their learning.

At tertiary education, statistics indicated that the inclination of undergraduates' interest is toward the social sciences, business and law courses (Ministry of Higher Education, 2011). This trend will somehow impede our national aspirations toward establishing a scientific and progressive society (Mahathir Mohamed, 1993). To address this declining enrolment in STEM related fields, science education needs to be more relevant and the program of study should be able to adapt to the changes in the development of science and technology. Fair weather (2008) had also suggested that to improve student learning and interest in STEM subjects if the faculty could be convinced to restructure their practices even slightly by replacing the current approach with some other educational approaches that might become effective opportunities to the first-year undergraduate and subsequently to the faculty in bringing STEM gradually into practice in future.

Xie, Fang, and Shauman (2015) had reported that interest towards science related subjects will be an aspiration for s STEM-type career are strongly predictive of STEM educational outcomes. This is because aspiring to a career in science appears to be a prerequisite for attaining a STEM degree and loss of interest is a main reason for attrition from STEM majors at higher education (Seymour, 1997).To implement integrated STEM education at higher education level and make this as a reality, undergraduates must be exposed with proper way of learning which use active engagement instructional approaches to teach STEM. With numerous studies showed that STEM enable to positively impacts student learning, this might also work in improving interest in learning genetics concepts with STEM through problem-based learning approach in this research. That was the reason why the current learning strategies need to be revised with the intention to facilitate undergraduates' performance in genetics courses at first-year undergraduates. As genetics course is a pre-requisite for a few majoring courses such as Microbial Genetics, Biotechnology, Genetics Engineering, Animal and Plant Genetics and other genetics related courses, thus, equipping the undergraduates with strong genetics concepts understanding will strengthen first-year undergraduates with the genetics concepts.

Research Focus

In this research, Piaget's cognitive constructivism is used as one of the theories to develop STEM problem-based learning activities. Investigation of undergraduates' prior knowledge during Idea Generation phase requires them to list out possible ideas, explanations or hypotheses to solve the problems. Under graduates tends to assimilate the new learning if prior knowledge is consistent with scientific concepts. However, if they don't have the proper understanding about related genetics concepts, they should be given the opport unities to adjust and modify their prior understanding as Accommodation process in their brain. From the construct vist model, the task of the educator is not to allocate knowledge but to provide them with opportunities and challenges to build the knowledge on related concepts.

Since the participants in this study never experiences neither STEM nor problem-based learning, the researcher had decided to implement Problem Based Learning Model from Temasek Polytechnic, Singapore in this research. This is because all available Problem Based Learning models share common characteristics, such as, problem-based learning as an instructional method that challenges students to "learn how to learn" by collaboratively solving ill-defined, real-world problems. It is based on the constructivist model of learning and consists of four key components, such as, (i) ill-structured problems that are likely to generate multiple hypotheses about their cause and multiple approaches to their solution, (ii) student-centered learning, where students determine what it is, they need to learn and find appropriate resources for information, (iii) teachers acting as facilitators or tutors, and (iv) authentic, real-world problems (Barrows, 2000). Since almost all Problem Based Learning Models consists of similar steps, Problem Based Learning Model from Temasek Polytechnic, Singapore (Wee & Kek, 2002) is chosen to deliver STEM. The fewer steps in this model will enable the first-year undergraduates to understand and follow the steps in a proper way. This rings even better because the participants in the study have never experience problem-based learning practice in their learning, thus this model will be appropriate to be implemented in this study.

Elements in STEM will be explain in this section accordingly. First element, Science (S) includes scientific inquiry including predicting and measuring the effect of variables on the final solution for the activity. Elements in "S" is as, (i) Understanding of the basic principles and functions of genetics concepts , (ii) Scientific investigation, (iii) Science as inquiry, (iv) Identifying questions to be answered, (v) Designing and conducting investigations, and (vi) Using tools to gather and interpret data, and (vii) Developing and understanding of genetics concepts. Second, for Technology (T) it was seen as every important function of product. Technology is about the designing or creating a product or solution. Elements in "T" is as, (i) Understanding of attribute designs, (ii) Developing the ability to apply design processes, (iii) Identifying appropriate problems, (iv) Designing solutions, (v) Revision before making improvements, (vi) Evaluating solution, (vii) Controlling and timing actions, and (viii) Reasoning with evidence. Third, for Engineering (E), engineering is an approach to designing product or solution, processes, and systems to meet human needs. In the context of STEM, is not talking about teaching engineering knowledge, it is about teaching engineering thinking. Elements in "E"is as, (i) Define the Problem, (ii) Generate Genetics Concepts, (iii) Develop a Solution, (iv) Construct and Test a Prototype, (v) Evaluate the Solution, and (vi) Present the Solution. Fourth, for Mathematics (M), how use math to test the solution. Elements in "M" is as, (i) Understanding ways of representing numbers, (ii) Selecting appropriate methods for estimating and measuring, and (iii) Collecting and handling data.

In this section with using Module Activity 1 as example, it explains how STEM connected with problem-based learning. Figure 1 shows some part in this activity.

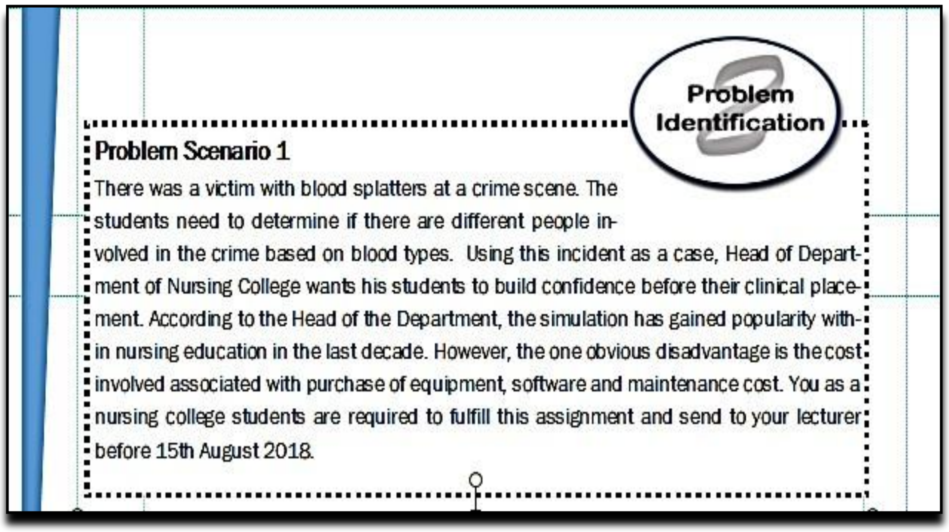

Figure 1. Stage 2: Problem Identification in PBL Process

In second stage, this stage it starts by presenting the problem by one of the students in the group as shown in Figure 1. The students will read the problem to another member of the group. Students are given the opportunity to clarify the problem to their facilitators. They might clarify any meaning that they didn't understand before proceed to the next stage. After clarification completed, they need to identify the problems. Each member of the group needs to share the main point found in the problem scenarios and it will be written in the module given to them. Then, one member of the group needs to read out what is the real problem of the problem scenario. To summarize, in this stage group identifies the facts of the problem and summarizes the gist of problem.

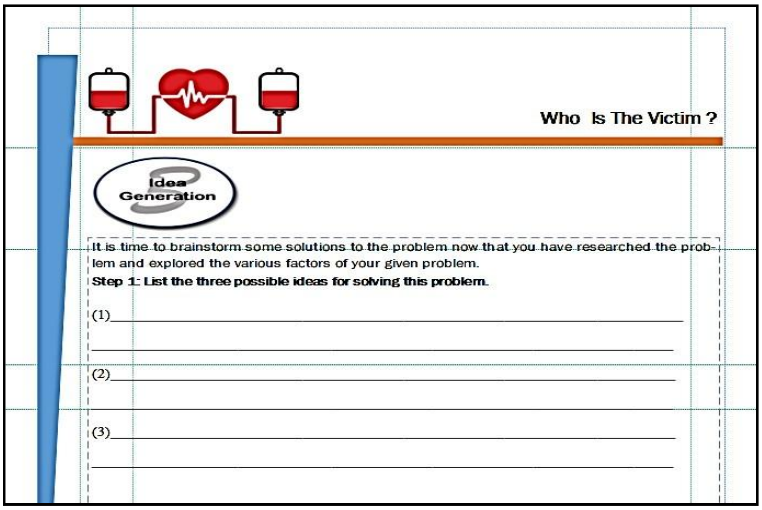

Figure 2. Stage 3: Idea Generation Identification in PBL Process

Stage 3, 4 and 5 runs simultaneously because the contents in Stage 3 and 4 relates with Stage 5. Figure 2 show the Stage 3 in problem scenario 1. In this stage, students need to brainstorm some solutions to the problem that they have researched and they need to explores the various factors of the given problem. They are required to list out at least three possible idea that facilitate them to solve the given problem.

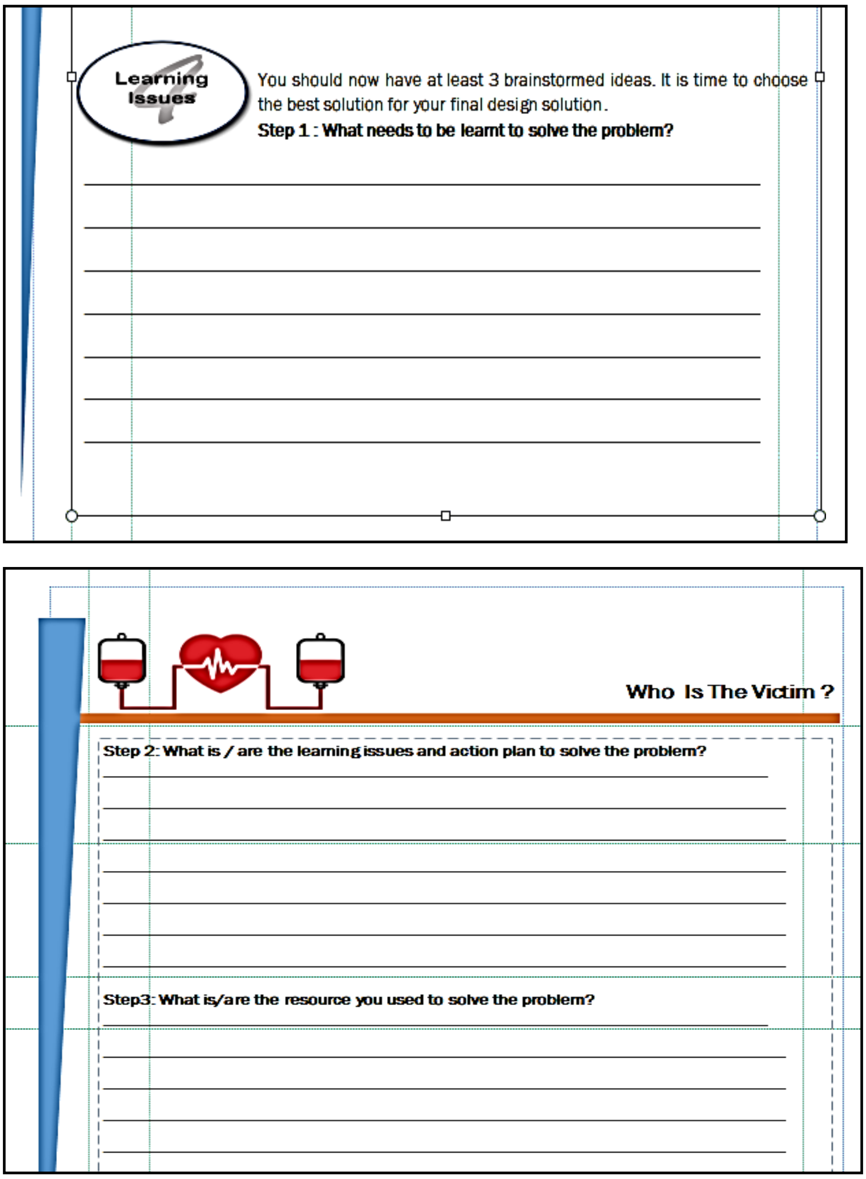

Figure 3. Stage 4: Learning Issues Identification in PBL Process

In this stage, students will decide what they need to do to solve the given problem as shown in Figure 3. Learning issues will be identified by them as much as they could. The more learning issues that are generated, it gives more ideas for them in order to get more information which might be helpful for them to solve the given problem. Students need to list all the learning issues arise via the group discussion. Since this is a group work thus, they need to works in a group to solve the given problem.

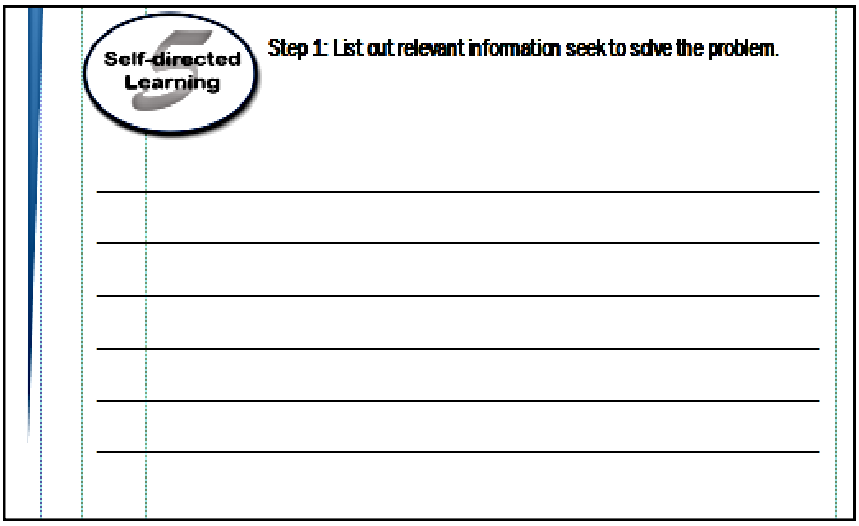

Figure 4. Stage5: Self-Directed Learning in PBL Process

In this stage, the respondents need to search information regarding the learning issues via group discussion and as shown in Figure 4. They are given the opportunity to choose the learning issues that they want. Before ends the session, tutor inquiries into possible research source that they will look into. Students need to present the information regarding the learning issues by following week. They are given enough time to search information related to the given work. To summarize, in these stages (Stage 3 to 5), the group generates possible ideas, explanations or hypotheses to understand or solve the problem. Then, group determines what needs to be learnt in order to solve or explain the problem. The group then seeks, selects and summarizes relevant information.

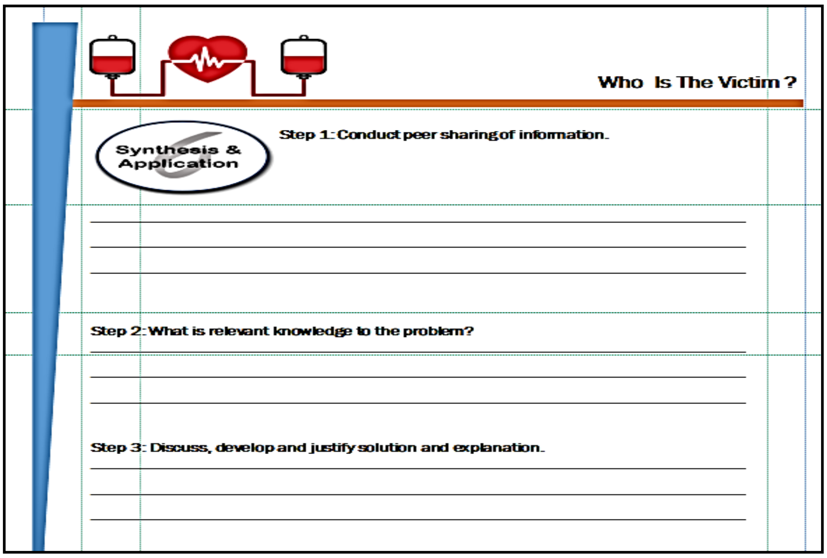

Figure 5. Stage 6: Synthesis and Application in PBL Process

During this stage as in Figure 5, it was starts by the tutor asking about the take away assignments given. Students were asked whether they had faced any difficulties in finding the resources regarding the learning issues. Students evaluate sources of information for credibility and validity. To begin with, the volunteered student will need to summarize the problem as per understanding.Then, students conduct peer sharing of the collected information from various resources. After sharing the information, they need to apply relevant research and knowledge to the problem. If they encountered any problems, they can develop more learning issue. This helps them to analyze and construct knowledge together. Then, they will need to discuss, justify and develop solution and explanation. Students need to summarize by doing the concept map after the discussion. To summarize, after research the group learns and applies the knowledge in order to develop a solution for the problem.

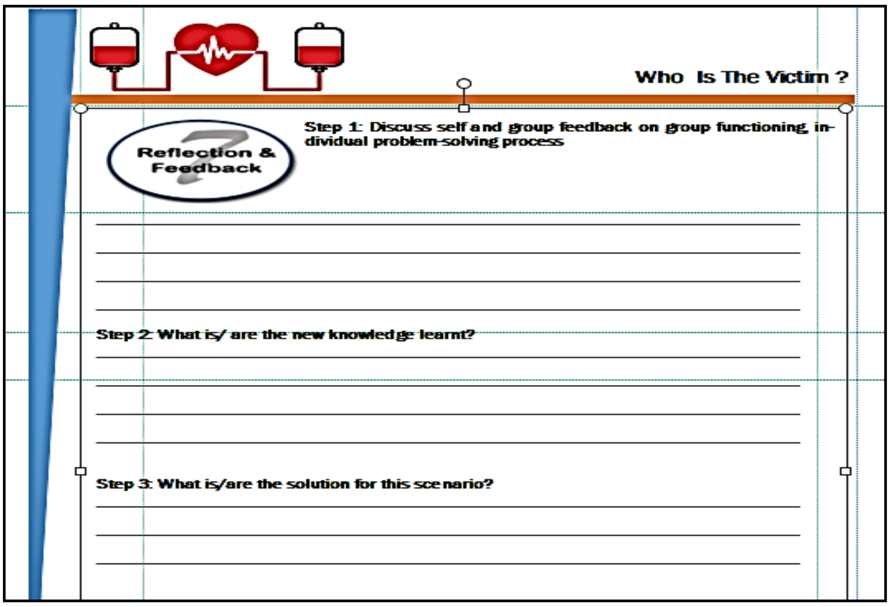

Figure 6. Stage 7: Reflection and Feedback in PBL Process

In this stage as in Figure 6, group feedback on group functioning, problem solving, and knowledge learnt will be discussed. Each member of the group was asked to share their experience in learning STEM through PBL. Then, the facilitation skills were also shared in this stage. To summarize, group conducts self and group reflection on problem solving skills, self-directed learning skills, solution, learning of new knowledge and tutor facilitation skills.

This research was conducted to study whether STEM through problem-based learning module able to enhance and retains undergraduates" interest towards genetics concepts among first-year biology undergraduates' in one of public university. Consequently, this research is important in terms of education for several reasons. STEM education is important to help Malaysia to moves to greater heights. If STEM education is not implemented and practices, Malaysia will continue to fall in world ranking in STEM subjects and will not be able to compete with other countries. This aligns with Malaysia Higher Education Blueprint (2015-2025), which desires to invest in Malaysia's youth. This is because, to thrive in an increasingly competitive global economic development, it requires the transformation of Malaysia's higher education system. Apart from proficiency in English, the jobs of tomorrow will require a greater emphasis on STEM. From this research, it is expected that the learning will be more relevant as undergraduates are exposed to the genetics concept of what they learn based on current and real-world situations. There are few advantages of using problem-based learning to learn STEM as suggested by previous researches. It will fosters understanding of connections among principles, concepts, and skills across discipline as suggested by Capon and Kuhn (2004). Applying problem-based learning to learn STEM was suggested that it will encourages collaborative problem-solving and interdependence in group work (Ward & Lee, 2002). Study by Goodnough and Cashion (2006) suggested that using problem-based learning to learn STEM will fosters connections among thinking, doing, and learning. Boud and Feletti (2013), will develops students' ability to apply their knowledge.

Research Methodology

General Background

A pre-experimental research design as one group pretest-posttest design were used in this research with the focus in researching the interest towards genetics concepts through STEM Problem Based Learning Module. There is only one intact group was employed in this research to receive the intervention. This design involves the use of an intervention on a target population that lack the element of random assignment and makes use of intact classes. This method is chosen because it is quite possible for the researcher to study educational related problems when the participants already present in a situation or in intact group (Creswell, 2005). In this design, the researcher measures the interest towards genetics concepts among the samples of the research in pretest. After the pretest, this same group will receive intervention on carrying out STEM-Problem Based Learning activities in the module for eight weeks. After intervention completed, the researcher measured the level of interest towards genetics concepts in the posttest. Delayed posttest (O_3) is carried out after six weeks from posttest (O_2). Figure 7 shows the outline of One Group Pretest-Posttests Design.

R	O_1	X	O_2	O_3
Indicators:				
O_1	Pretest			
X	Intervention			
O_2	Posttest			
O_3	Delayed Posttest			

Figure7. One Group Pretest-Posttests Design

Sample

In this research, a total of 50 first-year undergraduates from one of university had directly involved. The samples were selected from an intact group and it is assumed that the ability of the first-year undergraduates were equivalent. The undergraduates were grouped into 10 groups and per group there are five members. Each of them plays different roles in the group. The group members were assigned randomly by the lecturer to control the participant variable.

Instrument

This research took the core concepts identified in the Genetics Literacy Assessment Instrument (GLAI)by Bowling, Acra, Wang, Myers, Dean, Markle, and Huether (2008) developed by Professor Bethany Bowling with the team from University of North Kentucky. She is well-known because of her research that centered on genetics education, in particular with introductory courses like those taken as part of a core curriculum requirement. GLAI was utilized as the basis for the Genetics Interest Assessment (Doughney, 2013). In this research, Genetics Interest Assessment was re-named to Genetics Interest Questionnaire (GEQ). The items related to genetics interest were validated and checked for its reliability to Malaysia's higher education context.

Table 1

Construct of the Items in Genetics Interest Questionnaire

Constructs	Total Items	Item Number
Nature of the genetic material	8	8,11,14,15,19,21,22,28
Transmission	6	12,13,34,35,36,39,40
Gene Expression	6	9,10,24,27,29,31
Gene Regulation	4	16,18,25,26
Evolution	3	20,30,32
Genetics & Society	14	1,2,3,4,5,6,7,17,23,33,37,38,41,42

The researcher conducts face validity and content validity for GEQ. Validity of this instrument is done prior to a pilot study. GEQ was validated by three experts, (i) biotechnology lecturer for first-year undergraduates‟ course with 16 years teaching and research experiences, (ii) science lecturer in research field and teaching genetics related course with 8 years of experiences, and (iii) science lecturer in research field and teaching genetics related course with 10 years of experiences. To determine the reliability of GEQ and its time management for answering, a pilot test was conducted on 30 participants. These participants resemble the actual sample characteristics, but they were not involved in the main study. The Cronbach's alpha coefficient for internal consistency reliability measure for this this instrument was 0.979, which was high and indicated strong internal consistency among 42 items (George& Mallery, 2003). After the pilot test, several participants were selected randomly and interviewed; the informal interview were done to obtain constructive feedbacks from them to improve this instrument. After improvements were made based on given feedback, this instrument has been sent to same experts for conclusion before administrating into main study.

Data Analysis

In this research, the research questions will be answered with One-Way ANOVA Repeated Measures. Data analyzed for its normality before deciding appropriate statistics to analyze the research hypotheses (Pallant, 2016).The Q-Q Plots derived from pretest, posttest and delayed posttest showed that most of the points approaches the normal line(Appendix 2).But relying on graphical methods alone is not sufficient to provide conclusive evidence that the normal assumption holds (Razali & Wah, 2011). Therefore, to support the graphical methods, the statistical methods which is Shapiro Wilk Test was also conducted. Skewness and Kurtosis were also analyzed through descriptive statistics to check the distribution of data (Appendix 3). Based on the findings, the value of the skewness and kurtos is shows values approaching zero. Based on the range of values between -1and +1 as stated in George and Mallery (2003), this finding showed that the mean scores for the dependent variables approaches the normality.

Shapiro Wilk statistical analysis shows that if the p-value is less than or equal to the significance level (0.05), it concludes that the data is not normally distributed. If p-value is more than significance value ($p>0.05$), it shows that the data are normally distributed. The statistical values showed significant value more than 0.05 which shows that the data were normally distributed. Based on Shapiro Wilk Normality Test, the significance value is more than 0.05, so that it can be concluded that the data are normally distributed (Appendix 4). Because the research data set for interest is normally distributed, One-Way Repeated Measures ANOVA can be carried out in this research. Since, the statistical analysis produces significance value more than 0.05 for all the data sets, it means that data for three dependent variables are normally distributed. Thus, One-Way ANOVA Repeated Measures will be used for Inferential Statistics.

Multivariate test results (Table 4) shows the main effects of test periods on interest towards genetics concepts are significant (Wilks' Lambda = 0.007, $F(2, 50) = 3618.286$, $p < 0.05$, partial eta squared, $\eta_p^2 = 0.993$).

Table 2

Multivariate Test Results on Mean Score for Interest

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Interest	Wilks’Lambda	0.007	3618.286	2.000	48.000	0.000	0.993

Partial Eta Squared, η_p^2, which is the size of the effect can indicate the relative magnitude of the difference between the mean, or the sum of the variances in dependent variables that can be expected from the independent variable (Tabachnick, Fidell, & Ullman, 2007). Cohen (1988), had recommended guidelines for the value of that eta-square of 0.01 is small, 0.06 is moderate and 0.14 is considered large effect. The same guideline can be used to predict the size effect of partial eta squared value (Tabachnick, Fidell, & Ullman, 2007). The partial eta square value, η_p^2 = 0.993 obtained in thisresearch indicates that the size of the test times effect on interest towards genetics concepts is high.

Multivariate test output can be supported with univariate test findings for within subject's variable. The assumptions of sphericity will be checked using Mauchly's Test of Sphericity before selecting appropriate univariate test.

Table 3

Result of Mauchly's Test of Sphericity for Interest

Within Subjects Effect	Mauchly'sW	Approx.Chi-Square	df	Sig.	Epsilon[b]
					Greenhouse Geisser / Huynh-Feldt
Interest	0.915	4.277	2	0.118	0.921/0.956

Mauchly's test of Sphericity result in Table5 showed that this assumption was met, χ^2 (2) = 4.277, p = 0.118. The non significant value showed that variance-covariance matrices sphericity assumptions are obeyed (Howell, 2009) and will be used in univariate analysis.

Table 4

Result of Univariate for Interest

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Interest	Sphericity Assumed	70452.333	2	35226.167	2841.288	0.000	0.983
Error (Interest)		1215.000	98	12.398			

Univariate test results based on sphericity assumptions as showed in Table 6, it was found that the main effect of the test time was significant for interest towards genetics concepts (F = 2841.288, p <0.05, η_p^2 = 0.983). That Partial Eta Squared value, η_p^2 = 0.983 indicates that the size of the test time effect for interest towards genetics concepts is very large (Cohen, 1988).

Significant multivariate test results as in Table 4 and univariate tests as in Table 6 showed that at least one test pair have a significant mean difference in the mean score of the questionnaire on interest towards genetics concepts. To determine the test pair which have the significant difference, the Sidak test was conducted. Table 10 shows the results of the Sidak Test.

Table 5

Result of Sidak Test for Interest (Pairwise Comparisons)

Interest Towards Genetics Subject		Mean Difference	Std. Error	Sig.*
Pretest	Posttest	-41.70	0.61	0.000
	Delayed Posttest	-49.30	0.71	0.000
Posttest	Pretest	41.70	0.61	0.000
	Delayed Posttest	-7.60	0.79	0.000
Delayed Posttest	Pretest	49.30	0.71	0.000
	Posttest	7.60	0.79	0.000

Based on estimated marginal means

*. The mean difference is significant at the 0.05 level

The results of the Sidak Test as in Table 7 indicate that significant differences (p<0.05) are found in the following three mean pairs of scores:

i. Mean score of pretest on interest towards genetics concepts with the mean score of posttest on interest towards genetics concepts.
ii. Mean score of pretest on interest towards genetics concepts with the mean score of delayed posttest on interest towards genetics concepts.
iii. Mean score of posttest on interest towards genetics concepts with the mean score of delayed posttest on interest towards genetics concepts.

The mean score of pretest, posttest and delayed posttest of the interest towards genetics concepts was significant (p=0.000). By applying Estimated Marginal Means Test on interest towards genetics concepts, the pattern of mean differences can be obtained.

Table 6

Result of Estimated Marginal Means for Interest

Interest	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Pretest	120.20	0.401	119.39	121.01
Posttest	161.90	0.384	161.13	162.67
Delayed Posttest	170.68	0.612	168.27	170.73

The results in Table 8 show that the mean score of pretest on interest towards genetics concepts are 120.20 while the mean score of posttest on interest towards genetics are 161.90. This tells that there is an increase in the mean scores in the questionnaires on interest towards genetics due to intervention. The Sidak Test (Pair wise Comparisons) as showed in Table 7showed that the mean difference between pretest and posttest is significant. These results showed that Integrated STEM Problem Based Learning Module gives a significant enhancement among under graduates' interest towards genetics concepts.

Finally, the mean score of the post test on the interest towards genetics concepts are recorded as 161.90, this value shows a slight increase to the mean score of delayed posttest on interest towards genetics concepts, which are recorded as 170.68. The Sidak Test (Pair wise Comparisons) as showed in Table7 showed that there is a mean difference between pretest and posttest is significant. These results showed that Integrated STEM Problem Based Learning Module able to provide a positive retention effects on interest towards genetics concepts after the intervention. It can therefore, best conclude that Integrated STEM Problem Based Learning Module were able to give enhancement and positive retention on interest towards genetics concepts among first-year undergraduates.

Discussion

This research was conducted to study whether the Integrated STEM Problem Based Learning Module can enhance and retains the level of interest towards genetics concepts among first-year undergraduates who enrolled genetics courses in their first semester. Findings from this research clearly showed that the integrated STEM through problem-based learning approach had successfully enhanced and retained the interest towards genetics concepts among first-year undergraduates. Since this research uses a single group design, there is no mean of comparison between the intervention group and the control group. But the comparisons are done between three different times, namely, the pretest, posttest and delayed posttest. There are significance differences were recorded between the three tests. The ability of Integrated STEM Problem Based Learning Module to enhance the interest towards genetics concepts is shown by the significant difference between pretest and post test, while, the retention is shown by the significant difference between posttest and delayed posttest.

The findings from this research is in line with suggestion from Fair weather (2008) which suggested that to improve undergraduates' interest in using STEM to learn their subjects, the respected faculty who practice common teaching methods could be convinced to restructure their practices even slightly replacing approaches that might be effective. Thus, this research had followed suggestion from Fair weather (2008) by introducing the Integrated STEM through Problem Based Learning Module among first-year undergraduates at the respected faculty. A module integrates both theoretical and practical elements needed for learning science in Malaysia (Azman, Sharif, Parmin, Yaacob, Baharom, Zain, & Samar, 2018). This is mainly because using a module is considered as important for the students and educators to have educational method engaging with a hands-on element in science teaching and learning which can spark their interest towards learning science related subjects.

The findings from this research reveal that there is an enhancement and positive retention in interest towards learning genetics concepts among first-year undergraduates. This can be seen by increase in the means score from pretest to posttest and posttest to delayed posttest, respectively. Teaching STEM disciplines through integrating science, technology, engineering and mathematics would be more in line with the nature of STEM. Integrated STEM education can make learning more relevant and meaningful for students as suggested by Stohlmann, Moore, and Roehrig (2012). Previous research had showed that integrative approaches among science, mathematics, technology and engineering give positive effect on undergraduates' learning especially in increasing and improving their interest and learning in STEM as found in research by Becker and Park(2011).

Interest in learning genetics was chosen because according to Dainton (1968) it stated that in many countries, the research projects were initiated in order to examine the decline of interest in science related more closely and to explore effective measures on how to work to overcome it. Moreover, the use of an integrated curriculum has been found to improve students' non-cognitive learning outcomes, such as interest in STEM learning as suggested by Mustafa, Ismail, Tasir, Said and Haruzuan (2016), Thibaut, Ceuppens, De Loof, De Meester, Goovaerts, Struyf, and Hellinckx (2018) and motivation towards STEM learning by Wang, Moore, Roehrig and Park (2011), which in turn could lead to increasing numbers of STEM graduates in future as stated by LaForce, Noble, and Blackwell (2017).

The Integrated STEM Problem Based Learning Module was used to cater students' need. Students' interest will increase if they really willing to learn by themselves. Students will get bored and less attention will be given ifthey did not understand the topic with the ways of teaching andlearning. The similar research conducted by Blanchard, Southerland, Osborne, Sampson, Annetta, and Granger (2010), Michael (2006), Knight and Wood (2005) and Prince (2004) found that undergraduates' will learn more in courses that use interesting and active engagement instructional approaches. Previous research revealed that students perceived the lesson as personally, meaningful and interesting are topics that were important in or related to their daily lives as stated in Akerlind (2004). The form of activities like the use of group work and computers through which learning took place also played an important role in influencing student interest (Palmer, 2009). Based on the findings from this research, it can be concluded that integrating STEM problem-based learning into genetics subjects might be an effective way when attempting to increase first-year undergraduates' interest towards genetics concepts.

From the observation during the intervention process, the researcher of this research observed that the first-year undergraduates' really show interest in engaging in the learning process when they were given problem scenario that was related with life matter. They might feel to fully engaged in solving problem into something that are concern to them. All activities were carefully designed as suggested by Roger and Taylor (2011) and Fritz, Hussmann, Wingenbach, Rutherford, Egger, and Wadhwa (2003) which stated that the controversial genetics issues pool learning interest among the undergraduates. This was also supported by Lock and Miles (1993) which suggested the use of current event examples to facilitate student's meaningful learning. Previous research has found that traditional didactic lecture may lead to memorization of factual information, but often fail to elicit comprehension of meaningful learning (Loverude, Kautz & Heron, 2002; Wampold, Wright, Williams, Millar, Koscuik, & Penberthy, 1998).

The integration gives undergraduates more meaningful learning experiences by connecting disciplinary knowledge with personal and real-world experiences. Based from this research finding, it supports other study by highlighting that meaningful learning occurs when learners make connections between prior knowledge and new experiences and skills within real world contexts as stated in Brooks and Brooks (1999). Hirst (2010) pointed out that separated subject areas restricted learning by making learners alienated from real world experiences.

In Stage 5, the group will undergo self-directed learning, whereby, the group seeks, selects and summaries relevant information needed to solve the problem scenario. In Step 1 of Stage 5, undergraduates need to list out relevant information to solve the problem before they continue doing the activity. The use of engineering design thinking as way to teach science and mathematics in this research can be seen in stage 3 and 4. During this stage, undergraduates need to develop a solution before construct and test a prototype to solve the challenge.

Inculcation of self-direction stage in the process is seen as important. It is dependent on the learner and the learning environment. Learners pursuing higher education are expected to be self-directed and self-motivated for them to fully benefit. But not all undergraduates can fulfill this expectation because they might find it a real challenge. This finding is supported by Mala-Maung, Azman, and Abas (2006) which states that this statement especially applies to some undergraduates whose entire educational life have been one of rote memorization and whose main aim is to achieve high marks during examinations through reproduction of the facts they have learnt. Introduction of self-directed steps in the STEM problem-based learning activity is seen as important because as found by Shepherd (2006) and Lightfoot (2006) that some institutions of higher education have thus expressed concern about students having difficulty in adapting self-directed learning style expected by a higher education environment. Van der Steeg (2003) suggested that by creating strategies will enable students to develop self-directed learning. Thus, introduction of self-directed learning might be a right decision which may be a reason to observe enhancement and positive retention in interest among the undergraduates in learning genetics concepts by using Integrated STEM Problem Based Learning Module.

There are few studies which see positive impacts and retentions by implementing STEM in the undergraduates' classroom. STEM instructors have been charged with improving the performance and retention of students from diverse background as stated in Haak, Hille Ris Lambers, Pitre, and Freeman (2011). Haak et al. (2011) showed that a highly structured course design in STEM topic with problem solving, data analysis, and other higher order cognitive skills, improved the performance of all students in a college level introductory biology class. The findings of this research are in line with Honey, Pearson and Schweingruber (2014), which stated that an integrated approach in STEM education with the topics that present problem in current life will enable to increase interest of the course content.

In recent theories, interest is understood as a phenomenon that emerges from as individual's interaction with student's environment. Based on research output from Savery and Duffy (1995), it stated that problem-based learning embedded in the social constructivist view of teaching and learning. This statement is supported by Fos not (1996) which states that problem-based learning promotes self- regulated learning because it enhanced through exploration, cooperative social activity, and discourse. When students work with tasks in collaborative way with their group members, they are pushed to consider alternate ideas and perspectives, be responsible to others, and engage in intellectual environment. Furthermore, by fully engaging in the learning process it will allows students to create, discover, and deeply understand the task in a way that to attain when students are exposed only to traditional and passive lectures. These principles are the basis of the theory of constructivism as stated in Cross (1998) and Palinscar (1998).

Implications and Conclusion of the Research

Few implications of the research from the perspectives of theoretical, higher education curriculum, genetics lecturers and undergraduates we rederived from this research. From the perspectives of theoretical, the cognitive conflicts stimulate learning (Bergman, Sieben, Smail begovic, de Bruin, Scherpbier, and van der Vleuten, 2013). The learning become meaningful and benefits the first-year undergraduates in this research with the introduction of STEM through problem-based learning process to learn. This also in line with Bergman et al. (2013) which had stated that the knowledge retention is likely to happen when a problem or scenario resembles real life. In line with Singh and Rajput (2013) who asserts that cognitive constructivism emphasizes that individual learners by physically interacting with objects in their environment always attempt to make sense of the world around them. In the same vein, Ah-Nam and Osman (2017) observed that a learning environment based on constructivist learning theoretical framework establishes that learners construct their own new understanding in pursuance of existing knowledge. Learning environment based on construct vist learning theoretical framework enhance learners' involvement in solving from their own ideas. It has the potential to assist learners' engagement in STEM discovery activities when involved in the process of solving problem tasks.

From the perspectives of higher education, this research is in line with Fair weather (2008) which stated that the student learning and interest in STEM subjects can be improved if the faculty could be convinced to restructure their practices even slightly by replacing the current approach with some other educational approaches that might become effective opportunities to the first-year undergraduate and subsequently to the faculty in bringing STEM gradually into practice in future. From the findings of this research, it has been proved that the use of problem-based learning as an approach to deliver STEM in learning genetics concepts is possible to be implemented. Thus, it can be implemented in different science courses which are offered at higher education level. This research adds to literature regarding how the STEM facilitated through problem-based learning which can amplify first-year undergraduates' interest towards learning genetics concepts.

From the perspectives of genetics lecturers, learners at higher education especially at undergraduates' level must facilitate the opportunity to learn in the ways which allows them to engage and enables them to reach their full potential and develop skills that will help them thrive in the future. Thus, lecturers should be dynamic and adapt to various changes and yet hold on the basic concepts of learning at higher education. A lecturer must diversify teaching and learning methods. From the perspectives of undergraduates, since now, undergraduates have less access to quality STEM learning opportunities and through this research, the researcher take initiatives to introduce what is STEM and how STEM can be used and what is the outcome of STEM in their daily lives. By applying STEM problem-based learning approach, first-year undergraduates become more proficient in carrying out tasks cooperatively, working in groups effectively, accessing different resources, and identifying appropriate knowledge for learning issue as suggested by Beach, Henderson and Finkelstein (2012).

In this research, a pre-experimental research design as one group pretest-posttest design used with the focus in researching the interest towards genetics concepts through STEM Problem Based Learning approach through a module implementation. A major contribution of this research is that it has shown that the use of Integrated STEM Problem Based Learning Module was able to give enhancement and positive retention on interest towards genetics concepts among first-year undergraduates. It also had showed that theory of Cognitive Constructivism establishes a model for first-year undergraduates learning outcomes in its own environments while learning genetics concepts in STEM through problem-based learning context.

In this research, problem-based learning as a student-centered curricular method has significant potential for engaging first-year undergraduates in authentic STEM content through the active pursuit of workable solutions to real-world problems. The key findings in this research shows that the use of problem-based learning in STEM context to learn genetics concepts able to enhance interest which can see in posttest and delayed posttest. Therefore, to maximize this positive impact of learning genetics using the problem-based learning in STEM context, education policy should give attention to STEM education and support STEM learning engagement at higher education in Malaysia. The research has proven that Integrated STEM through problem-based learning approach could enhance and retains the interest in learning genetics concepts among first-year undergraduates. Hence, it is strongly suggested that the Integrated STEM through problem-based learning approach could be incorporated into the teaching and learning science related courses at undergraduate's education. This research has shown that the Integrated STEM through problem-based learning approach could enhance and retains the level of interest in learning genetics concepts among first-year undergraduates.

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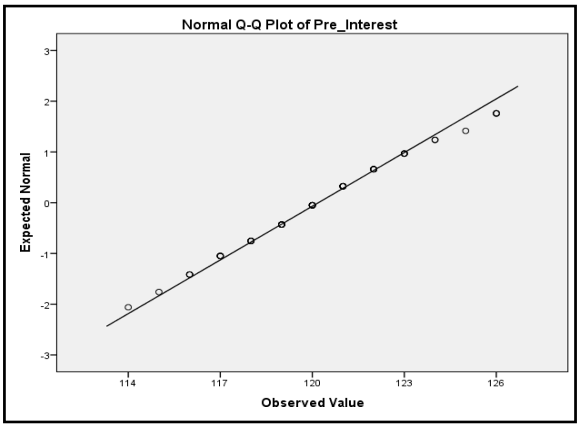
Appendix 1

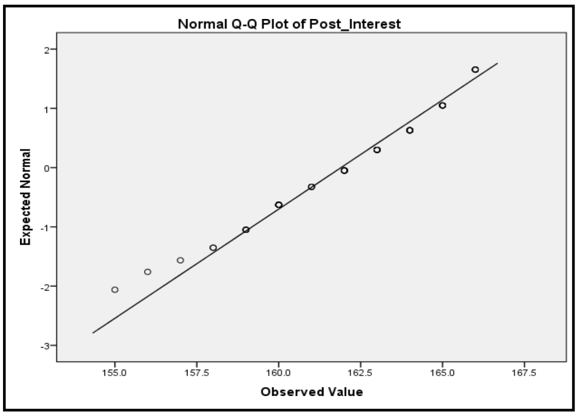
Description on Mean, Standard Deviation, Minimum and Maximum Value for Pretest, Posttest and Delayed Posttest

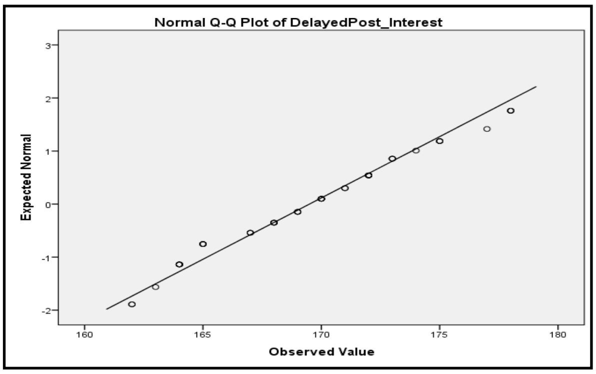
	Pretest	Posttest	Delayed Posttest
N	50	50	50
Mean	120.20	161.90	170.68
Standard Deviation	2.84	2.71	5.21
Minimum	114.00	155.00	162.00
Maximum	126.00	166.00	183.00

Appendix 2

Q-Q Plots







Appendix 3

Skewness and KurtosisValue

Interest		Statistics	Std. Error
Pretest	Skewness	.130	.337
	Kurtosis	-.227	.662
Posttest	Skewness	-.433	.337
	Kurtosis	-.330	.622
Delayed Posttest	Skewness	.147	.337
	Kurtosis	-.681	.662

Appendix 4

Test of Normality based on Shapiro-Wilk test

Interest	Shapiro-Wilk		
	Statistic	Degree of Freedom	Significance
Pretest	0.979	50	0.524
Posttest	0.959	50	0.081
Delayed Posttest	0.964	50	0.125