DEVELOPMENT AND EFFECTIVENESS OF STEM-BASED GAMIFIED EXPERIMENTS ON STUDENTS' PERFORMANCE AND MOTIVATION

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ABSTRACT

This research aims to develop and determine the effectiveness of STEM-based gamified experiments (STEM-GE) on students' performance and motivation. The development of STEM-GE was based on ADDIE model, constructivist, flow and motivation theory. Quasi experimental design was used on a number of 40 foundation students from a science course in one of the private university. The sample was selected by using cluster random sampling procedure with 20 students for each treatment and control groups. Two instruments were used, namely test questions and questionnaire on motivation. Data were analysed using descriptive and inferential statistics. The findings indicated that STEM-GE have good validity (percentage of agreement = 92%). The findings of t-test revealed that there was a significant increase in students' performance ($t(38) = -2.897$, $p < .05$) in the treatment group by using STEM-GE compared to the control group. Mean score for students' motivation showed that there was a high motivation ($M = 4.07$, $SD = 13.48$) in the treatment group by using STEM-GE. Pearson correlation analysis showed a significant strong positive correlation ($r = .812$) between student's performance and motivation in the treatment group. As a conclusion, STEM-GE has improved students' understanding and motivation to conduct experiments during practical classes. The study implicates that the use of gamified strategies for experiments with STEM content can enhance teaching and learning in science.

PEMBANGUNAN DAN KEBERKESANAN EXPERIMEN BERASASKAN STEM DENGAN UNSUR PERMAINAN TERHADAP PRESTASI DAN MOTIVASI PELAJAR

ABSTRAK

Kajian ini bertujuan untuk membangun dan menentukan keberkesanan eksperimen berasaskan STEM dengan unsur permainan (*STEM-GE*) terhadap prestasi dan motivasi pelajar. Pembangunan *STEM-GE* adalah berdasarkan model ADDIE, teori konstruktivis, teori *flow* dan teori motivasi. Reka bentuk kuasi experimen telah digunakan pada sejumlah 40 pelajar dari kursus aliran sains asas di sebuah university swasta. Sampel dipilih menggunakan persampelan rawak kelompok yang terdiri daripada 20 orang pelajar untuk setiap kumpulan rawatan dan kawalan. Dua instrumen digunakan iaitu soalan ujian dan soal selidik motivasi. Data dianalisis menggunakan statistik deskriptif dan inferensi. Dapatan kajian menunjukkan *STEM-GE* mempunyai kesahan (persetujuan pakar = 92%) yang baik. Analysis ujian-t menunjukkan terdapat peningkatan yang signifikan dalam prestasi ($t(38) = -2.897$, $p < .05$) dalam kumpulan rawatan menggunakan *STEM-GE* berbanding dengan kumpulam kawalan. Motivasi pelajar dalam kumpulan rawatan menggunakan *STEM-GE* menunjukkan skor min yang tinggi ($M = 4.07$, $SD = 13.48$). Analisis korelasi Pearson menunjukkan bahawa terdapat hubungan positif yang kuat dan signifikan ($r = .812$) antara tahap prestasi dan motivasi pelajar dalam kumpulan rawatan. Kesimpulannya, *STEM-GE* telah meningkatkan kefahaman dan motivasi pelajar untuk menjalankan eksperimen semasa kelas praktikal. Kajian ini membuktikan bahawa penggunaan strategi permainan untuk eksperimen dengan kandungan STEM dapat meningkatkan keberkesanan pengajaran dan pembelajaran sains.

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LIST OF ABBREVIATIONS

ADDIE	Analysis, Design, Development, Implementation and Evaluation
CSI	Crime Scene Investigation
CVI	Content Validity Index
GPA	Grade Point Average
I-CVI	Item Content Validity Index
KPI	Key Performance Indicator
KS	Kolmogorov-Smirnov
MCQ	Multiple Choice Questions
MEB	Malaysia Education Blueprint
MOE	Ministry of Education Malaysia
MOSTI	Ministry of Science, Technology and Innovation
SMTSL	Students' Motivation Towards Science Learning
S-CVI/UA	Scale Content Validity Index/ Universal Agreement
S-CVI/Ave	Scale-Content Validity Index/Average
STEM	Science, Technology, Engineering and Mathematics
STEM-GE	STEM-Based Gamified Experiments
UTAR	University Tunku Abdul Rahman

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In the light of development of science and technology, new discovery horizon has created a demand for the new generation to be sound and innovative in par with the rapid growth of the economy. Thus, Malaysian economy transform from production-based to knowledge-based economy (Fadzil & Saat, 2014) to meet up the demand. Science and technology education is increasingly emphasized as it is absolutely essential for the development of the country and compete with other nations.

The Malaysian government has tentatively speculated that about half a million headcounts of specialised and skilled manpower in science, technology, engineering and mathematics (STEM) focused employees, ranging widely from science background orientated graduates, and a large number of skilled and semi-skilled

employees according to Ministry of Education, MOE (2015). This only can be achieved if the quality of the STEM education is able to benchmark the needs of the country by providing productive and highly skilled graduates in science and technology.

According to Malaysian Education Blueprint (MEB) 2015 – 2025, the six attributes that students should have are knowledge, thinking skills, leadership skills, bilingual proficiency, ethics and spirituality and national identity. There are three core measures that will be taken to strengthen the STEM education. Firstly, raising students interest through new learning approaches and improve the curriculum by incorporating higher order thinking skills, increasing the use of practical teaching tools and the content of the studies are more relevant to daily life. Secondly, sharpening skills and abilities of teachers and thirdly building public and student awareness in STEM. The main objective of the STEM initiative that taken is to ensure Malaysia has sufficient number of qualified STEM graduates to fulfil the employment needs of the industries which in turn to support the economy.

The evolving Malaysian education curriculum from knowledge-based and content-led by memorizing abstract concepts has transform into practice-based and process-led which involves real world problem solving (MOE, 2015). Thus, students able to face challenges and be competitive at global level as the STEM education gives importance for the learning which involves thinking. It is found that gamification method remarkably gain interest as teaching and learning tool. It offers an effective learning interest and engagement towards studies. Brom et al. (2014) stated that gamification also provide opportunities for enhancing students' social

interaction and engagement in collaborative learning. An effective game environment will make the learner actively participate in the learning process and work towards the goal by selecting actions and experiencing from the consequences (Trybus, 2012).

Besides this, Chang, Peng and Chao (2010) proposed that hands-on experiments improve students understanding on STEM topics and gives opportunities for the students to participate actively in the activities. This cultivates their understanding and polish their practical and manipulative skills. Based on Baviskar, Hartle and Whitney (2009), practical experiments which involves inquiry skills offers the learner to build and modify their understanding besides engage the learner towards the activity. The knowledge is constructed when the learner engages in the process of learning which involves higher order thinking skills and problem solving skills where the students have to figure out to solve the particular challenge (Carnegie Corporation of New York, 2009). This is supported from the findings by Nyet, Goh and Sulaiman (2016) which stated that the students able to make connection if the activities are engaging and this will provide a better understanding of concepts.

1.2 Background of the Study

Gamified learning refers to game play with defined learning outcomes and objectives. The main principal of game is giving incentive to encourage and motivate the players to engage in the task given to them. There are variety of gamified curriculum where some with heavy technology-based game, paper-based game and physical activity-based game. Basically, game play involves players to learn rules and regulation of the

game and understand the strategies and then adapt and improve the skills to make progress in the game. According to Plass, Homer and Kinzer (2015), gamified learning focuses the affective perspectives of players' emotions, attitudes, belief and engagement which contribute to cognitive, motivation and cultural aspects of learning.

Gamified curriculum design will make changes in progress of the students' studies (Van Eck, 2011) where the students will involve actively in the activity and take the ownership of the learning (Chang et al., 2010). This improves students' motivation, self-esteem, collaboration, engagement, problem solving (Granic, Lobel & Engels, 2014) and academic enrolment in STEM subjects and careers by reaffirming and reinforcing content knowledge (Cooke, 2016). Besides that, it stimulates interest and the learning outcomes of the syllabus also can be achieved through game. Cooke (2016) strongly recommended the need of gamified learning strategies to be implemented in science courses to connect STEM content with real life problems.

Maiti, Maxwell, Kist, and Orwin (2014) suggested that practical skills is also one of the effective way to increase students' interest in STEM topics. Practical experiments emphasises learning through inquiry which is greatly emphasised in STEM education to enhance the understanding of scientific knowledge. Inquiry-based learning encourages students to think and find solution to a problem, based on the observation, investigation and discussion with the peers from the outcome and results.

Yakar and Baykara (2014) added that hands-on experiments give opportunity for the students to draw conclusion, enhance the manipulative skills by handling apparatus and equipment which will lead to meaningful science learning and development of problem solving and critical thinking skills. These essential skills acquired by the students from hands-on experiment gives some hope for Malaysia to fulfil the employment needs in STEM fields which support the economy. Moreover, hands-on experiments lead to more students' engagement compared to normal traditional classroom lessons which involves memorizing and taking test (Carnegie Corporation of New York, 2009).

He, Holton, Farkas, and Warschauer (2016) proposed that out-of-class activities such as summer programs, after school enrichment activities and science fairs will play a significant role in nurturing STEM interest among students. This study is supported by Hausamann (2012) who encouraged university and research centres to set up extracurricular science labs to attract young graduates in STEM disciplines. Besides that, high-tech experiment can be carried out when they are out-of-school lab. This enables the students to link with the standard curriculum and school lesson with the high-tech experiments.

It is believed that this approach will enable the students to learn collaboratively when they participate in the research activities, conduct investigation and evaluation, carry out inquiry activities, innovative and reflect from the learning process as it is more engaging for the students besides improving their problem-solving skills. As STEM approach is mainly focused on the pedagogical strategy and methods which emphasizes knowledge and skills in the integrated form of disciplines

from science, technology, engineering and mathematics to face the challenging world, the experience gained from learning through inquiry-oriented and problem-based activities will be a foundation for the students to understand relevant issues and makes them to think critically and creatively about the process of solving them.

Thus, hands-on experiments and gamified learning are engaging learning as it provides a meaningful learning platform for the students to acquire important scientific concepts and relate it to the real life context which is being endorsed in the STEM education.

1.3 Problem Statement

STEM education is a forefront issues among educational practitioners in producing skilful and productive students. However, the statistic indicates that there is a decline in the number of students' interest and participation in STEM disciplines. The percentage of graduates from science related courses were only about 45% in 2011 (MOE, 2013). According to Ministry of Science, Technology and Innovation (MOSTI), there will be a shortage of scientist and engineers in Malaysia although The National Council for Scientific Research and Development estimated about 493 830 scientist and engineers by 2020 (MOE, 2013).

Approximately 15% of secondary school students who met the requirements to study science after national level examination are reluctant to continue in science field (MOE, 2013). This is in line with the statistic from annual programme monitoring

report (ANPR) of foundation studies, University Tunku Abdul Rahman (UTAR) (2016) where the enrolment of science students in 2016 was dropped 11.6% compared to 2015. Besides that, the number of students that are terminated, withdrawn from the studies and applied for course transfer from science stream to art streams are increased. This scenario provoked questions among science lecturers on the existing science curriculum as some of the students could not cope with the studies and have applied for course transfer to art stream. Some of the authors (Hausamann, 2012; Osman & Saat, 2014) proposed that the decline in the number of science and engineering students is due to the existing curricular which does not motivate the students to involve in the science and technology activities.

The calls for the improvement in the curriculum and instruction methods is greatly emphasised over the past decade to uphold the nation's innovation capacity. It is believed that all people, especially the young generation must have some degree of scientific and technological literacy in order to lead a productive life in the society. Thus, STEM education is greatly highlighted by the government, educational institutions and numerous professional organisations to prepare the nation for the knowledge-driven economy and technology workforce skills (Duderstadt, 2008).

Based on the studies conducted by Osman and Saat (2014), one of the major problem faced in STEM education in Malaysia is the limited number of learning materials and activities that integrate science, technology, engineering and mathematics. Academicians involved in the preparation of the content, pedagogy and technology should assist each other in order to achieve the goal of integrating STEM education materials. Qian and Clark (2016) suggested that some of the strategies that

can integrate technology into STEM teaching and learning are hands-on experiment, inquiry and project-based learning. Besides on the knowledge retention when performing hands-on experiments, students are actively engaged in the lesson, build confidence and promote learning comprehensive at multiple levels.

This is supported by the studies conducted by National Academy of Engineering and National Research Council (2009) which states that the curricular should emphasise and focus on the integrated activities which will have a better engagement of students instead of instruction which is designed in the formal way for the students to learn. Fadzil and Saat (2014) stated that many benefits will be acquired by the students when they perform science-practical activities. However, the importance of practical components is generally very limited in Malaysian science classroom. Moreover, Malaysian students are having difficulties in using and handling apparatus (Fadzil & Saat, 2014).

Educational institutions mainly focus and assess the students based on the cognitive aspects such as students' performance in tests or final exams. The non-cognitive aspects such as motivation, engagement, self-esteem and determination which also contribute to learning style and instructional method are not emphasised and highlighted. Hausamann (2012) in agreement with the findings by Osman and Saat (2014) that students that highly keen into science will be demotivated and lose interest if the instructional methods are under challenged their talents. Thus, Hausamann (2012) proposed that extracurricular science labs should be conducted to attract university students where high-tech experiments and activities should be conducted besides the standard curriculum and syllabus in the university. The findings

from Hausamann (2012) study showed that about 65% of students expressed interest in extracurricular STEM activities, 94% of students had fun in conducting the experiments, 93% of students felt the experiment relevant to everyday life and 65% of students planned to enrol in STEM related careers.

Game as an educational tool also gaining popularity among students and teachers as the findings from Entertainment Software Association revealed that about 97% of youth play computer, video and mobile games (McGonigal, 2011). Gamified learning offers an effective learning by enhancing problem-solving skills, improving higher order thinking and promoting engagement towards the studies. Nevertheless, gamified learning in engineering curriculum showed a negative result on the students' knowledge learning outcomes (Rieber, 2005). Thus, more studies to investigate this instructional method are needed to provide a solid grounding.

There are so many studies on gamified learning and hands-on experiments conducted to enhance the STEM education. However, most of the studies are focused on digital game-based learning rather than physical involvement of game-based learning. Moreover, hands-on experiments that are designed and conducted in the class are restricted to syllabus and time frame. Less findings on gamified hands-on experiments are studied. Thus, this research is conducted to motivate the students and enhance interest in STEM education among foundation students in science stream by developing hands-on experiments with crime scene investigation (CSI) concept. Furthermore, the impact of STEM-based gamified experiments (STEM-GE) on students' performance is evaluated since Becker and Park (2011) stated that less research conducted on the effects of STEM education on students' achievements.

MOE is strongly encouraging STEM integration activities among students especially in the informal setting to meet up the targeted STEM related field graduates in Malaysia. Hence, students can actively participate in the activity and enhance their problem solving skills and higher order thinking which being emphasized in STEM education (Chang et al., 2010). Osman and Saat (2014) added that appropriate STEM instructional methods and suitable assessment procedure are very crucial to create a meaningful and effective learning experience.

1.4 Purpose of the Study

This study is conducted to encourage and further promote the development and enhancement of STEM which indirectly creates an awareness and passion towards science. Gamified experiments are used as it will easily attract the focus and involvement of students to participate actively in learning which involves hands-on experiments and at the same time enhance the problem solving skills and critical thinking skills which are not achieved with only traditional method of experiments.

Besides this, it is also to evaluate the effectiveness of STEM-GE on students' performance and to determine students' motivation when they get involved in this activity. The independent variable in this study are the methods of experiments. The dependent variables are students' performance and motivation.

1.5 Objectives of the Study

The objectives of this study are as follow:

1. To develop and validate STEM-GE.
2. To evaluate the impact of STEM-GE on students' performance and motivation.
3. To determine the relationship between students' performance and students' motivation in the treatment group.

1.6 Research Questions

The research questions for this study are as follows.

1. Does STEM-GE that developed has good validity and reliability?
2. Does STEM-GE improve students' performance in test compared to traditional method of experiments?
    (i) Is there any difference in the mean score of pre-test on students' performance between treatment and control groups?
    (ii) Is there any difference in the mean score of post-test on students' performance between treatment and control groups?
    (iii) Is there any difference in the mean score of pre-test and post-test on students' performance of treatment group?
3. Does STEM-GE improve students' motivation compared to traditional method of experiments?

(i) Is there any difference in the mean score of pre-SMTSL on students' motivation between treatment and control groups?

(ii) Is there any difference in the mean score of post-SMTSL on students' motivation between treatment and control groups?

(iii) Is there any difference in the mean score of pre-SMTSL and post-SMTSL on students' motivation of treatment group?

4. Is there any relationship between students' performance and motivation in the treatment group?

1.7 Hypotheses

The following hypotheses were investigated in this study.

H_{01} There is no significant difference in the mean score of pre-test on students' performance between treatment and control groups.

H_{02} There is no significant difference in the mean score of post-test on students' performance between treatment and control groups.

H_{03} There is no significant difference between pre-test and post-test mean scores on students' performance of the treatment group?

H_{04} There is no significant difference in the mean score of pre-SMTSL on students' motivation between treatment and control groups.

H_{05} There is no significant difference in the mean score of post-SMTSL on students' motivation between treatment and control groups.

H_{06} There is no significant difference between pre-SMTSL and post-SMTSL mean scores on students' motivation of the treatment group.

H_{07} There is no significant relationship between students' performance and motivation in the treatment group.

1.8 Conceptual Framework

Conceptual framework is to describe the relationship between the variables in a variety of ways and with various symbols. It provides a graphic representation of key variables and illustrates possible relationships between variables. This graphic representation of variables often improves a reader's ability to understand the study.

ADDIE model is used in the development of STEM-GE. This learner-centered instructional design consists of five phases which are Analysis, Design, Development, Implementation and Evaluation. On the other hand, the learning theory that is applied for this study is constructivist theory and flow theory. According to Qian and Clark (2016) & Li and Tsai (2013), constructivist theory is the most popular theory being used in gamified learning. Based on this theory, the learner will involve actively in constructing his or her understanding based on previous experience. As this research is on STEM-GE, the students will conduct the experiments and manipulate the results based on the observations, and personalise it into knowledge in order to solve the investigation that they conducted. The method is evaluated using test to observe on the knowledge gained by the students. Based on constructivist theory, students will take active role in constructing new knowledge. When students perceive valuable and meaningful learning task, the students will involve actively to learn as motivation is the process of goal-directed activity. Furthermore, value of science learning, student's

learning goals and self-efficacy can be observed when the students take up important roles in influencing students in constructing and reconstructing their science concepts. Since this study is on practical aspect, constructivist theory applied where knowledge is created when students conduct the experiments and obtain clue to solve the case study with goal directed action.

Whereas the flow theory is used for the development of the scenario, dialogues, task and rubrics which is on the CSI. Flow theory is applied since the CSI have an elements of challenging activity which require analysing skills, problem solving and critical thinking. Students with clear goals will concentrate in the task which lead to loss of self-consciousness and intrinsic rewarding is gained when the students able to find the suspect.

In addition, motivation theory according to Kapp (2012) is applied to assess students' motivation by using students' motivation towards science learning (SMTSL) which consist of six scales: self-efficacy, active learning strategies, science learning value, performance goal, achievement goal, learning environment stimulation. According to Kapp (2012) motivation in gaming activity can be divided into two types, intrinsic and extrinsic. Extrinsic motivation is more on behaviour to avoid punishment whereas intrinsic motivation is more on the willingness of learner to take up the activity as it stimulates.

The combination of constructivist theory, flow theory, and motivation theory reveal that knowledge that students' constructed can be assessed using test and motivation factors such as self-efficacy, science learning value, student' learning

strategies, the individual's goal and learning environment can be evaluated using SMTSL. Figure 1.1 shows the conceptual framework for this study.

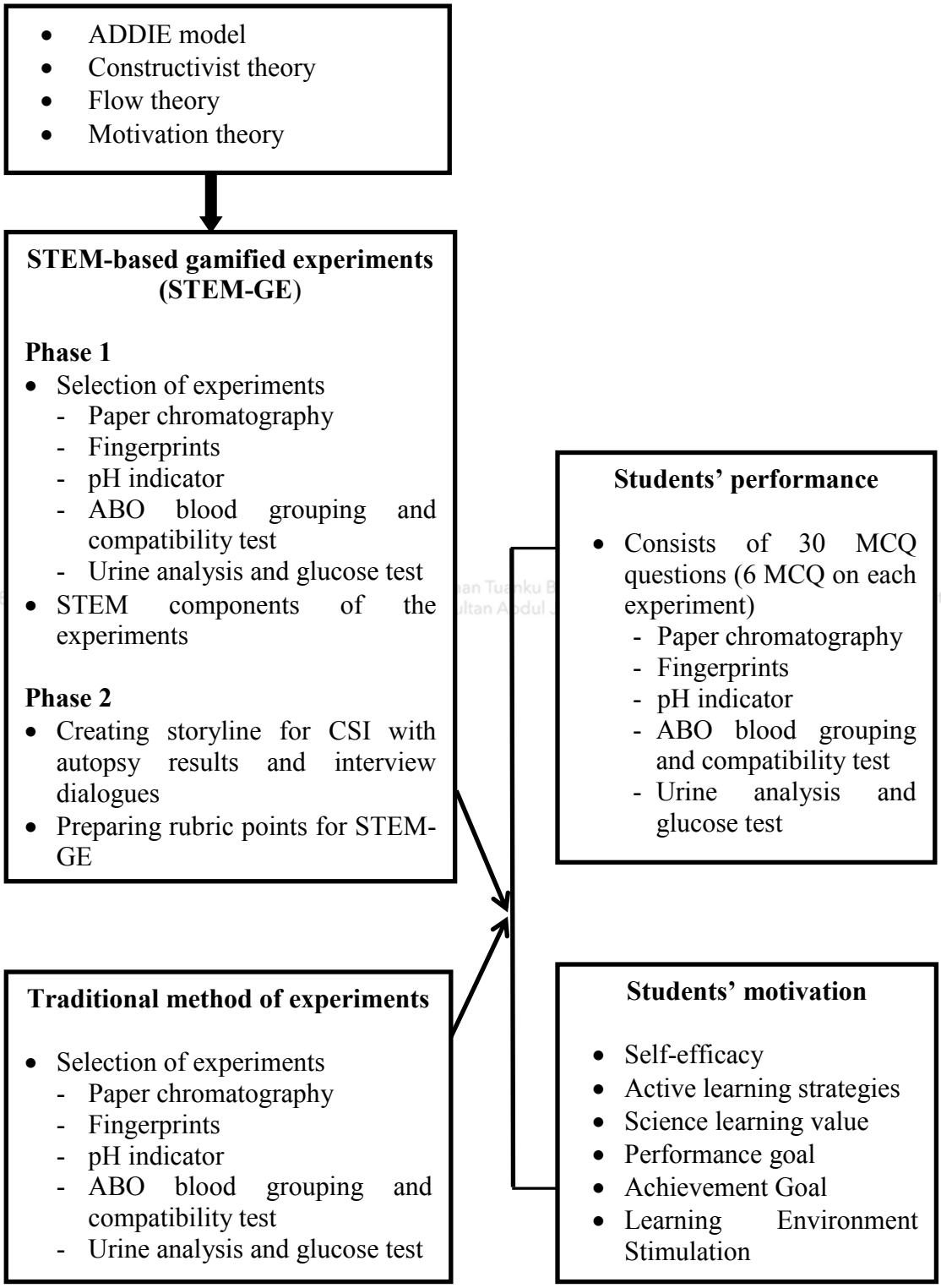

Figure 1.1. Conceptual Framework

1.9 Significance of the Study

This study investigates the instructional approach using gamified experiments among foundation students. The results and outcomes of this study can provide information and benefits not only for students but for instructional designer, university and country. The following are the significance of this study:

1.9.1 Students

The evidence can be used to address concerns of game approach in experiments where it will enhance students' interest in science education and provide a meaningful learning. An effective learning is very important in the learning process as the students able to participate actively and engage in the lesson with the best educational experiences. Engagement is referring to the entire mental activity involved in the perception, attention, reasoning and emotions. It can be influenced by interest in which the people will tend to be more engaged and motivated in their activities (Michale & Staphen, 2011). In addition, game experiments which involve inquiry skills offer knowledge retention and improve students' academic performance by promoting students' motivation and engagement in the learning process. Both gamified learning and inquiry-based experiment were believed to increase problem solving skills, critical thinking, students' engagement and motivation in the activity (Chang et al., 2010; Carnegie Corporation of New York, 2009; Granic et al., 2014).

1.9.2 Instructional Designer/ Academic Practitioner

Instructional designer can plan extracurricular activities for the students. Moreover, the results can aid the development of new curriculum based on STEM pedagogical content knowledge, impact on science course offerings to STEM related field at the university level, assisting the planning of course content, recruitment of students and allow the higher education institution to utilize and providing the best course design for the students.

1.9.3 University

The outcomes of the study will provide information to university in designing the course structure for the students. In addition, the results of this research also will be beneficial to the university students who are currently not motivated with science instructional strategies and believe their current learning environment is not engaging as they want ownership of their learning process. Thus, the outcome of this study can impact students' university life, assist with course planning and have the potential to boost faculty evaluations.

1.9.4 Country

This study gives evidence in producing skilful and productive students in the field of STEM. Thus, the students are highly competitive and able to face challenges at global

level which are highlighted in STEM education. This instructional method gives hope for Malaysia to fulfil the employment needs in STEM fields.

1.10 Limitation of the Study

The first limitation that is identified in this study is only foundation students are being studied. Thus, differences in population might limit the generalization of the findings. Besides this, the differences in the curriculum across the universities in Malaysia will effect on the design of gamified experiments.

Time constraint is one of the issues that usually lecturer faced as practical session are restricted to syllabus and time frame. Thus, only five topics were selected for this activity. Besides that, more time is needed for preparation of gamified activity to be carried out during practical session.

1.11 Operational Definition

The following are definition for the terminologies used in this study. Various definitions and interpretations exist for the terms but these definitions are appropriate for the terms in this text.

1.11.1 Gamified Experiments

In this study, gamified experiments refers to game play with defined learning outcomes and objectives (Salen & Zimmerman, 2004) which involves hands-on experiments with certain task and obtain points, scores, progress (Pirker, Gutl & Astatke, 2016) and knowledge. The points are given based on the rubrics that created to evaluate the students' practical skills such as planning skills, manipulative skills, class participation, safety measures/ precaution, and analysing skills. The points are displayed on the score board for students to monitor the progress and engage the students in the activity.

1.11.2 STEM

In this study, STEM refers to Science, Technology, Engineering and Mathematics components that consist in the experiments. The Science component of the experiments is mainly on biology facts, concepts and disciplines. The Technology component of the experiments is the use of technological tools such as pH meter, blender, computer and clinistix during the experiments. The Engineering component of the experiments is the use of knowledge by students in designing model and homemade products to test the theory. Mathematics components of the experiments is the study of pattern, relationship, measurements and calculation using the formulas.

1.11.3 STEM-GE

In this study, STEM-GE refers to gamified experiments with STEM contents which involves physical involvement of the individual such as use of hands or touching with hands when conducting experiments where the individual participate actively in the task given. STEM and game elements are incorporated into each experiment. The students conduct the experiments and manipulate the results based on the observation. The game elements in the form of points are given for students when they conduct the experiments.

1.11.4 Crime Scene Investigation

In this study, crime scene investigation (CSI) refers to a case study which involves a mock crime scene scenario, interview dialogues and autopsy results that are created for students to investigate and obtain clue from the experiments to find out the identity of the suspect. The scenario and task that are given in each experiment are arranged by narrowing down the identity of the suspects.

1.11.5 Motivation

Motivation refers to general desire or willingness of someone to do something without any force (Pirker et al.,2016). Motivation of students towards experiments that focused in this study refers to activity or behaviour which the learner undertakes

because the activity stimulates learning or a feeling of accomplishment (Kapp, 2012). Students' motivation in terms of self-efficacy, active learning strategies, science learning value, performance goal, achievement goal and learning environment stimulation is evaluated using SMTSL questionnaire that developed by Tuan, Chin, and Shieh (2005).

1.11.6 Performance

In this study, performance refers to the process of obtaining knowledge through thought, experience, and the senses (Wilson, 2015). Knowledge gain from this activity is evaluated using test which involves thirty multiple choices questions (MCQ). There will be six questions from each experiment topic. Students' performance is evaluated based on the results that obtained from the test.

1.11.7 Foundation students

In this study, foundation students refer to third trimester, science streams students of 2017/2018 intake of UTAR. This group of students have completed their secondary education and will be pursuing their bachelor programme upon completion of one year of foundation studies.

1.12 Conclusion

This research is a study on impacts of STEM-GE on students' performance and motivation for foundation students in UTAR. Chapter 1 explains the purpose of the study, background of the topic such as strategies that Malaysia takes to strengthen the STEM education, gamified curriculum and the importance of practical components. The model and learning theories that are used to develop STEM-GE are stated in this chapter. In addition, the relationship between variables is displayed on conceptual framework to give an overall picture of the study which focuses on STEM and game elements that incorporate into the experiments to evaluate the impact of this practical session on students' performance and motivation.