STUDENTS' ACCEPTANCE OF USING A FLIPPED STEM CLASSROOM ENGINEERING-BASED MODULE

***Khadijeh Mohammad Musa Naser**
Siti Hajar Halili
Rafiza Abdul Razak
Fakulti Pendidikan, Universiti Malaya
**ajai912@gmail.com*

Abstract: This study aims to identify the students' acceptance of using a Flipped STEM classroom (FSC) Engineering-based module. The study sample consisted of 120 students from the seventh grade in a private school in Jordan. A questionnaire was employed in this study. The unified theory of acceptance and use of technology (UTAUT) was used in this study to determine the extent of students' acceptance of the FSC engineering-based module. The results showed that the students' acceptance to use the FSC engineering-based module was high. the results showed that students had more level of acceptance for performance expectancy and effort expectancy dimensions. The study recommends submitting the FSC engineering-based module for enhancing problem-solving skills for elementary school students in STEM subjects.

Keywords: *Engineering-Based Model, Problem-Solving Inventory, STEM, Acceptance, Unified Theory of Acceptance Of Using Technology*

INTRODUCTION

Research has indicated that an individual's perception and beliefs about his or her problem-solving skills somewhat influences how a person deals with a problem (Heppner & Krauskopf, 1987), and his or her ability to solve problems (Heppner, Witty, & Dixon, 2004). Be exposed to different scientific contexts and concepts to help them refine and construct their thinking and also has a positive impact on academic outcomes (Chesloff, 2013; Argaw, Haile, Ayalew, & Kuma, 2017; Ertmer & Simons, 2006; Savery, 2006)

There is a lack of study focusing on how to enhance students' ability to solve problems in STEM education are few (Lo, Lie, & Hew, 2018; Shernoff, Sinha, Bressler, & Ginsburg, 2017; Tran & Nathan, 2010). A study by Tarhan and Acar-Sesen (2013) examined the impact of problem-based learning on the understanding of school students of certain STEM concepts. The convictions of students on problem-based education were also analyzed. While students were taught in the experimental groups using Problem-Based Learning, the control groups adopted a teacher-centered approach. The findings indicated that average student scores were significantly higher in experimental groups than in control groups. Evaluation of the students ' positive beliefs after each activity also reflects a scale of results.

According to Wilder (2015), the review of 10 quasi-experimental of pre-test -post-test research experiments to determine the effectiveness of PBL in different STEM disciplines, the results can be explained by the following: seven studies have shown that PBL has significantly increased its productivity in the development of student learning growth over traditional teaching approaches. These seven studies have shown differences between students 'results in the pre and post-tests in chemistry and physics disciplines, while the other three studies; in Foods and nutrition, Biology and Agriculture revealed that when it came to student learning of content knowledge, PBL was as effective as the lecture-based method. Therefore the PBL approach was more effective in a subject related to applying knowledge (i.e physics) than traditional instruction in achieving learning gains.

Literature Review

Teachers and students are generally satisfied with using the flipped classroom(Bhagat, Chang, & Chang, 2016; Clark, 2015; Schultz et al., 2014). Bhagat et al. (2016) explored the effectiveness of the flipped classroom learning environment concerning high school students' performance and motivation, trigonometry was taught in the experimental classroom unit (N = 51), and traditional teaching approaches were used to teach the control group (N = 41). The results demonstrate that students are very satisfied to work on classroom problems.

Students demonstrate positive perceptions about the flipped classroom methodology in STEM subjects at various school levels: In the study of Bates and Galloway (2012) flipped a classroom in a large introductory physics course with pre-class reading and quiz tasks, and found that 80% of survey respondents preferred the flipped structure to a traditional approach. (Fulton, 2014) found that the flipped classroom approach demonstrates advantages such as increased student engagement, better use of classroom time, discussion with peers, access to expert advice from others, and access to instruction at any time, anywhere.

Other studies were conducted at the university level on the effect of the flipped classroom on their performance and perceptions about the approach in the science course. While González-Gómez, Jeong, and Rodríguez (2016) compared students' achievements and post-task survey results to know the students' perceptions about flipped classrooms. A statistically significant difference was found on all assessments with the flipped class students performing higher on average. Besides, most students had a favorable perception about the flipped classroom noting the ability to pause, rewind and review lectures, as well as increased individualized learning and increased teacher availability.

Recently, a review of the situation in flipped classrooms (Lundin, Rensfeldt, Hillman, Lantz-Andersson, & Peterson, 2018) shows that the students' interest in the flipped classrooms field is increasing and varies from country to country. With some inputs from countries like India and Malaysia, research on the flipped classroom is dominated by publications from the United States. Building on this, this study will explore the usability that a flipped classroom module brings to elementary school students who practice solving engineering challenges in physics courses, from the students' point of view. It was agreed that the Engineering design process resembles originative processes(Billiar, Hubelbank, Oliva, & Camesano, 2014) has effective and logical ways to formalize the development of K-12 STEM lessons (Howard, Culley, & Dekoninck, 2007; Siew, 2016).

One of the successful design processes is the eight steps were developed by the Massachusetts Department of Education (2006), a guide for teachers and curriculum coordinators from pre-K to high school. The method varies in the practice of engineers by discipline and project. Even with this variation, some core EDP characteristics have been identified in the education community: (1) The design process starts with identifying the problem; (2) Design problems have many potential solutions, and engineers need to consider systemic ways to distinguish between them; (3) Modeling and analysis are necessary for design; and (4) The design process is iterative. Figure 1 showed the modified Engineering Design Process (EDP) for upper elementary and beyond by Massachusetts (2016).

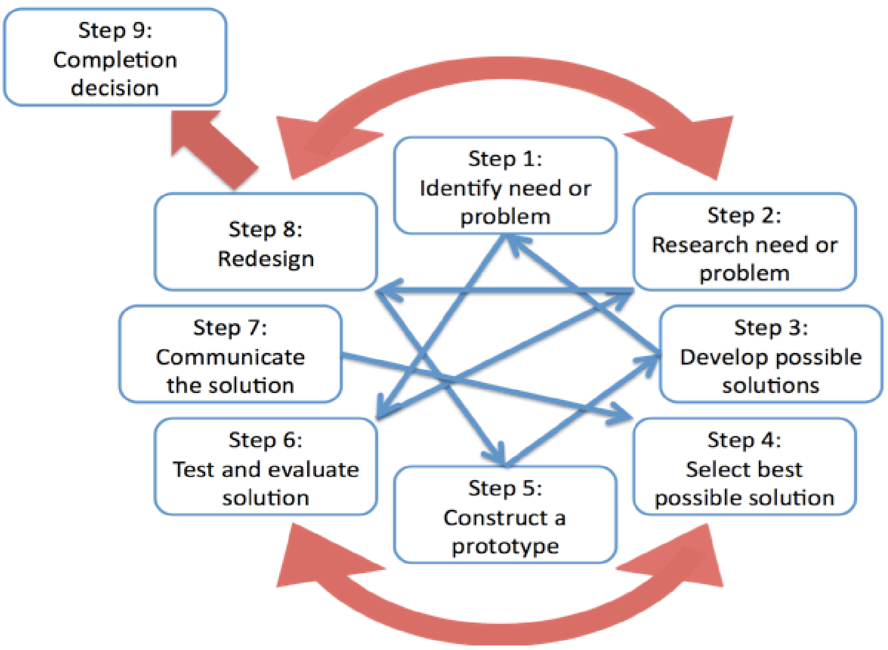

Figure 1. Modified Engineering Design Process (EDP) for upper elementary and beyond (Massachusetts, 2016)

Through engineering challenges, students build and apply cognitive knowledge tools by engaging in the engineering process: proposing multiple solutions, building models, creating prototypes, making trade-offs between standards and constraints, and communicating with traditional speech practices to accomplish instructional tasks at hand(Kelly &

Cunningham, 2019). Such challenges/problems tend to be ill-structured and may have various acceptable solution paths and be limited by rigid and negotiable constraints that are not always presented with the problem(Khandani, 2005; Mentzer, Huffman, & Thayer, 2014). Estapa and Tank (2017) confirmed, including a design-based approach to STEM Integration in an elementary level poses many obstacles that must also be tackled to ensure that STEM educational environments are successful and well-integrated. therefore research for those of the primary grades appears inadequate (English & King, 2015).

The aim of the study

This research is presented according to the research question as follows:

1. What are the students' level of acceptance to use the engineering-based module in STEM courses?

METHODOLOGY

Research design

This research was a quantitative method using a survey to collect data. This research is also conducted in a private school in Jordan using purposive sampling. The purposive sampling in this research involves primary students which are from the seventh-grade level. Several 120 students were selected as the subjects of research. The researcher used an established questionnaire by the unified theory of acceptance and use of technology (UTAUT) as an instrument to collect and analyze data.

Data Collection and Analysis

The quantitative means in this study (UTAUT) instrument were translated from the original form into the Arabic language, as recommended in the literature review (Van de Vijver & Hambleton, 1996). Two professional translators who were native speakers of the Arabic language and were also fluent in the English language proceeded with independent forward translations of the target language. The preliminary Arabic version developed was translated back into the original language by another professional translator. The two versions, the back-translation and the original one, were compared and modifications were made where discrepancies between the two were found. Afterward, the produced scales were reviewed by an expert committee that gave their feedback on the clarity and comprehension of the questionnaire items. After this, the final Arabic versions were produced.

A survey-based on UTAUT was administered to determine the students' acceptance of using the FSC engineering-based module later on. acceptance theory proposed by Venkatesh, Morris, Davis, and Davis (2003) explains user intentions to use an information system (IS) and subsequent usage behavior. This theory explains the four main constructs Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating conditions. Also, this theory suggests that these four constructs are moderated by gender, age, experience, and voluntariness of use (Venkatesh, Morris, Davis, & Davis, 2003). As espoused in figure 2.

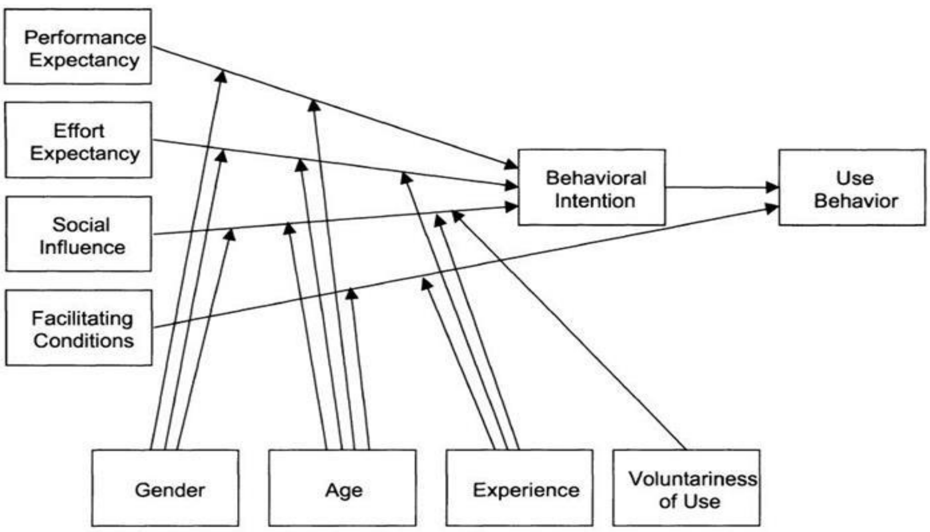

Figure 2. UTAUT model by"Venkatesh et al., (2003)

Since all students in this study are female and have about the same age (13-14 years) and have the same experiences in dealing with such a module, the three variables will not affect in determining students 'acceptance to use the FSC engineering-based module. Table 1 shows the Definitions of the UTAUT variables in the context of this study.

Table 1
Definitions of the UTAUT Variables in the Context of This Study

Constructs	Definition
Performance Expectancy (PE)	the degree to which using a module will provide benefits to students in performing certain activities
Effort Expectancy (EE)	The degree of ease associated with student s' use of the module
Social Influence (SI)	The degree to which students perceive that important persons (e.g., teacher and friends) believe they should use the new module
Facilitating Conditions (FC)	The degree to which students believe that the resources and support exists to proper the use of the module (perform a behavior)
Behavioral Intention	The strong desire to use the FSC module their learning.

According to the Jordanian context, UTAUT was used in three types of research for the same authors; Abu-Shanab and Pearson, in Commercial sector Internet banking in Jordan, But there is no Jordanian study that employed UTAUT in education (Williams, Rana, & Dwivedi, 2015). The data was analyzed using the IBM Statistical Package for Social Science (SPSS) 25.0 using descriptive analysis such as means and standard deviations.

After completing the implementation of the FSC engineering-based module, data were collected through a questionnaire to answer the research questions as shown in table 2.

Table 2
Research Matrix of the FSC Engineering-Based Module

Usability	Numbers of participants	Data collection tool
Students acceptance to use FSC engineering-based module in STEM courses	120 female students of 7th grade	UTAUT (Venkatesh et al., 2003)

FINDINGS AND DISCUSSION

The result of analyzing the questionnaire based on UTAUT reveals a high level of students' acceptance to use the FSC engineering-based module as support to their learning through the key constructs table 3.

Table 3
Means and Standard Deviations for Students' Level of Acceptance to Use the FSC Engineering-based Module

Item no.	Dimension	Number of Participants	Mean	Standard deviation	Level of acceptance
4	Facilitating Conditions	120	4.24	0.71	High
1	Performance Expectancy	120	3.98	0.86	High
3	Social Influence	120	3.97	0.78	High
2	Effort Expectancy	120	3.71	0.99	High
Total		120	3.98	0.68	High

In the context of this research, the results showed that students had more levels of acceptance for performance expectancy and effort expectancy dimensions. Findings are discussed based on the four basic constructs in the UTAUT model which are Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions. Based on the results, students accept the use of FSC engineering-based teaching and learning process and develop high perceptions about their performance and effort expectations after implementing the FSC engineering-based module.

Findings also show positive perception about their performance expectancy that using FSC engineering-based module would improve students learning through increasing their productivity and increase their chance to get better grades and accomplish their tasks more quickly in STEM courses. According to effort expectancy, findings show that the module

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was convenient and easy to be used the module allows students to interact clearly and skilfully. this parallel to (Meguid & Collins, 2017). If the instructional methods allow students to interact with each other and with the teacher, it increases their skills and is considered easy to be used.

Evaluation of the students' perceptions about social influence as the degree at which the students perceive how important others believe she should use the FSC engineering-based module in learning. The results show that the teacher and colleagues have encouraged and convinced them to use the FSC engineering-based module.

Students found the FSC engineering-based module is useful for their course and that there is an influential social role for the teacher that helped in the learning process and imparting skills. These findings are important and support the opinion of Hartshorne and Ajjan (2009) who believe that social network technology has the potential to enhance teaching and learning and interaction among students and teachers. In the context of this research, the finding shows that students have high believes about the technical, individual, and organizational infrastructure exists to support the use of FSC engineering-based module Findings indicates that available support and facilities have a positive impact on students perceptions to use the FSC engineering-based module .this parallel to the study of (Chavoshi & Hamidi, 2019) that technological and individual factors are effective on perceived ease of use of technology learning.

Furthermore, the findings revealed that students accept to study problem-based designs. This is parallel to Sonnleitner et al. (2012). Moreover, the results revealed that students accept the study of technology-based problem-based designs. This parallels with the result of the study of Chavoshi and Hamidi (2019) that students considered working with technology to solve problems fairly easily. And it adds fun to the work. Secondly, when comparing differences between the pre and post of PSI means' scores on the total of dimensions. The results revealed that there is a decrease in the means' scores on the three dimensions after implementing the FSC engineering-based module. Taylan (1990) pointed out, high scores show that the respondent perceives oneself as insufficient in terms of problem-solving skills, while low scores show the respondents' problem-solving skills as being at a satisfactory level. Moreover, the module has increased increase students 'perceptions of their ability to solve problems this part of the findings supports the literature that teaching students problem-solving skills increase their perceptions of their ability to acquire these skills (Ancel, 2016; Bayindir & Olgun, 2015; Heppner & Petersen, 1982; Lee & Brysiewicz, 2009).

CONCLUSION AND RECOMMENDATIONS

In conclusion, this FSC module has many strengths as identified through students' perspectives evaluation. Firstly, the FSC module increases their performance expectancy, since it raises student's productivity and increases their chance to get better grades in STEM course. it has a role in improving students' learning. Secondly, this FSC engineering-based module enhances students' effort expectancy through clear interaction during the implementation and it became easy for them to implement the activities related to the engineering challenges. Thirdly, the FSC engineering-based module acts as social network technology and has the potential to enhance learning. Next, students believe that the FSC engineering-based module provides required technical, individual, and organizational infrastructure that exists to support the use of the module.

These are 4 dimensions included in the UTAUT questionnaire, which provide a comprehensive evaluation of the module's aspects from the students 'point of view. The FSC engineering-based module raises students' appraisal of their problem-solving skills which therefore will influence how they deal with their problem-solving abilities. The problem-solving model has been successfully applied and evaluated by UTAUT on some undergraduate courses. However, according to the researcher, there is a lack of contribution to the evaluation of courses by students in schools. Therefore, employing UTAUT in evaluating the use of an instructional module applied to school students is an important beginning that can be adopted especially in the Arab context.

Therefore, this study is important because the acceptance factor is an aspect to be taken into account to support the teaching and learning process in an interesting and meaningful learning environment. Thus, the positive attitude of students justified the need to develop a module as suggested in this study in other courses. It is expected that the Jordanian Curricula and Instructional Technology Department (CITD) as the main organization for curriculum design and other educational institutions, benefit from the results of this study in which improvement to teaching and learning methods can be made more effective by establishing a framework for planning the course better. Therefore, this study is expected to add many practical and methodological implications, in addition to supporting the findings of the previous literature in new contexts.

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