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Technology Integration to Promote Desire to Learn Programming in Higher Education

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***Abstract*— The use of technology integration is the way of innovation in today's world-class learning. Technology integration is a combination of technologies such as computers, mobile devices like smartphones and tablets, digital cameras, the internet, and more in the practice of daily lecture sessions. Technology integration could help the process of learning especially for courses that considered as tough by the students. Therefore, educators need to be aware of the choice of methods or approaches so that teaching and learning are conducted in meaningful ways. Programming courses are compulsory for students in Faculty of Information Sciences and Technology, National University of Malaysia. However, some students find it difficult to excel in programming courses. In this study, technology integration in learning programming courses challenges the limitations of student opportunities in solving real problems lead to inconsistently use of the expertise and skills. In addition, the challenge of learning programming leads students to generate rote learning. Hence, technology integration in learning programming should be appropriate with the application of technology and applying meaningful learning so that the technology integration will be effective and meaningful. This study is conducted to propose and verify a technology integration framework for learning programming courses. Stratified Random Sampling through quantitative study method is used which involving 109 respondents. Quantitative data are analyzed using multiple linear regression method. Based on previous studies, five factors have been identified namely learning technology, learning competence, technology implementation, meaningful learning and contextual learning that would affect students' desire to learn programming courses. The results discover that all the factors have significant relationships in influencing the desire to learn programming courses among undergraduate students for the faculty. This study is expected to assist educators and administrators to apply and improve the use of technology integration in meaningful learning for programming courses.**

***Keywords*—programming course; learning technology; learning competence; technology implementation; meaningful learning; contextual learning.**

I. INTRODUCTION

In higher education learning, students in computer programming courses usually find the subject as difficult and complex [1], [2]. Among the main problems in programming learning involve difficulty to understand variety of technical topics such as variables and functions and further to apply the concepts to execute computer program [3], [4]. The problems usually create other issues related to lack of motivation and engagement in class [5], [6]. Thus, computer-programming courses commonly have high rates of academic failure [7].

Various interventions have been conducted by programming course instructors to improve programming learning experience specially to address lack of students' motivation and participation [5]. However, various teaching and learning strategies present continuous challenges for researchers and educators to conduct an efficient environment to promote desire to learn in programming courses [8]. In such situation, the key issues with creating desire to learn programming is how to integrate various strategies in order to ensure the beneficial of students' interaction with the technological tools and contents that leads to meaningful learning [9]. Although many studies addressed the problems [4], [10]–[13], currently, there are still minimal studies conducted empirical research in regards to programming learning using technology integration and meaningful learning [10]. Therefore, this study embarks to bridge the gap to describe the relationship between integration technology and desire to learn programming. The objectives of this study are to propose and verify a technology integration framework for learning programming courses.

A. *Technology Integration in Programming Courses*

The current generation of students, generation Z, are digital natives who grow up with digital technologies. They are confident in using new technologies such as the internet, learning videos, mobile technologies and other "tools of the digital age". In line with current development, technology integration has become one of the major interests in pedagogical innovation especially regarding programming teaching and learning [14]. As an example, Web 2.0 technology supports collaborative learning environments using blogs and wikis in which students could become the owner, creator and contributor of the web content and knowledge [15].

Learning technologies such as social networking applications, blogs, wikis, web-based presentation tools, and online mind mapping tools have become important approaches in teaching and learning [16], [17]. These technologies enhance teaching and learning process by efficiently share and distribute materials [16]. In addition to that, Twitter and Facebook can be utilized as discussion, forum and information sharing [14]. Meanwhile, Blog (such as WordPress), learning management system and Massive open online courses (MOOCs) are commonly used as archives for teaching aids and students' reflection [18]. Game-base technology such as Kahoot is utilized in the classroom from time to time to engage students in classroom participation and to provide competitive but fun learning environment [19]. Visualization tool acts as a cognitive tool to support programming learning to externalize the complex process of completing a realistic programming project [10].

Learning competence in computer programming involves various skills in designing algorithm, writing program, understanding the syntax as well as the logic of the program [7]. Therefore, students are required to be skilled in all processes; design the algorithm, translate the algorithm into program code and write the program code with the correct syntax. Programming involves dynamic actions, more specifically practical and often independent problem-solving skills [20]. Therefore, students are trained to select, reflect, evaluate, justify, communicate, be innovative and creative in their problem solving to generate a more desired learning environment [6]. The aim is to equip students with essential skills as they are expected to be creative, problem solver and critical thinker. To excel, programming students require the following learning competences: creativity, critical thinking and imagination as well as concrete understanding of functional procedures in computing [21].

Technology implementation in programming courses enhances teaching and learning process in various ways. Learning management tools, blogs, wikis and online mind mapping tools have become essential in classroom to efficiently share and distribute materials [17]. In addition to that, Twitter and Facebook can be utilized as discussion, forum and information sharing [14]. Along with face-to-face contact, virtual platform for peer observation of programming tasks can provide opportunities to follow the task completion processes and to assist students to share ideas and solve problems more efficiently [10]. Programming is a step-by-step process where a single error at any stage leads to failure of the entire programming design. Therefore, learning technologies implementation such as visualization tool aims to scaffold the complex programming concepts, encourage efficient thinking and reflection, and enhance performance feedback [16]. For efficient monitoring and speedy responses to students' difficulties, continuous assessment and peer observation using technologies will be helpful to understand concepts, complete homework assignments, and ask questions [22] [23]. All these tools aim to create a desired programming learning environment to suit students' needs [11], [24].

Meaningful learning is associated with relating new knowledge to prior knowledge including to make use of knowledge to solve the real world activities and complex problems [25]. Implementation of learning technologies should consider this element to engage and immerse students' participation in programming learning activities [11]. Among the activities may involve tools to virtualize the real-world scenarios and tools to emphasize on common syntax errors and recovery [10]. Collaborative learning using learning technology can be an effective tool for teaching and learning programming courses to motivate students and to ensure sharing ideas and problems are among the norms in the classroom [12].

Contextual learning in computer programming courses aims to assist students acquire skills that could solve real problems [26]. Therefore, activities in programming courses involve programming problem solving in a realistic context. This environment would provide students with opportunities to learn and practice the skills they will be using in their future careers [10]. Programming involves a complex task since the code writing process is prone to semantic and syntax errors [7]. Hence, a lot of practice in programming in an authentic case is considered as among main reasons for success in programming [6]. Students might approach various ways to solve a problem using different algorithms and flow charts, but practically, they need to write the code to obtain tangible output [17]. Contextual learning helps students monitor their own learning, applies learning in a variety of life contexts and encourages students to learn from one another [4]. This strategy helps students to be motivated and inspired by the authentic programming cases [9].

B. *Technology Integration Framework for Programming Learning*

Based on extensive review of previous research, the technology integration framework for programming learning is proposed, as presented in Fig. 1. The framework consists of five factors in technology integration construct as independent variables and students' desire to learn programming courses as the dependent variable. The study uses 'framework' instead of 'model' to emphasize the aim to examine the relationship and interaction among factors [9]. The factors are learning technology, learning competence, technology implementation, meaningful learning and contextual learning. All the identified factors have been researched before but in separated studies. This study merges all these factors in technology integration framework and examines the relationship using empirical data. The items of each factor are simplified in Table I.

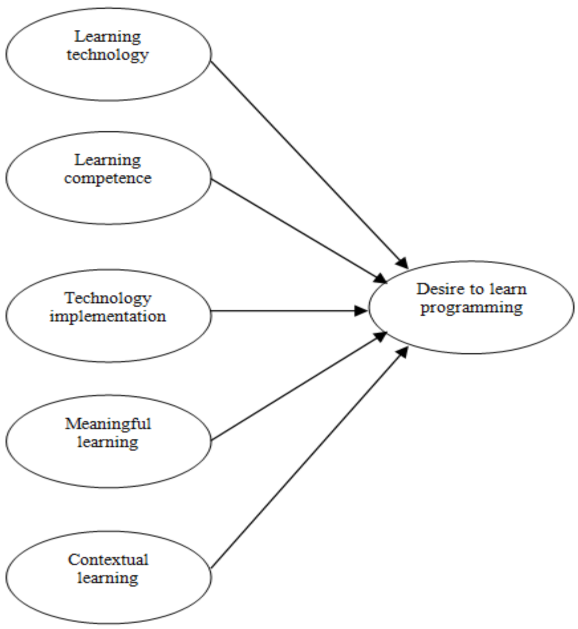

Fig. 1 Technology integration framework for programming learning

TABLE I
ITEMS IN TECHNOLOGY INTEGRATION FRAMEWORK

Factor and Item	References
Learning technology (Frequent use of these tools.)	[16], [18], [19]
Learning management system e.g. i-folio	
Online game e.g. Kahoot	
Learning competencies (Tools contribute to.. in programming courses)	[11], [15], [16], [20], [21]
Communicate with peers and instructors	
Seek knowledge	
Connecting concepts	
Critical thinking	
Applying concepts	
Technology implementation (Use tools to.. in programming courses)	[14], [16], [17], [18], [22], [23]
Access materials	
Discuss using forum	
Complete task and assignments	
Getting feedback	
Evaluate learning process	
Meaningful learning (Use tools to.. in programming courses)	[12], [14], [17]
Construct concepts e.g. syntax, semantics	
Collaborate learning	
Design, develop and test program	
Complete / conduct task and assignment	
Apply libraries and documents	
Contextual learning (Use tools to.. in programming courses)	[6], [13], [17], [26]
Simplify task in flow chart	
Solve problem	
Develop syntax	
Correct errors	
Apply concepts to new problem	
Learn the norms	
Desire to learn programming (Technology integration in programming courses support...)	[6], [11], [19]
Involvement in learning activities	
Enjoyment in learning	
Comprehension in program code	
Motivation in solving tasks	
Interest in mastering programming domain	

These factors would affect students' desire to learn programming courses. The relationship is tested using multiple liner regression to verify the framework. The next section describes the procedure to conduct the empirical study. This will be followed by section that presents the multiple regression analysis results.

II. MATERIAL AND METHODS

A. Location

This study is conducted among undergraduate students at Faculty of Information Science & Technology (*Fakulti Teknologi dan Sains Maklumat, FTSM*), Universiti Kebangsaan Malaysia (UKM). The faculty is among the pioneers in offering programming courses in Malaysia. The programming courses offered are including Computer Programming, Web Programming, Mobile Programming, Multimedia Programming, Integrative Programming, Information Programming and Programming Paradigm.

B. Sampling

The data that being analyzed for this study considered as primary data with the respondents involved consisting of first, second- and third-year students. Sample selection among all years of students is to ensure that the various levels of academic achievement and knowledge of programming are included which are low, medium and high. These students are pursuing or already attended at least one of the programming courses that being offered by the faculty.

The respondents are selected using probability sampling method which is the stratified random sampling because of the non-uniform population. This technique is implemented to make sure that all students had a chance of being chosen. Sample size is based on Krejcie and Morgan [27]. Therefore, the total of respondents is 109 students.

C. Questionnaire

A set of questionnaires is developed and distributed to the respondents during class and through Google Form. The questionnaire is based on previous researches as listed in Table I. It has two sections with the first section consisted of questions about demographic of the respondents. While the second section is about the factors of this study. The factors that being identified are learning technology, learning competence, technology implementation, meaningful learning and contextual learning. These factors could affect the desire to learn programming courses. A five Likert scale is used namely 1: strongly disagree, 2: disagree, 3: slightly agree, 4: agree and 5: strongly agree. Likert scale could give more flexible range for respondents to express their opinions.

D. Validity

Validity is used to measure the accuracy, usage of language and content relevant to the purpose of the study, the meaning and usefulness of the instruments that enable data to be incorporated into the study. For this study, the validity of the items is reviewed by two experts from the National University of Malaysia, who evaluated the questionnaire form before it is distributed. As a result of these assessment, a lot of changes in sentence structure, language and abbreviations, are corrected. In order to gain more understanding from the respondents, easier words should be used and irrelevant questions are eliminated.

E. Reliability

The Cronbach's alpha test is a probability coefficient test to determine reliability. The alpha coefficient ranges and their strength suggests that all factors must be above 0.6 as recommended by [28]. Table II shows the results of the reliability measurement. The table shows that all factors that being studied, learning technology, learning competence, technology implementation, meaningful learning and contextual learning have value Cronbach's alpha of greater than 0.6. The value also true for desire to learn programming courses. Therefore, the questionnaire is reliable and useful as a measuring instrument.

TABLE II
CRONBACH'S ALPHA FOR FACTORS

Factors	Cronbach's alpha
Desire to learn programming	.600
Learning technology	.702
Learning competence	.799
Technology implementation	.792
Meaningful learning	.666
Contextual learning	.922

F. Data Analysis

Multiple linear regression method is used to analyze the data. This method is chosen to identify which factors would give significant relationships in influencing the desire to learn programming courses among students from FTSM, UKM. The approach is suitable to verify the proposed framework [29]. The data are analyzed using SPSS (Statistical Package for the Social Sciences) statistic software version 25.

III. RESULTS AND DISCUSSION

This section presents the analysis output and argument regarding the findings. It starts with demographics information. Following this, the validation of technology integration for meaningful programming learning framework is presented using regression analysis. Regression analysis is used to explain the relationship between five factors in technology integration as independent variables and meaningful programming learning as the dependent variable. To present the result, the assumptions of regression analysis will be checked first. Next, the discussion regarding the main findings will be elaborated.

A. Demographics Information

The summary of respondents' profile is presented in Table III. There are four demographic features selected in the study i.e. gender, academic entrance, academic year and program to clarify the demographic background of the respondents. The distribution follows the real composition of student population in general. There are 109 respondents participated in this study, and all 109 completed questionnaires are used for data analysis.

B. Regression Analysis Assumptions Test

Regression analysis is conducted after taking into consideration important assumptions. The assumption issues are related to multicollinearity, multivariate outlier data, normality, homoscedasticity and linearity.

Multicollinearity issue is regarding to cases in which independent variables are highly linearly related [29]. Tolerance and variance inflation factor (VIF) test are conducted in order to verify that multicollinearity is not a problem. Therefore, the five technology integration factors are regressed against each other to produce VIF and tolerance measurements. The results in Table IV show no significant multicollinearity exists between the dimensions in all cases. Technology implementation factor provides the highest VIF score 2.914 and lowest tolerance 0.343. Thus, all cases represent acceptable scores for tolerance >.10 and VIF <10 [29].

Normality of data distribution is assessed using normal P-P plot residuals, some of the results are as presented in Fig. 2, together with assumption test for homoscedasticity and linearity. Normal data distribution is identified by its signature of straight line parallel to the linear graph [29]. From the normal P-P plot residuals for this study, it confirms that the data distribution is normal.

Homoscedasticity describes a sequence of random variables with all its variables have the same finite variance. Homoscedasticity assessment aims to examine if the relationship between the independent and dependent variables is the same across all values of the independent variables [29]. Scatterplot graph for homoscedasticity is also presented in Fig. 2, to show that a positive relationship between the variables. It also shows that most of the values are inside the -3.3 to 3.3 range that fall in the main cluster. Thus, the data meets the assumption of homoscedasticity.

Linearity assumption ensures that a linear relationship exist between the independent and dependent variables [29]. Scatterplot graph using the studentized plot against the dependent variable is presented in Fig. 2. Linearity pattern is fulfilled in the plot that fulfills the linearity assumption.

TABLE III
RESPONDENT BACKGROUND

	Demographic feature	Frequency	Percentage
1.	Gender		
	Male	41	37.6%
	Female	68	62.4%
2.	Academic entrance		
	High school certificate	10	9.2%
	Matriculation	69	63.3%
	Diploma	22	20.2%
	Asasi Pintar	8	7.3%
3.	Academic year		
	Year 1	40	36.7%
	Year 2	34	31.2%
	Year 3	35	32.1%
4.	Program		
	Computer Science	39	35.8%
	Information Technology	17	15.6%
	Multimedia	27	24.8%
	Information Science	26	23.9%

TABLE IV
MULTICOLLINEARITY TEST

Factors	*Tolerance*	VIF
Learning technology	.959	1.043
Learning competence	.383	2.609
Technology implementation	.343	2.914
Meaningful learning	.350	2.858
Contextual learning	.669	1.496

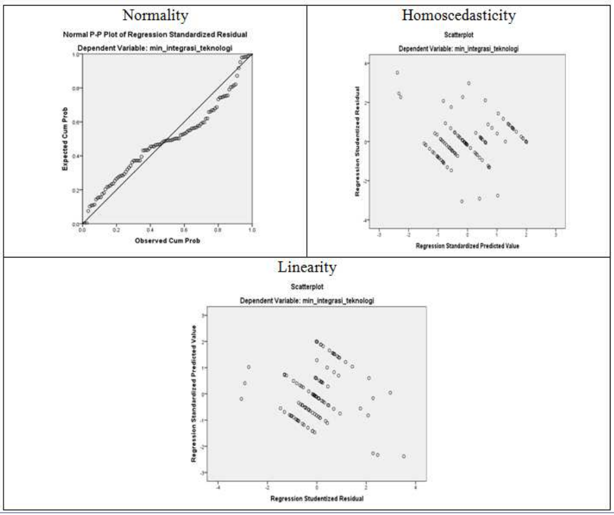

Fig. 2 Assumption validation: normality, homoscedasticity and linearity

C. Regression Analysis Results

Multiple regression analysis is performed to check if respondents' experience with learning technology, learning competence, technology implementation, meaningful learning and contextual learning are strong predators of their desire to learn programming. Table V presents the model summary, ANOVA results, and coefficient values.

TABLE V
REGRESSION ANALYSIS SUMMARY

R	R Square	Adjusted R Square	Std. Error
.840a	.705	.691	.18982
F	**p-value**		
48.796	.000		

Factors	Unstandardized coefficient		Standardized coefficient	t	p-value
	B	Std. Error	Beta		
Constant	.973	.306		3.178	.002
Learning technology	.205	.094	.120	2.190	.031
Learning competence	.222	.068	.282	3.260	.002
Technology implementation	.171	.076	.208	2.265	.026
Meaningful learning	.267	.084	.293	3.184	.002
Contextual learning	.153	.043	.204	3.106	.002

The result describes respondents' desire to learn programming is explained by learning technology, learning competence, technology implementation, meaningful learning and contextual learning: R=.840, R^2=.705, adjusted R^2=.691 with F=48.796 and p-value<0.0001. Coefficients of Determination (R^2) describes the variation in respondent's desire to learn programming can be explained by the regression model. The results suggest that the model explains 70.5% of the variance in respondent's desire to learn programming.

Table V shows the probability value (p-value) of all factors are less than 0.05: learning technology (*B*=.205, ***β***=.120, t=2.190, *p-value*<.05), learning competence (*B*=.222, ***β***=.282, t=3.260, *p-value*<.05), technology implementation (*B*=.171, ***β***=.208, t=2.265, *p-value*<.05), meaningful learning (*B*=.267, ***β***=.293, t=3.184, *p-value*<.05) and contextual learning (*B*=.153, ***β***=.204, t=3.106, *p-value*<.05). The unstandardized coefficient (*B*) results highlight the increment of respondent's desire to learn programming for every unit of technology integration factor. As an example, for every unit of learning technology, respondents' desire to learn programming go up .205 points. This applies to all factors.

The regression analysis results also suggest estimation model, as presented in Equation 1. The value of respondents' desire to learn programming can be estimated using the equation. All five factors in technology integration i.e. learning technology, learning competence, technology implementation, meaningful learning and contextual learning are strong predictors of students' desire to learn programming. The regression analysis conducted reveals that all the five technology integration factors in the programming learning framework are verified.

desire to learn programming
*= 0.973 + (0.205 * learning technology) + (0.222 * learning competence) + (0.171 * technology implementation) + (0.267 * meaningful learning + (0.153*contextual learning)*
(1)

D. Discussion

This study identifies and verifies learning technology, learning competence, technology implementation, meaningful learning and contextual learning as strong predictors of students' desire to learn programming. The study offers novel contribution in terms of empirical study of technology integration with inclusion of both technology elements and learning strategy (meaningful learning and contextual learning) in higher education programming courses [20]. The five technology integration factors are considered important in promoting students' desire for programming learning as shown by respondents in this study. The results reveal experience from students on how the technologies were integrated in learning programming in FTSM and how the factors contribute to desire to learn. The findings add more elaboration on technology integration in the study context conducted by [4], [16], [18], [19], [24]. Students' desire to learn programming is essential in programming course to ensure students engage and participate in learning activities, having fun throughout the class, get motivated and shows interest to explore programming topics [30].

The technology integration strategy is essential to influence students' desire for programming learning. The general aim is to address critical problem in programming learning related to lack of interest and motivation [6]. The verified framework that consists of five factors in integration technology construct as independent variables and students' desire to learn programming courses as the dependent variable enhance researchers' and educators' understanding regarding the key issues in creating desire to learn programming by five technology integration factors [30].

Learning technology plays an important role to promote desire to learn programming, as found from the result. This finding is in line with the previous study of [31][35] which shows the influence of technology tools on the development of intellectual capacity. With the help of technology-based programming instruction, students find it is easy to learn from their mistake and correct their understanding in the semi-private environment [30]. Consequently, the approach assists students to gain self- esteem in learning; actively control their immediate environment, and contribute at their fullest ability to learn at their own pace [36].

Technology competence is another strong predictor to students' desire to learn, as highlighted in the findings. This finding supports the previous findings of [31]. Technology enabled instruction promotes social construction, cooperative learning, and communicative competence among students, thus give more improvements in student learning [30]. Technology advancement nowadays witnesses students and instructors engage to work on their mobile devices and other digital tools [36]. The incorporation of technology into students learning activities, classroom instruction, educational materials invite more persuading environment to enhance students' desire to learn [32].

Next, the findings show that technology implementation have a positive relationship with students' desire to learn programming. This finding is in line with the previous study of [37], [38] which shows the influence of technology tools on conducive learning. Technology supported instructions transform programming teaching and learning by offering smart assistance to deliver teaching, engage students, increase students' attention and interaction [40], [41].

Subsequently, meaningful learning is also another strong predictor to students' desire to learn, as highlighted in the findings. Consistent with the findings of [42], [43], meaningful programming learning encourages learning takes place while students create interaction with the social environment (interpersonal learning) rather than individual learning. Via technology integration, students have a better chance to interact with peers, instructors and learning materials [30][44].

Finally, contextual learning appears to be the last predictor to students' desire to learn, as highlighted in the findings. This finding supports the previous findings of [45] that show an increase in student interest, a more positive way of thinking and a conducive learning environment as a result of contextual learning approach. Parallel with the work of [46] and [47], contextual programming learning promote learning takes place while students actively solving problems in the real world situations rather than theoretical orientation. With the help of technology integration, instructors are encouraged to efficiently use active learning during lectures and to effectively combine conventional assessment with authentic assessment methods [38].

IV. CONCLUSIONS

This study has proposed and verified a technology integration framework for programming learning to enlighten strategies in producing desired programming learning environment. The technology strategy aims to create a desired learning experience in higher education learning specifically in programming courses due to lack of interest and motivation. There are five factors in the framework, namely learning technology, learning competence, technology implementation, meaningful learning and contextual learning. The verification using multiple regression analysis reveal all five factors as strong predictors of students' desire to learn programming. The findings show that these factors play essential role in assisting instructors in engaging and motivating students in learning complex concepts in programming. This demonstrates another evidence of the positive impact of learning technology, learning competence, technology implementation, meaningful learning and contextual learning, in persuading students' desire to learn programming. Instructors who are keen to look forward towards a future that increases technology integration in programming learning in the hope that this strategy can enriches the learning environment may benefit from the research. Apparently, educators in any field are facing similar challenge to transform their instructions to suit the current generation who prefer social interaction in their learning activities and more research are required to fulfill this need.

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