

E-Learning of STEM in Malaysian Higher Education Institutions: Status and challenges

Sheiladevi Sukumaran¹, Nadiatul Syima Mohd Shahid², Nabilah Abdullah^{3*}, Sharmanee Thiagarajah⁴

¹Faculty of Medicine and Health Science, UCSI University,
Jalan Menara Gading 1, 56000 Kuala Lumpur, Malaysia.
sheiladevis@ucsiuniversity.edu.my
sharmanee@ucsiuniversity.edu.my

²Faculty of Health Sciences, Universiti Teknologi MARA,
Cawangan Pulau Pinang, Bertam Campus, 13200 Pulau Pinang, Malaysia.
nadiatul@uitm.edu.my

³Faculty of Education, Universiti Teknologi MARA,
Puncak Alam Campus, 42300 Puncak Alam, Selangor, Malaysia
nabil789@uitm.edu.my

*Corresponding Author

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Abstract: The 4th Industrial Revolution and COVID-19 pandemic have globally impacted the economy, livelihood and organizations. With digitalization, many programs including STEM-based courses that require hands-on approach have gone online. This research was carried out to analyze the status of STEM Education in Malaysian higher education institutions and to explore challenges of e-learning integration with STEM subjects. A concurrent triangulation mixed-methods design was employed whereby quantitative and qualitative approaches took place simultaneously. The qualitative data were gathered via questionnaire while qualitative approach used semi-structured interviews. Respondents were STEM educators who teach and/or manage STEM programs in HEIs within the Klang Valley. Junior lecturers are found comparatively better using different software programs, exploring websites and handling multimedia tools for e-learning purposes. 83% survey respondents claimed their institution has no STEM e-learning policy, contributing to further challenge in STEM Education development. Respondents agreed sound e-learning implementation of STEM requires lecturers with subject specialization, able to approach application of knowledge, skills and values to problem solving, can collaborate with others and adept at integrating technology. Meanwhile, the HEIs must engage stakeholders to counter resistance plan to change, and to measure the effectiveness of integrating e-learning in meeting the strategic goals in STEM education.

Keywords: E-learning, Higher education, STEM Education

1. Introduction

STEM education is an interdisciplinary approach integrating four disciplines knowledge, namely Science, Technology, Engineering and Mathematics. Initially introduced over two decades ago, it has since gained popularity as prominent curriculum in schools worldwide due to its theoretical and practical approaches to teaching and learning. With specific focus given to 4C namely communication, collaboration, creativity and critical thinking (Fazurawati, 2018), STEM education is said to be the way to develop critical thinkers, enhance scientific literacy and promote innovations

– all of which are characteristics of skilled manpower aspired by the nation (Kärkkäinen & Vincent-Lancrin (2013)Ministry of Education, 2017;); the emphases are on cohesive learning areas linking educators and students through the progression of project-based learning, reasoning, and learning collaboratively to encourage reflection and thinking out-of-the-box.

Malaysian Education Development Plan, PPPM 2013-2025 stated that, educators in the field of science and technology need to improve competitiveness and skilled manpower in order to meet the challenges (Ministry of Education, 2017). This is supported by the National Council for Scientific Research and Development as an initiative of New Economic Model, by addressing the need of manpower with the knowledge and skills in line to handle revolutionary wave. An average of 493 830 skilled worker needs to support the rate of increase in STEM is about 31% per annum (Ministry of Education Malaysia, 2017).

The Ministry of Science, Technology and Innovation (MOSTI) estimates that there is a deficiency of manpower 236 000 people in this field of High Technology (Nur Azlina, 2018). Malaysia Education Development Plan 2013-2025 proposed 11 necessary strategics to operational shifts implemented to achieve the desired vision (Ismail, 2017). Hence, to face global economy challenges in increasing more resources to the country, educators should be trained with STEM related knowledge to move towards the threshold of the industrial revolution (IR 4.0) (Makgato, 2020; Fazurawati , 2018). This matter is also supported by the Former Minister of Education Malaysia, YB Dr Maszlee Malik announced. STEM4ALL launch campaign at Bett Asia Leadership Summit and Expo in 2019 to build a culture of inclusion among Malaysians on STEM education for marginalized rural communities, low-income families, students with special needs (Checa & Bustillo, 2020). In addition, Malaysia STEM Exploration Center, Malaysia Global Science and Innovation Advisory Council (GSIAC) and Center of Engineering Education (CEE) University Technology Malaysia are working with related agencies in formulation of STEM education that can cultivate awareness of society (Ministry of Education, 2013). The purpose of this research is to identify issues and challenges associate with integration of eLearning in STEM in Malaysian higher education institutions

2. Problem Statement

The Ministry of Higher Education aims to improve the quality of STEM education for transforming the existing national education system (Ministry of Education Malaysia, 2018). Despite facing financial, human resource, and other challenges to develop the expected number of STEM graduates, STEM implementation initiatives have been put in place in three phases since 2013. The phases include strengthening the quality of STEM education with reinforcement in curriculum, establishment of training to instructors and the usage of multimode learning models (Phase 1: 2013 – 2015); and implementing campaigns and collaborations to foster community awareness of STEM (Phase 2: 2016 – 2020). Presently, this initiative is in the third phase which focuses on shifting STEM to excellent levels through enhancement in operation (Ministry of Education Malaysia, 2013). The institutional role as a whole and that of STEM educators have become more essential; this is seen through more aggressive and active campaigns and collaborative cooperation between and among wide-ranging STEM partners (Nur Amelia, 2019). These efforts were initiated after the Ministry of Science, Technology and Innovation (MOSTI) estimated there will be a shortage of manpower by 236 000 people in high-technology related fields (Nur Azlina, 2018). And presently, the National Council for Scientific Research and Development’s projection of an average of 493 830 skilled workers that Malaysia needed by 2020 to address challenges of fourth industrial revolution (IR4.0) have yet to be met.

The result of global education ranking in 2017 where Malaysia ranked at 52th out of 72 countries technology literacy and problem solving have failed. Cited as reasons for failure include ineffective use of basic pedagogy, lack of training opportunities, sub-par teacher competency and efficacy, inadequate facilities, and poor student involvement – all of which hamper students’ interest to do science and mathematics (Rasid et al., 2020) . The result of a survey by Khazanah Research Institute in 2018 which revealed 32 percent student enrolment in STEM related courses at tertiary level truly reflect the reality of poor interest in STEM. Optimal use of new technological tools is said to be a possible mechanism to motivate learning, enhance knowledge and improve performance of students; it can also allow instructors to tailor their classes to suit individual student but yet be even apt for

dealing with large numbers of students. This suggests that a possible way of improving the acquisition of various cognitive and non-cognitive skills, and of student interest in STEM is via the integration of eLearning in STEM. Nonetheless, there are many issues and challenges associated with the implementation of eLearning in STEM, both at school as well as at the tertiary level. For effective implementation of eLearning of STEM that would eventually support the nation's aspiration for skilled graduates in science and technology, those issues and challenges must be addressed accordingly.

3. Research objective

This study therefore was carried out to provide overall analysis of STEM Education status in Malaysian higher education institutions (HEIs) via identifying the issues and challenges of e-learning integration of STEM. Specifically, it addresses the question: *What are the issues and challenges that Malaysian HEIs encounter when integrating eLearning of STEM?*

4. Research framework

The Systemic Change Model by Roberto (2018) and the E-learning Cycle Model by Laird (2004) served as the models that underpinned this study which tapped into two major education elements namely STEM education and e-learning. Both models were selected because they both concentrated on the best practices for e-learning implementation. They offer simulations, outlines, tools and cases to assist this research in managing STEM education for implementing e-learning more effectively. The systemic change model had been referred by 191 research articles over the period 2015-2019 and of that a total of 176 were for e-learning implementations (MS Academia, 2020). On the other hand, the e-learning cycle instructional model had been referred by 198 from 2015-2019 and of that total 179 was for e-learning implementation (ibid., 2020). The two major domains of this research, e-learning and STEM education, are dependent on each other. The following framework (refer to Figure 1) was built based on these two models and served as the conceptual basis of the study:

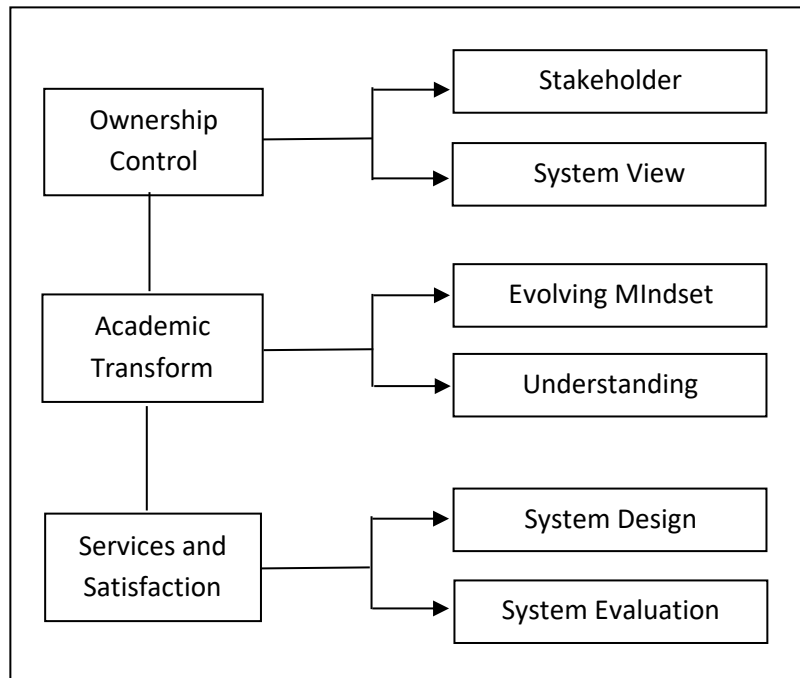


Fig. 1: Conceptual framework model of the research. (adapted from Systemic Change Model by Roberto (2018) and the E-learning Cycle Instructional Model by Laird (2004).

5. Methodology

This research employs extensive evaluation of quantitative data using SPSS and qualitative data using NVIVO. Basic rationale for obtaining both data types is to give force to counterbalance the weakness in between quantitative scores on an instrument and to level out the limitations of qualitative responses. Both data sets were analysed separately, and interpretations made to reveal whether the outcomes support or challenge each other. The direct evaluation of both data sets as ‘triangulation’ of data sources were used. In short, a concurrent triangulation mixed-methods design was adopted to look in depth the interrelationship between significant relationships of issues and challenges on integrating eLearning in STEM education in higher education institution. The two data collection instruments employed were a self-administered questionnaire and semi-structured interview protocols.

It was identified that data for the research would be obtained from higher education institutions (HEIs) with a university status that offer STEM program. In line with government’s ambition to make Malaysia a regional hub for education, most HEIs aims to become among the top-ranking universities in the country. But the HEIs in Kuala Lumpur and Selangor are seen as more established, technologically advanced and are highly innovative in teaching and learning (Ministry of Education, 2018). Thus became the population of the study. There were 41 HEIs listed within the stipulated geographical location, of which 35 are private and 6 public, respectively. In choosing the sample, the researchers also considered, as basis, the notion put forward by the Ministry of Education (2016) that universities in Malaysia are guided by and closely monitored based on the Universities and University College Act 1971 which determine that the number of educators and students is set at the ratio of 1:18. Only HEIs with e-learning implementation in their STEM education programs were selected.

In the quantitative part of the study, sampling of HEIs was based on equal probability of selection design with one stage cluster sampling whereby data eventually was obtained from 14 private and 3 public universities. The respondents were STEM educators in those HEIs. The instrument used was the adapted version of Siebel 4.0-2 Survey Questionnaire (SSQ) distributed online via google platform. The rationale for adapting SSQ was based on its extensive use in past studies examining e-learning platform from the perspective of the ‘users’ using the Systemic Change Model as their theoretical foundation (Hambling, 2010). The SSQ has since been cited in not less than 14 research articles from 2015-2019 (MS Academia, 2020); it has a face validity of 0.867 and a reliability value within 0.78 range. The questionnaire has four parts: (1) demographic data, (2) eLearning status whereby eLearning can be in the form of virtual reality systems, flipped classrooms, massive open online courses MOOCs, cloud computing and others, (3) impact of eLearning integration of STEM to educator and institution, and (4) issues and challenges faced by educators and institutions.

Because the instrument was distributed online through identified keypersons, there was no way of knowing how many actually received the link. Nevertheless, using Krejcie and Morgan’s (1970) model with 95% confidence level, a total of 131 feedbacks were required for this research to be considered statistically significant. The following formula was used to determine sampling size (refer to Table 1):

$$s = \frac{X^2 NP (1-P)}{d^2 (N-1) + X^2 P (1-P)}$$

s= required sample size

X²= the table value of chi-square for one degree of freedom at the desired confidence level.

N= the population size

P= the population proportion

d= the degree of accuracy expressed as a proportion

Besides that, Krejcie and Morgan’s (1970) model was used because it was an appropriate model to get the sample size and this model has been cited in 394 studies. From the total citations, 342 were ISI citation from the year 1999-2019 (MS Academia, 2020), of which 192 citations were used in determining sample from higher education institutions.

Table 1 : Academic staff based on level of education in higher education institution in Malaysia

Criteria	Number of educators
Total population of educators in higher education institutions with STEM education	11763
Total estimated population of educators' higher education institutions with STEM education and related to e-learning implementation	1764
Required sample size, N	131
Confidence level	95%
Margin of Error	5%

Analysis of data used IBM SPSS Statistics version 24.0. Data normality was assessed using skewness and kurtosis value. Based on normality result it was used to find out the differences in the measurement of issues and challenges factors among educators' category. To find out the correlation between issues and challenges and educator categories, a Spearman correlation was conducted based on normality result. eLearning integration was addressed with factors as ownership control (OC), academic transform (AT), and service and satisfaction (SS) most influences the STEM education factors as stakeholders' involvement (SI), system view (SV), evolving mindset (EM), understanding transition (UT), system design (SD), and system evaluation (SE). For that, stepwise multiple regressions were also performed. In order to determine which variables contributed to factors for eLearning integration, they were regressed against STEM education.

For the qualitative study, six stakeholders who are highly-involved-in-STEM were purposively sampled for the interviews. A representative each from the Malaysian Association of Private Higher Education (MAPCU), the Ministry of Education (MOE) and HEI top-ranking official were recruited to give their input regarding STEM policy development and program implementation at the organizational level and beyond. Meanwhile, the remaining three participants were selected based on their operational involvement in curriculum development and teaching of STEM courses. A summary of the interview participants and other details is displayed in the following table.

Table 2: Qualitative research participants and interview details

Stakeholder post	Institution	Number of interviews	Interview duration	Coding theme
Deputy Vice Chancellor	A	1	1.5	PM-1-1-535-454
Committee Member	MOE	1	1.5	DM-1-1-554-232
Committee Member	MAPCU	1	1.5	PG-1-1-467-435
Senior lecturer	B	1	1.5	DM-1-1-453-646
Lecturer	C & D	2	1.5	DW-1-1-945-565

All interviews were video recorded using meeting platforms they are comfortable with and the interviews were later transcribed. For the analysis, eLearning and STEM were used as *a priori* themes, given their prominence in the literature for NVIVO analysis. The key advantage of using *a priori* themes was that they can hasten the initial coding phase of analysis which was usually very time consuming. These cue questions then automatically provided themes for investigation and subsequent analysis of the data gathered. The data were identified by dividing text data coding into analytically meaningful segments which were sorted and arranged in order. Codes were then examined for overlap and redundancy and these codes collapsed into broad themes or descriptions of the setting or participants. This selective coding the researcher identified as the "main" themes in the data related them systemically to other categories that were developed in the axial coding process. The constant comparative method was used as a data analytic technique in this study. It involved inductive and concept building orientation of all qualitative research. As the name implies, the basic strategy was to constantly compare data sets and themes generated and also within and between levels of

conceptualization until findings were confirmed. As this study involved multiple cases, there were two stages of analysis namely within cases analysis and the cross-case analysis.

The first stage was the within case analysis whereby each case was regarded as a comprehensive case in and of itself. From the data collected from each institution, comparisons were made through interactions between the researcher and the participants so that the researcher could learn as much about the contextual variables as possible that might have a bearing on the institutions. The second stage, cross-case analysis, only began once the first stage was completed. It sought to build abstractions across the cases. Here, the researcher attempted to build a general explanation that fits each of the individual cases. In the cross-case analysis, the categories or themes emerged from the first case were compared with the categories or themes emerged from the second case. The data analysis process was iterative because it involved moving back and forth between the data collection and analysis. It involved a complex process of abstract concepts that indicate categories of data that were with inductive reasoning, deductive reasoning, description and interpretation. In essence, the researchers made agreed-upon assessment to a description that fitted the situation or themes that captured the major categories of information, bringing their perspective to the interpretation. The first segment of the coding was for stakeholder post PM-Deputy Vice Chancellor, DM-Committee Member, MOE, PG for committee member MAPCU, DM for senior lecturer and DW for lecturer. The second refer to recording session. The third segment refer to data collected institutions. The fourth segment was the theme category and the fifth segment was the cross-analysis theme segments

Members check were also conducted to rule out the possibility of misinterpreting the meaning of participants interpretation to verified and confirmed with the interview participants if the description was correct, complete and realistic if the included themes were accurate and if the researcher's interpretation was fair. Peer examination conducted to seeks colleagues to comment on the findings as they emerged to counter situation where the researcher was familiar to the phenomenon in the study at the outflow of the research objectives. This was found extremely crucial in triangulation process of this study it provide the researcher a different perspective and this was especially helpful when as breakthrough when researcher faced a bottleneck situation during the data analysis phase, especially in synthesizing the findings.

6. Results and discussions

6.1 Demographic Data

A total of 140 respondents completed the online survey. Out of the 140 returned, 131 were accepted (93.6%) and 9 questionnaires were rejected due to incomplete responses (6.43%). Majority (n=107; 81.7%) of the respondents were female.

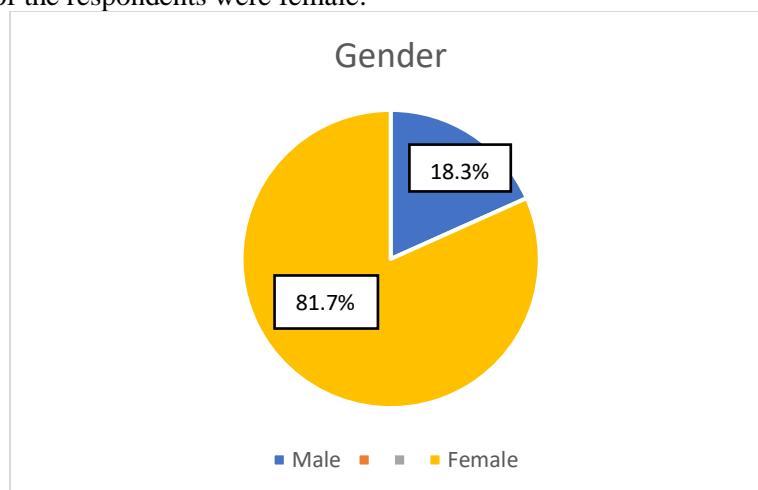


Fig. 2: Respondent Distribution by Gender (n = 131)

The mean age of the study subjects were 22.02 ± 1.51 years. The minimum age range of the subjects was between 30-35 years of age comprising of 79 subjects, whereas the maximum age of the subjects

was 50-55 years old which consists of 5 subjects. Ethnicity-wise, there were more Malays than other races who responded to the questionnaire. Detailed distribution of respondents by ethnicity is displayed in Figure 3.

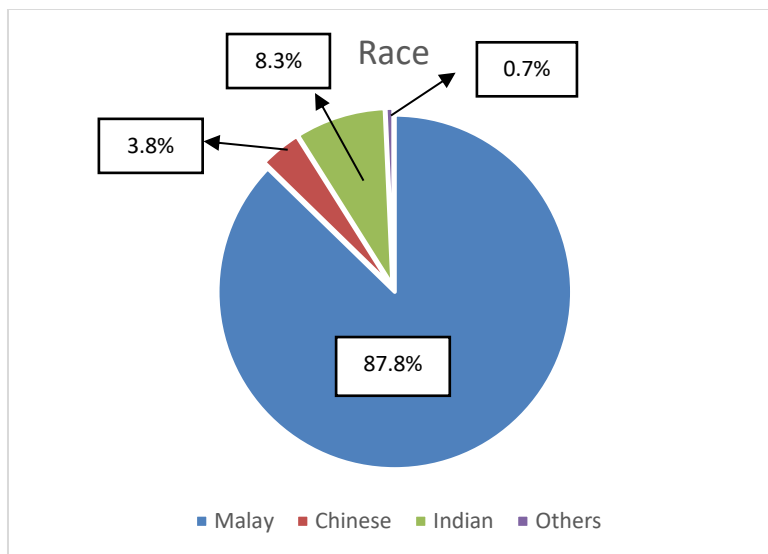


Fig. 3: Distribution of Age of the Studied Sample (n =131)

6.2 Issues and Challenges of STEM Education in Malaysian HEIs

The reporting on descriptive statistics of the issues and challenges factors were evaluated and analyzed with mean, standard deviation, minimum and maximum value obtained shown in Table 3.

Table 3: Descriptive statistics of the issues and challenges factors

Factors	Mean \pm SD	Minimum	Maximum
Stakeholder Involvement (SI)	10.64 \pm 2.11	5.00	17.04
System View (SV)	10.37 \pm 2.81	7.00	18.81
Evolving Mind (EM)	11.47 \pm 2.54	4.75	18.57
Understanding Transition (UT)	9.49 \pm 4.18	0.00	22.12
System Design (SD)	10.90 \pm 4.06	3.00	21.11
System Evaluation (SE)	10.38 \pm 3.39	2.00	19.04

6.2.1 Test of normality

The normality test was done by using the skewness and kurtosis test to evaluate the issues and challenges. The results of the test showed statistically significant with the p-value lesser than 0.05, these include the value of skewness and kurtosis. The distribution exhibiting the skewness and kurtosis values were high and it was categorized as skewed distribution. Therefore, for the calculated skewness and kurtosis values, zero assumes perfect normality in the data distribution is seldom achieved, more and less 2.58 indicates rejecting the normality assumption at the probability level, and more or less 1.96 signifies a 0.05 error level (Seels & Glasgow, 1991). Hence, the results suggested that system evaluation was unlikely to be produced by a normal distribution. Table 4 displays a summary of the skewness and kurtosis for the main variables of this study. By applying the above criteria to the skewness values for each of the study variables, it is that none of the variables fall outside the more and less 2.58 range of skewness. Thus, the data for this study is normal with regards to skewness. Univariate skewness and univariate kurtosis value range from -0.105 to 1.103 and -0.284 to 1.473 respectively. The relatively large value of Mardia's normalized multivariate estimate kurtosis (23.623)

showed evidence that the data are slightly not multivariate normal. In order to address the issue of multivariate non-normality, bootstrapping is conducted to assess the stability of parameter estimates and report them more accurately. Within the context of SEM, bootstrapping provides a mechanism for addressing situations where the statistical assumptions of large sample and multivariate normality may not hold (Boon, 2013). In this study the Bollen-Stein bootstrap procedure was employed.

It is a modified bootstrap method for the χ^2 goodness of fit statistic which provides means to test if the specified model is correct. In particular, it can be used to correct for the standard error and fit statistic bias that occurs due to non-normal data. It tests the adequacy of the hypothesized model based on the transformation of the sample data such that the model is made to fit the data perfectly. In this study, 1000 bootstrap samples were drawn with replacement from this transformed sample. The Bollen-Stein bootstrap p-value is 0.356 ($>.05$) indicating that there is sufficient evidence to reject the hypothesized model. Considering the feasibility and statistical significance of all parameter estimates, the substantially good fit of the final model and the lack of any substantial evidence of model misfit, the author concludes that the dimensions can represent an adequate description of educators' perspective in integration of e-learning in STEM education.

Table 4: Normality Test Result

Factors	Normality test	
	Skewness	Kurtosis
Stakeholders' Involvement (SI)	1.103	1.473
System View (SV)	.481	.778
Evolving Mindset (EM)	.664	.681
Understanding Transition (UT)	.703	.284
System Design (SD)	.105	.579
System Evaluation (SE)	.141	.408

6.2.2 Correlation between issues and challenges in eLearning and STEM education

This section reports on the findings that address on independent variables (ownership control (OC), academic transform (AT), and service and satisfaction (SS) most influences the dependent variables of stakeholders' involvement (SI), system view (SV), evolving mindset (EM), understanding transition (UT), system design (SD), and system evaluation (SE). For the said purpose, stepwise multiple regressions were performed. In order to determine which variables contributed to independent variables were regressed against dependent variables. Table 5 illustrates the summary of Stepwise Multiple Regression analysis for independent variables that were predicted to contribute to the dependent variables. Displays the summary of Stepwise Multiple Regression analysis for independent variables that were predicted to contribute to the dependent variables.

Table 5: Summary of Stepwise Multiple regression analysis for variables predicting of factors

Factors	Model Summary		ANOVA		Coefficients		
	R^2	Adjusted R^2	F-value	p	Beta	t-value	p
<i>SI</i>							
OC	.087	.047	35.14	.000*	.265	3.07	.000*
OC+AT	.112	.069	14.87	.000*	.217	1.74	.004*
<i>SV</i>							
OC	.046	.085	14.42	.000*	.543	3.36	.000*
OC+AT	.047	.036	9.48	.000*	.452	3.25	.005*
<i>EM</i>							
AT	.423	.172	5.23	.000*	.432	3.45	.001*

AT+SS <i>UT</i>	.294	.184	12.53	.000*	.312	3.15	.000*
AT	.022	.013	10.24	.000*	.234	3.52	.003*
AT+SS <i>SD</i>	.519	.146	9.12	.000*	.352	4.12	.000*
SS	.423	.231	7.47	.000*	.546	2.43	.000*
SS+AT	.412	.213	15.54	.000*	.343	3.46	.003*
<i>SE</i>							
SS	.176	.128	15.63	.000*	.472	2.57	.000*
SS+AT	.236	.242	4.23	.000*	.345	3.32	.000*

*mean effect significant

According to the analysis, there are eLearning integration factors for STEM education. For stakeholder's involvement, with all variables entered into the equation, OC yield an adjusted R^2 of .047 ($F(1, 486) = 35.14, p < .005$). AT produced an adjusted R^2 of .069 ($F(2, 217) = 14.87, p < .005$). No other factors entered the equation. For stakeholders' involvement, OC was the primary predictor accounting 7.4 percent of the variance. Other factors did not achieve significance. For system view, with all factors entered into the equation, OC yield an adjusted R^2 of .085 ($F(1, 486) = 14.42, p < .005$). AT produced an adjusted R^2 of .036 ($F(2, 486) = 9.48, p < .005$). No other factors entered the equation. For system view, OC was the primary predictor accounting 5.8 percent of the variance. Other factors did not achieve significance.

For system design, with all variables entered into the equation, SS yield an adjusted R^2 of .321 ($F(1, 486) = 7.47, p < .005$). AT produced an adjusted R^2 of .231 ($F(2, 486) = 15.54, p < .005$). No other factors entered the equation. For system design, SS was the primary predictor accounting 32.1 percent of the variance. Other factors did not achieve significance. For system evaluation, with all factors entered into the equation, SS yield an adjusted R^2 of .176 ($F(1, 486) = 15.63, p < .005$). AT produced an adjusted R^2 of .224 ($F(2, 486) = 15.63, p < .005$). No other factors entered the equation. For system evaluation, SS was the primary predictor accounting 18.2 percent of the variance. Other factors did not achieve significance. Therefore, it could be concluded that the contribution of STEM education factors decreases from OC and SS between 31.54 percent to 9.23 percent.

For evolving mindset, with all factors entered into the equation, AT yield an adjusted R^2 of .172 ($F(1, 486) = 12.53, p < .005$). SS produced an adjusted R^2 of .184 ($F(2, 486) = 12.53, p < .005$). No other factors entered the equation. For evolving mindset, AT was the primary predictor accounting 2.17 percent of the variance. Other factors did not achieve significance. For understanding transition, with all variables entered into the equation, AT yield an adjusted R^2 of .013 ($F(1, 486) = 10.24, p < .005$). SS produced an adjusted R^2 of .146 ($F(2, 486) = 9.12, p < .005$). No other factors entered the equation. For system view, AT was the primary predictor accounting 1.3 percent of the variance. Other factors did not achieve significance.

7. Analysis and Discussion

Wide variation based on issues and challenges including amendment of the institutional mission, reformation of the operations, classroom integrated with eLearning facilities, and overview of innovative technologies, integrating and collaborating with other eLearning practicing universities viewed as an institutional transformation. The obligation to accelerate knowledge acquisition of eLearning components, which result in creativity of technology is clearly the vehicle for performance acceleration. According to Alhabshi, Ismail, and Bacha (2017), eventually the accomplishment in developing a highly effective workforce comes from positioning the strategic intent with people, procedures, and technology. Triangulation of data based on interview and questionnaire showed that most significant challenges that educators encountered were adapting effective transition. At the same time, respondents also claimed that strategic planning should not ignore people who have conscientious objections, or different perceptions of old way of teaching as fundamental role of

educators. They should be taken in consideration by closely monitor, evaluate and decrypted in order to achieve the eLearning integration in STEM education. Respondents also agreed that overcoming issues involving institution operation such as substantial cuts or infusion of funding, technological innovations, actions by competitors, and the need for dramatic increase in services require technical skills support. Organizing training and support for educators are extremely important due to heavy dependency of eLearning on technology and securing such support and training from the university is a major concern for educators (Md Enzai et al., 2021; Zamri, Jamalul Lail & Ibrahim, 2017). Zakaria et al. (2018) elaborated that the issues for policies and procedures of good handling in integration of eLearning should have detailed dynamic content, driven and supported by tools for measuring the progress against learning objectives. Encouraging cooperation between different faculties to produce better results as an aspect of handling eLearning integration with STEM education was pointed out as one way to resolve issue. Similar finding was corroborated by an interview participant from a private higher education. According to him:

“.....the awareness of an imminent incidental change in educators’ behavioural system. Educators will need to act in a different manner and this will have an impact on both their self-perception and on how other private higher education institution view them. Collaboration from internal and external need to encourage the educators to operate in more appropriate action. At the basic level, there is a feeling of relief that teaching and learning style is going to change and not continue as before. Whether the past is perceived or there is still a feeling of anticipation and excitement of the improvement. Many lecturers at that time have a view that there is the satisfaction of knowing that some of the thoughts about the old system were correct.” [DW-1-1-945-565]

Almost all interview participants also pointed out their strong agreement with eLearning implementation for STEM not being utilized effectively due to policy structure, implementation method, eLearning platform, training inadequacy, lack of speed in broadband, level of awareness towards IR4.0. These findings supported similar outcomes reported by Hyatt et al. (2013). In addition to eLearning constant transition encourage and improvise the e-learning integration with tools such as email, LMS platform and electronic chat were vital (i.e. online interactive learning, simulation, augmented and virtual reality, and digital gaming) (Muhamad Adnan et al., 2021; Checa & Bustillo, 2020; Nadelson & Seifret, 2017). Institutionalizations of knowledge starts with the need for proper tool as well as methods to analyze and organize. There may be different tools in eLearning integration with STEM but each would be likely to represent technology that supports different aspects of capturing information and placing it as knowledge. The portal tools would turn knowledge into action and application for educators to play vital role. According to Ravet and Layte (2017), this is a critical component for ensuring quality in STEM development and enhanced educator knowledge and awareness. In this study, some educators were reported to have faced issues like change initiatives, temporary belief on their competency, a loss of authority or control, lack of faith in their ability to learn new skills and loss of job security and the feeling that the organization is not appreciate to the extra effort resulting from poor STEM eLearning implementation.

Adaptation of system create a goal to gain and share in the training process, open up new information sources and cultivate knowledge sharing and collaboration. Information retrieval supports ad hoc need for imperative knowledge which need to be stored as internal and external information at any time and place. More than half of the research interviewees agree that the eLearning integration need to be flexible and active. As illustrated in the following quotation by the committee member of MAPCU, HEIs should check that educators affected by the change agree with, or at least understand and the need to agree to share knowledge

“The deans must use face-to-face communications to handle sensitive aspects of educators. Educators who lead e-learning integration for STEM subjects should encourage other educators to communicate face-to-face. Email and written notices should be at conveying and developing understanding to be flexible and active if the educational institution management needs to make change to happen quickly. A more sensible time-frame is more disastrous than presiding over a change. Training and collaboration needed for quick change with proper consultation and involvement, will leads to difficulties”. [PG-1-1-467-435]

This study showed the respondents strongly disagree that challenges at institution level due to eLearning integration need to be solve immediately. Educational leaders need to be well prepared and respond swiftly accordance to the changes of eLearning integration. Educators can slow down or project a semblance of plan while maintaining the status quo. Before initiating to solve issues, university leaders must ensure the efficiency and reliability of the administration and communication systems. This finding is also similar to the one conducted by Ong and Jambulingam (2015) in that communication will help to prevent other organizational problems from being used to distract faculty from embracing the change. Majority of the respondents also strongly disagree on not to recognize the complexity and diversity of different universities and colleges, in determining the type of transition to imposed. Each university have a unique business, human resources, and technology environments.

Several interview participants mentioned that transparent and consistent communications from top-down, bottom-up, side-to-side, and peer-to-peer are critical to the success of organizations experiencing significant change, as highlighted by the MOE below:

“Those are responsible for managing change, need to remember that educators do not relish change, they find it deeply disturbing and threatening. Educators' fear of change is as great as their fear of failure. For educational institutions with their unique business, change that entails new actions by communication. Objectives and processes for a group or team of people, use workshops to achieve understanding, involvement, plans, measurable aims, actions and commitment. Encourage management team that coordinates e-learning use workshops.” [DM-1-1-554-232]

Naveed et al. (2020) pointed out organizations must ensure that consultant should be highly experienced in addressing technical glitches and focused on the needs of dealing with eLearning integration. Effective implementation of eLearning, according to the authors, require purposeful development of an integrated system which considers inputs from instructors and students on the teaching and learning content and resources, whilst working in concerted effort with other stakeholders responsible for decision making and technological management of infrastructure. Equally crucial are the consultations held and professional training carried out to enhance the instructors' capabilities in adopting miscellaneous technical applications during STEM lessons.

8. Conclusion

A full realization of the strategic aspects of eLearning integration is essential for the successful growth in STEM. The finding of this research revealed educational excellence has become a moving target, and it is dynamic. The main thrust has been on development, which is flexible and has a generic focus goal for educators. HEIs with committed top management, far sighted and motivated to provide exceptional education are found to be more advanced with respect to eLearning integration of STEM. The eLearning process must be customized to address the complex characteristics of learning courses, educators' skills and market needs. The HEIs also need to do more than merely coming up with *ad hoc* policies which are not well thought or not comprehensive via imposing unreasonable eLearning integration timeline. For the educators, embracing technological advancements, and being consistent in using them to transform educational and business practices are considered new channel for STEM education. Performance indicators and management information can serve as valuable input for defining areas of improvement where consistency is required. Since successful eLearning implementation depends on both the “hard structures” (referring to technology hardware such as platform, applications, tools, etc.) and the “soft structures” (encompassing people-related aspects including the management support and educators' knowledge and skills institutional structures) within the institution, it is therefore crucial for all stakeholders – managers, educators and students - to collaborate in a concerted manner so that STEM education flourish and impactfully contribute to the development of technologically adept workforce of the nation.

9. Suggestion for Future Research

The research did provide a holistic overview on the status and challenges of eLearning implementation of STEM in HEIs. In most HEIs, the implementation of eLearning of STEM has begun but more structured planning and adoption of sound, relevant technologies are required. Human and other forms of resources too need to be deployed to scale up the use of technology in teaching STEM. What would be good is perhaps for the HEIs to engage in individual case study evaluating on, amongst others, the strengths and weakness of their infostructure policy, status of IT integration for teaching and learning, and on how best to upskill the educators with regard to using technology for the adoption of eLearning to take place effective and efficiently. Benchmark reports on the initiatives to drive eLearning of STEM, addressing the context, input, content and processes enhancements would certainly be of benefit.

10. Co-Authors Contribution

The authors affirmed that there is no conflict of interest in this article. All authors carried out the fieldwork. Author 1 carried out the statistical analysis, interpretation of the results and contributed significantly in consolidating the findings and conclusion of the study. Author 2 wrote the literature review while Author 4 prepared the research methodology and did the data entry. Author 3 was responsible for refining the instruments used and overseeing as well as refining the entire writeup of the paper.

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