International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-4, November 2019

# ICT Integration Practices of STEM Teachers in TVET

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***Abstract:*** ***STEM Education is important for a country to be advanced in economy and technology. It is achieved through skilled and multi-talented workforce produced by Technical Vocational Education and Training (TVET) which is a component of STEM Education. Technology becomes a mechanism for STEM teachers to engage their students in STEM disciplines. However, STEM teachers have barriers and challenges integrating technology in STEM Education. Therefore, it is the purpose of this study to examine STEM teachers' technology integration practices in the context of ICT. This is a preliminary study that is conducted in MARA TVET – one of the private providers of TVET in Malaysia. Using a quantitative data collection tool, 32 STEM teachers from MARA TVET in Borneo Region participated in the study. The study employed adopted SPMa (Standard Practices MARA Educators) instrument that consists of three dimensions: basic ICT skills, integrating ICT in teaching and learning and communicate skillfully using ICT. The overall result revealed that the level of ICT integration of STEM teachers in MARA TVET is high (M = 2.63, SD = 0.80). Dimension basic ICT skills had the lowest mean (M = 2.41, SD = 1.04) and followed by dimension integrating ICT in teaching and learning (M = 2.69, SD = 0.90). Dimension using ICT to communicate had the highest mean (M = 2.78, SD = 1.04). In conclusion, the level of ICT integration of STEM teachers in MARA TVET of Borneo Region based on adopted SPMa instrument is moderate. Though ICT skills affect ICT integration in teaching and learning, there is also a need to examine other factors that affect the success of ICT integration. STEM teachers' knowledge is a proposed variable to be investigated in future research.***

***Keywords:*** ***engineering field, in-service STEM teachers, MARA TVET, teaching experiences.***

## I. INTRODUCTION

Globally, STEM Education becomes the subject of interest of ministries of education since it is the platform of economic growth by many countries [19]. STEM education produces workforce with STEM skills which includes analytical thinking, critical thinking and innovation [17],[31]. STEM skills are necessary to level up the future workforce to a standard that can compete globally. It is through STEM Education that a country can improve its productivity by having innovativeness in their work [7], [29]. Therefore, a country that leads in STEM Education brings economic growth to their countries.

Like other countries, STEM Education also becomes a main focus in Malaysia Education system [24]. Malaysia Education Minister, Dr. Maszlee Malik expressed his concern about the declining number of students choosing STEM in his keynote speech during Global Summit Asia Bett Leadership and Expo 2019. He also reported that the number of students opts for STEM was only 44% in the year 2018 compared to 49% in the year 2012 [32]. The same scenario persists in the state of Sarawak, the largest state in Malaysia. It was reported there was only 24.3% students enrolled in STEM stream in Sarawak schools [6]. The declined number of students pursuing STEM disciplines will cause shortage number of engineers and scientists produced by Malaysia. Based on statistics from National Council for Scientific and Research Development, Malaysia in need of 500 000 scientists and engineers to support the Industrial Revolution 4.0 yet there are only 70 000 registered engineers in the country [31]. This is an alarming situation for Malaysia.

Technology becomes part of our lives. Since future work evolves according to the changes of technology, so does its workforce. Internet of Things (IoT), big data, cloud computing are among technologies in TVET that support industrial revolution 4.0 [2]. Therefore, STEM teachers in TVET need to equip themselves with these technologies to strengthen the quality of STEM teachers. Several studies indicate the importance of technology in STEM Education. In 2009, Sanders first emphasized the potential of technology in STEM education as a critical key to global competitiveness [28]. The author argued technology as the mechanism to maintain students' interest and motivation in STEM disciplines and play a vital role in 21st century. A decade later, similarly, [12] pointed out that integrating technology can enhance STEM learning. In his narrative review, de Jong proposed for technology-based learning which applied to STEM topics could foster deep conceptual knowledge [12]. However, STEM teachers found barriers and challenges integrating technology [21], [23].

In order to have an effective STEM teaching and learning, STEM teachers need sufficient technology knowledge and skills [14], [33]. Yet, STEM teachers are found to have limited knowledge on technology [13], [35]. [13] conducted a STEM seminar as an intervention to increase the technology usage by STEM teachers [13]. However, the study revealed that STEM seminars had no influence on technology level of use of teachers. On the contrary, [16] found a positive impact on the usage of iPad as teaching and learning tool in STEM classroom.

Manuscript published on November 30, 2019.
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There were nine STEM teachers participated in a summer professional development perceived competency in using iPad to design lesson plan that engaged students in the learning. Another study conducted by [38] found that technology integration in STEM applications had no positive impact on Technology Knowledge, Pedagogical Content Knowledge and Technological Field Knowledge of 29 pre-service teachers in elementary mathematics teaching [38]. The studies above show inconsistencies findings in the influence of technology on STEM teachers. Furthermore, STEM teachers are also found lack in content knowledge related to STEM subjects and pedagogical knowledge [14], [29], [37].

In Malaysia, there has been research trends on the study of technology integration in TVET [1], [2], [18], [27], [30], [39]. The existing studies investigated various aspects such as teaching phenomenon and teachers' views about teaching practices [39], perceptions of mobile learning [27], explore issues and challenges [30], lecturers experiences and confidence in using educational technology [1], industry 4.0 in TVET [2] and factors influencing instructors' knowledge [18]. However, the above-mentioned studies were not conducted in the context of STEM Education. Up to this date, this is the first study of technology integration practices of STEM teachers in TVET.

The study was conducted in MARA TVET which is one of the private providers in Malaysia. MARA TVET is established to cater the needs of the indigenous people in Malaysia who are known as 'bumiputera'. Moreover, MARA TVET has the experience of training 'bumiputera' TVET students for more than five decades. Furthermore, problem-based learning and hands-on competency are the pedagogical practices of STEM teachers in MARA TVET.

It is the purpose of this study to examine ICT integration practices of STEM teachers in MARA TVET based on Standard Practices of MARA Educators (SPMa) instrument. The study is guided by three research questions:

1. Based on SPMa ICT instrument, what is the level of ICT skills of STEM teachers in MARA TVET?
2. Based on SPMa ICT instrument, what is the level of ICT integration in teaching and learning of STEM teachers in MARA TVET?
3. Based on SPMa ICT instrument, what is the level of using ICT to communicate of STEM teachers in MARA TVET?

## II. LITERATURE REVIEW

### A. ICT skills

It is the purpose of STEM Education to prepare students for a better future career in STEM disciplines. According to [17], it is important for students to acquire STEM competencies such as technology skills. Additionally, working in STEM disciplines should be competence in using computers to conduct activities that require them to gather and process information efficiently [17]. Therefore, STEM teachers also need to acquire high ICT knowledge and skills. In STEM Education, ICT tools is used to assist instructional practices of STEM teachers in transforming abstract to concrete concepts [10]. Furthermore, ICT promotes higher order thinking skills and conceptual understanding among STEM students. According to [4], ICT can support cognitive learning, but STEM teachers still used traditional methods of teaching. Even though STEM teachers showed proficiency in ICT, yet there is still confusion in the effectiveness of ICT integration [4]. Therefore, professional developments and trainings are important for STEM teachers to upgrade their ICT skills. For example, in a professional development cultivating teacher readiness for Ipads, STEM teachers had positive and productive experience to enhance their knowledge and skill in the ICT integration practices [16].

### B. ICT integration in TVET teaching/learning

Technology integration into teaching/learning activities involves technology tool to enhance students' understanding [8]. Teachers utilize technology in designing their teaching/learning activities and employ it in the success of the lesson. In other words, teachers rely on technology as the dominant tool to deliver the teaching and learning process [5]. Therefore, the act of technology integration involves interactions among three elements of teachers' expertise which are content, pedagogy and technology [3]. Hence, technology integration is a complicated process that teachers face barriers in the effort to meet the challenge of 21st century learning skills.

The success of ICT integration has raised concerns of STEM teachers in TVET. According to a review conducted by [37], the three learning domains of ICT integration in teaching/learning are cognitive, affective and psychomotor [37]. However, ICT integration only found to be effective in cognitive domain [4]. The authors suggested that efforts and concerns on selecting appropriate multimedia framework, guiding learning theories and ICT tools to be employed to ensure success of ICT integration. Furthermore, uncertainty on choosing which pedagogical approach becomes a barrier for STEM teachers to fully utilize ICT facilities in effective teaching and learning [1].

### C. ICT skills for communication

Using ICT as communication serve basic skills to STEM teachers [9], [11], [17]. Communicating using ICT includes the use of electronic mail, networks, websites and multimedia. Nevertheless, STEM teachers are still lacking using ICT as a mean to communicate [11]. Consequently, this will discourage them to use ICT as part of their teaching and learning tools. Several studies have indicated how technology enhances students' learning. Even tough teachers do aware the need to equip themselves with todays' advanced technology [9], [17], teachers are not confident on how to use in their teaching and learning [9].

## III. RESEARCH METHODOLOGY

Below is the step by step research methodology that is employed to achieve research questions.

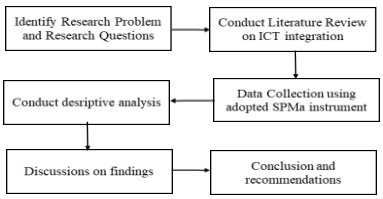


**Figure 1. Research steps**

For the purpose of this preliminary study, STEM teachers in MARA TVET of Bornoe Region has been chosen as the sample of population. There were 32 STEM teachers from 4 engineering departments participated in the study. 26% of the respondents are STEM teachers from Automotive Engineering, 11% of the respondents from Civil Engineering, 37% from Electrical Engineering and 26% are from Mechanical Engineering. The adopted SPMa instrument was distributed and self- administered. There are three dimensions of ICT integration practices which are basic ICT skills, ICT integration in teaching/learning and using ICT to communicate. The instrument employs 5 likert scale range from 0 – totally disagree to 4 – totally agree.

**Table- I: Distribution of Respondents**

| No. | SPMa ICT Integration | |
|---|---|---|
| | ***MARA TVET*** | ***Percentage (%)*** |
| 1 | Automotive Engineering | 26 |
| 2 | Civil Engineering | 11 |
| 3 | Electrical Engineering | 37 |
| 5 | Mechanical Engineering | 26 |

Demographic information of respondents was obtained. 78% of the respondents are male and 22% are females. The distribution of teaching experience of STEM teachers is displayed in Table II. Majority of the respondents have been teaching for more than 10 years and 20% is in the category 1 to 3 years, 4% has been teaching 4 to 6 years and 12% is in the category 7 to 9 years.

**Table- II: Years of Teaching Experience**

| No. | SPMa ICT Integration | |
|---|---|---|
| | ***Teaching Experience*** | ***Percentage (%)*** |
| 1 | Less than 1 year | 0 |
| 2 | 1 – 3 years | 20 |
| 3 | 4 – 6 years | 4 |
| 4 | 7 – 9 years | 12 |
| 5 | More than 10 years | 64 |

Descriptive analyses were used in this study. The study started with internal consistencies. The coefficient alpha was tested and achieved 0.741. According to [22], the coefficient alpha above 0.60 the instrument is reliable. Then, the data was examined descriptively by generating means and standard deviations.

**Table-III: Value of Alpha Cronbach Coefficient**

| No. | Reliability Test | |
|---|---|---|
| | ***Dimension*** | ***Cronbach's Alpha*** |
| 1 | Basic ICT skills | 0.741 |
| 2 | Integrate ICT in teaching | |
| 3 | Using ICT to communicate | |

## IV. RESULTS

Overall, the dimensions in SPMa instrument that assessed ICT integration practices are in the moderate level as all the means of the dimensions score above 1.34 out of 4.00 point (M =2.63, SD = 0.80). The results show that the mean and standard deviation of Basic Skills in ICT (M = 2.41, SD = 1.04) score the lowest mean, followed by ICT Integration in teaching and learning (M = 2.69, SD = 0.90). Comparing the dimensions in the adopted SPMa instrument, Using ICT to communicate has the highest mean (M= 2.78, SD= 1.04).

**Table- IV: Descriptive Analysis**

| No. | SPMa ICT Questionnaire | | |
|---|---|---|---|
| | ***Dimension*** | ***Mean*** | ***Standard deviation*** |
| 1 | Basic ICT skills | 2.41 | 1.04 |
| 2 | Integrate ICT in teaching/ | 2.69 | 0.90 |
| 3 | Using ICT to communicate | 2.78 | 1.04 |
| 4 | SPMa ICT | 2.63 | 0.80 |

## V. DISCUSSION OF FINDINGS

This study was designed to gain insights of technology integration practices of STEM teachers in TVET. It was part of preliminary study. The study examined three research questions which were 1) What is the level of ICT skills of STEM teachers in MARA TVET? 2) What is the level of ICT integration in the teaching and learning of STEM teachers in MARA TVET? and 3) What is the level of using ICT to communicate of STEM teachers in MARA TVET? The empirical findings provided support for further investigation of technology integration practices in teaching and learning of STEM teachers in TVET. Moreover, this study was an effort to address technology integration of STEM teachers in Malaysia TVET.

The overall study of ICT integration of STEM teachers in TVET is moderate based on the mean score range from 2.40-2.78 with moderate level of ICT skills and ICT integration in teaching and learning. This finding supported [4] that proficiency in ICT skills still affected ICT integration in teaching and learning. Moreover, [17] has highlighted for STEM teachers to equip themselves with the 21st century skills and STEM competencies for these are the skills that future TVET students need. Though the mean score for 'Communicate skillfully using ICT' is in the high level, STEM teachers still need to upgrade their technology skills through professional development and training [16] as technology is ubiquitous. Besides that, technology becomes a potential mechanism for maintaining students' interest in STEM disciplines [12], [28].

However, the standard deviation results in dimension basic ICT skills and Using ICT to communicate reveal the highest value with 1.04. Standard deviation represents the variability of the sample chosen can be examined from demographic information [22]. The distribution of the respondents is given in two forms: engineering field and teaching experience categories. Each of the engineering field is having a different syllabus which may contribute to the result of standard deviation in the study. For example, AutoCAD software is employed in automotive, civil and mechanical engineering while BAS (Building Automation System) is included as part of syllabus in Electrical Engineering department.

Therefore, there are various level of ICT skills possess by STEM teachers from different engineering field Furthermore, teaching experience of the respondents is categorized in 4 different range. According to [21], year of teaching experiences is significantly affected the confidence in using technology [21]. Therefore, the various teaching experiences contributes to the high value in standard deviation of the study.

The study suggests some implications to STEM stakeholders on the importance of technology integration in STEM Education in TVET as one of the components of STEM Education.

Besides that, there is a vital need to investigate other factors that influence technology integration practices of STEM teachers. One of the factors that is proposed is teacher knowledge as a variable that ensure the success and effectiveness of technology integration. The findings of the study can help to design professional development and trainings of in-service STEM teachers in upgrading their technology skills and teacher knowledge.

Since this is a new area of study of STEM Education in TVET, the findings can contribute to the empirical gap in Malaysia. From the theoretical perspectives, this study provides new insights to understand STEM teachers practices in integration technology in teaching and learning in the engineering field of TVET.

## VI. CONCLUSIONS

This study consists a few limitations. Firstly, the small sample size and conducted in only one centre of MARA TVET of Borneo Region. To gain better perspective of technology integration of STEM teachers, a large sample size that involves other MARA TVET centres in Borneo Region are needed. Secondly, the study was conducted in a quantitative approach. However, the findings of this study will serve as basis for highlighted areas for a qualitative research to gain better understanding of why the moderate level of technology integration of STEM teachers.

In conclusion, the study has contributed to the empirical gap of technology integration practices of STEM teachers in TVET. STEM teachers are the key drivers to equip students with STEM literacy and shaping their STEM career choice [19], [25]. Moreover, technology integration plays various roles in enhancing STEM learning. Since STEM teachers act as agent of change and curriculum delivery, technology becomes mechanism to transform STEM teachers' instructional practices [12], [20], [36] and improve STEM teachers' affective factors such as anxiety, teaching efficacy, interest and competencies [23], [35], [38] and to enhance STEM teachers' knowledge [18], [38].

## ACKNOWLEDGMENT

The authors would like to gratefully acknowledge MARA TVET as one of the private TVET providers in Malaysia for giving the support and permission to conduct this study and STEM teachers who involved in the preliminary study of this research.

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**List of publications :**

1)Talwar Yadar P., Binti Mohamad F., Bin Mustaffa M., Bin Othman M., Yin Bee O. and Chiun Hian C. (2019). Internet Addiction Among University Students: Psychometric Properties of Three Factor Model Internet Addiction Test. Online Journal of Health and Allied Sciences, 18(1), 1-7.

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