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RELATIONSHIP BETWEEN STEM VIDEOS IN TEACHING AND STUDENTS' LEARNING ENGAGEMENT

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Abstract

The use of multimedia like video is one of the most effective methods of teaching and learning especially for Science, Technology, Engineering and Mathematics (STEM) subjects. This study aimed to identify the relationship or impact of STEM video use on student learning engagement in Malaysia. A quantitative study using survey design was conducted on 367 teachers teaching STEM subjects in Malaysia. The study data were analyzed using SPSS 20 software and the findings indicate that the level of STEM video use among teachers is high (mean = 3.65, sd = 0.48). Student engagement levels were also high (mean = 3.63, sd = 0.45). The findings also show a positive

relationship between STEM video use in teaching and learning and student learning engagement (r = 0.685. Sig. = 0.00).The study might have implications for teaching and learning process and the policymakers in framing future strategies in teaching STEM subjects. In conclusion, teaching using STEM video has an impact on student learning engagement.

Keywords

Multimedia, Impact of STEM Video, Students' Learning, STEM, Teaching and Learning

1. Introduction

Malaysia is a country that is growing rapidly along with the development of globalization at the present time. In the direction of world-class education, Malaysia needs to bring a change that will give an impression to the world of education. Among the most recent changes in the world of education in Malaysia is the use of information technology in teaching and learning. Malaysian Minister of Education, Dr. Maszlee Malik in news report Bernama on 5 July 2018 states:

'Educators should strive to convey efficient teaching and learning through technology'.

The above statement clearly shows the importance of using technology in delivering effective teaching. It is because, lately, the explosion of information technology has developed so well.

The use of information technology such as computers, smart phones and tablets in teaching and learning is a must in 21st Century. Using video in teaching and learning is one of the strategies that can enhance students' learning. Students' understanding of the subject is improved effectively as they get a clearer picture of what they are learning through their senses. As a result, students' learning and their academic performance is improved.

This is also in line with Jean Piaget's Cognitive Learning Theory that explained how a child constructs a mental model of the world (Wadsworth 1996). This method of learning is active, constructive and long lasting that also encourages students to fully engage in the learning process. By this way, learning, thinking and remembering get easier. One of the examples of the cognitive learning strategies is using visualizations to improve students' understanding and recall. Therefore, using videos in teaching and learning is a part of the strategies.

2. Background

The Malaysian Education Development Plan 2013-2025 (PPPM 2013-2025) clearly states that the use of information and communication technology (ICT) has greatly benefited in improving

the quality of learning in Malaysia (Ministry of Education Malaysia 2013). In this plan, the government will provide internet access and virtual learning environments through 1BestariNet for all 10,000 schools by 2013. In the future, all students will have access to the school's 4G network through 1BestariNet. The network serves as the foundation for building a virtual learning platform that teachers, students, and parents can use to share learning resources, implement interactive learning, and communicate effectively.

Malaysia has gone through three phases in the country's policy of science and technology development. The three fundamentals are:

1. Formulation & Implementation of the First National Science & Technology Policy (1986 - 1989) focusing on efforts to enhance the independence of scientific and technological capabilities to assist economic activity.
2. Technology Industry Development: A National Action Plan (1990 - 2001) that emphasizes Science, Technology, Engineering and Mathematics (STEM) Education in student development through innovative and creative thinking in a competitive global economy. A variety of creative and innovative ways can be applied through the use of meaningful learning contexts and relevant to the real life of students through the Engineering Design approach in the pursuit of critical and creative thinking.
3. The Second National Science & Technology Policy and Action Plan (2002 - 2010) focusing on efforts to enhance scientific and technological independence to assist economic activity by creating a good environment to encourage scientific creation and improve infrastructure in the field of scientific, education and other related fields.

Teaching using STEM video is one of the steps of the Ministry of Education in its initiative to promote Science, Technology, Engineering and Mathematics (STEM) in Malaysia. In addition, these interactive STEM videos strongly encourage the involvement of more holistic teachers and students in teaching and learning. This is because the use of multimedia like STEM video is a 21st Century Learning Strategy that emphasizes on elements such as communication, collaboration, critical thinking, creativity and the application of pure and ethical values. Therefore, this study was conducted to determine the extent of STEM video usage among teachers in Malaysia. In addition, student involvement in STEM video learning is also identified. Furthermore, this study identifies the impact of using STEM video on student learning engagement. Finally, suggestions were made to

enhance the effectiveness of STEM video use on students, especially in terms of students' understanding, attitudes and interest in STEM subjects.

3. Problem Statement

Lately, the number of students enrolled in the science stream at school or university level has been alarming. In fact, data from the Malaysian Examination Board shows that the number of students taking STEM subjects in the Malaysian Certificate of Education (SPM) exam is decreasing based on the comparison between 2016 and 2017 (Ministry of Education Malaysia 2017). This data is supported by data from the Ministry of Higher Education which shows that the number of students taking STEM fields at matriculation level decreased between 2016 and 2017 from 9082 to 9033 (Ministry of Higher Education 2017). In terms of academic achievement, data from the Malaysian Examination Board showed that the average STEM subjects had a Grade Average above 3.00 (Ministry of Education Malaysia 2017). This reflects the low level of science awareness among Malaysians students and an effort should be made to overcome this problem.

As a result, Malaysia still lags behind in international competition especially in the fields of Science and Mathematics. This is evident from Malaysia's achievements in the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA). At TIMSS 2015, Malaysia ranked 22nd in Mathematics and 21st in Science out of the 39 participating countries. The same is true for PISA where Mathematics scores are 421 (OECD average is 494), Science score is 420 (OECD average is 501) and Reading score is 398 (OECD average is 496) (Ministry of Education 2015).However, the achievements of PISA in 2018 show an increase in achievement in Reading literacy (415), Mathematics literacy (440) and Scientific literacy (438). These figures are closer to the OECD international average of 487 for Reading literacy and 489 for Mathematical and Scientific literacy respectively (Ministry of Education Malaysia 2019).

As such, the Ministry of Education Malaysia (KPM) has taken steps and developed strategies to identify teaching methods that can enhance students' understanding of science concepts. Among these initiatives are the provision of interactive STEM videos that enhance students' cognitive abilities. In 2016, the Division of Residential Schools partnered with Universiti Teknologi Malaysia (UTM) to provide 18 STEM videos as teaching aids for use in secondary schools. This effort is being made to support the STEM strengthening initiative with a vision to produce quality human capital to

meet the needs of the country in the field of STEM and to meet the challenges of the world with the application of STEM subjects.

4. Objectives

The objectives of this study are:

1. Identify the level of use of STEM video in teaching and learning of teachers.
2. Identify the level of engagement of student learning on STEM subjects.
3. Identify the relationship between STEM video use in teaching and learning and student learning engagement.

5. Research Questions

1. What is the level of STEM video use in teaching and learning of teachers?
2. What are the levels of student engagement after using STEM video?
3. What is the relationship between the use of STEM video in teaching and learning and student learning engagement?

6. Hypothesis

Based on the third research question, the following research hypotheses are constructed:

Ho1: There is no relationship between the use of STEM video in teaching and learning and student learning performance.

7. Literature Review

Video-based teaching is an important innovation in teaching and learning. This is because the use of video in teaching can build students' cognitive skills. According to the cognitive theory of multimedia learning, the human information processing system involves two channels: visual and verbal processing in which each channel has limited capacity to process. According to this theory, a set of cognitive processes will occur and be coordinated during the active learning process (Mayer 2014). In other words, there are three assumptions in this multimedia cognitive theory namely two channels, limited capacity and active processing. Figure 1 shows the cognitive model of multimedia learning that shows the human information processing system.

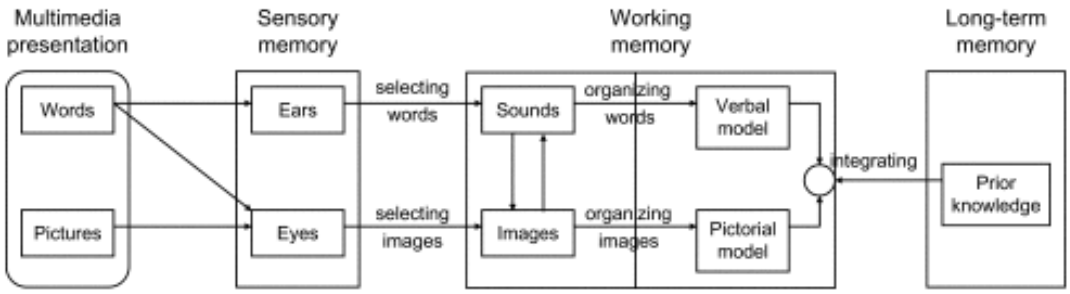

Figure 1: *Cognitive Theory of Multimedia Learning (Mayer 2014)*

Many studies have been conducted to study the effects of video use on student learning (Harwood et al. 1997; Zhang et al. 2006; Hamizan & Zaid 2014; Ekanayake & Wishart 2014; Guy, R., & Marquis 2016; Mohd Fazly 2016). Most of these studies show the positive impact of video use on student learning. The use of interactive video in teaching demonstrates improved academic achievement (Harwood & Mc Mohan 2014; Guy & Marquis 2016), attitude (Harwood & Mc Mohan 2014) and student interest (Mohd Fazly 2016). Zhang et al. (2003) conducted an interactive video use study on the effectiveness of student learning. This study of 138 university students in the United States used experimental design. The results show that the use of interactive video can improve student performance and satisfaction. The same impact was also shown in Harwood and McMohan's (2014) study. They conducted a quasi-experimental study of 450 students in grades 9-12 to study the effects of attitude and achievement on chemistry subjects. The findings show that there is a positive relationship between teaching using video and achievement and students' attitude towards the subject of chemistry. Studies on BLOSSOMS videos have shown that BLOSSOMS videos can increase the level of understanding and critical thinking of science concepts among students (Hamizan & Zaid 2014). The concepts of science can be understood clearly and effectively when they are connected to real life outside the classroom. Therefore, the use of BLOSSOMS or STEM videos that apply science learning to real life outside of the classroom has improved the understanding of student science concepts.

STEM videos are interactive videos that are divided into several segments. The division of these segments makes it easier for students to understand the concepts they want to convey. This makes learning more effective and enhances student performance in terms of their interests, attitudes and achievement. According to Mohd Fadly (2016), the use of segmented video techniques can enhance student interest and achievement. Figure 2 shows the conceptual framework for this study.

In this conceptual framework, the use of STEM video in teaching and learning is an independent variable while student learning engagement is a dependent variable.

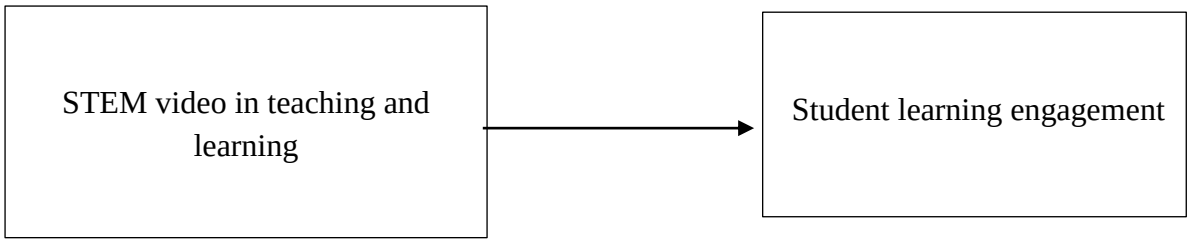

Figure 2: *Conceptual Framework*

8. Methodology

This study uses a quantitative approach with survey design as data can be collected directly from samples and can be generalized towards the population. The research instrument is a questionnaire form. The questionnaire used is divided into three sections as follows:

1. Part A: Demographics
2. Part B: The use of STEM video in teaching and learning
3. Part C: Student learning engagement after using STEM video

In this study, STEM teachers in Malaysia need to first implement teaching using STEM video. Next, they need to fill out a questionnaire in the form of a Google form submitted through their State Department of Education. The questionnaire used was constructed by the researcher using a 5 point likert scale of (1) Strongly Disagree, (2) Disagree, (3) Uncertain, (4) Agree and (5) Strongly Agree. The questionnaire was divided into 3 sections, Parts A, B and C. Section A was demographic while Parts B and C contained 10 items respectively.

Sample of this study are STEM teachers who teach in schools under the Ministry of Education Malaysia. According to the Division of Teachers Education, the population of STEM teachers in Malaysia is 39,561. In the survey method, the sample is selected from the population and generalized to the population (Creswell 2012). The sample of this study was determined using stratified random sampling technique. In stratified random sampling, populations were divided into groups of similar or homogeneous nature, and samples were randomly selected from each group (Cohen, Manion & Morrison 2007; Airasian & Gay 2003). This sampling technique was chosen

because schools in Malaysia are not uniform in terms of location and gender of teachers. Determination of sample size is based on the table of sample size proposed by Krejcie and Morgan (1970). Thus, out of a population of 39,561 STEM teachers, 380 teachers were selected.

Before analysis is performed, data is cleaned to remove outliers. Normalization tests were also performed to ensure that the data were normal. The quantitative data obtained were analyzed descriptively using SPSS version 20 software to find the percentages, mean and standard deviations. Data were also analyzed using statistical inference using Pearson correlation to identify the relationship between STEM video use in teaching and learning and student learning engagement.

9. Finding

This section will describe all the results of the quantitative analysis. Quantitative findings refer to the findings from the survey data. The findings of this study are based on the research questions and the hypotheses of the study.

9.1 Demography

After the data cleaning process, only 367 people were involved in the study sample. Of these, 110 were male and 257 were female. In terms of school location, 200 people teach in the city while 167 people teach in the rural.

9.2 Level of STEM Video Use in Teaching and Learning of Teachers

The first research question concerns the level of STEM video use in teachers' teaching and learning. The findings show that overall Malaysian teachers use STEM video in teaching and learning at a high level (mean = 3.65, sd = 0.48). Table 1 shows that out of 10 items, the item of STEM video application relate the concepts taught to the real situation in daily life is the highest mean value (min = 4.00, sd = 0.59). While the item teacher often use STEM video in the teaching and learning is the lowest mean (mean = 3.17, sd = 0.79).

Table 1: *Level of STEM Video Use in Teaching and Learning*

ITEM	N	Mean	SD	LEVEL
I often use STEM videos in my teaching and learning	367	3.17	0.79	Moderate
My teaching is more interactive when using STEM video applications	367	3.77	0.67	High
STEM video applications can enhance the effectiveness of my teaching process	367	3.90	0.60	High
The STEM video app allows me to relate concepts taught to real life situations	367	4.00	0.59	High

I can customize STEM videos in my teaching	367	3.70	0.68	High
I was able to solve the problem of understanding STEM-related concepts when using STEM Video	367	3.85	0.65	High
I was able to do the practical activities suggested in the STEM video	367	3.40	0.75	Moderate
STEM video applications make it easy for me to monitor student learning activities	367	3.61	0.67	High
I share STEM videos with students before they can be implemented	367	3.25	0.81	Moderate
I'm going to use STEM videos in the future	367	3.89	0.65	High
OVERALL	367	3.65	0.48	High

Indicator: mean 1.00-2.50 low, mean 2.51-3.50 moderate, min 3.51-5.00 high

9.3 Level of Student Learning Engagement

The second research question concerns the level of student engagement after teaching using STEM video. The findings show that overall student engagement is high (mean = 3.63, sd = 0.45). Table 2 shows that out of the 10 items, the item of students' were able to relate what they learned to the real situation in their daily lives is the highest(mean = 3.96, sd = 0.57). While the of student also used STEM video outside teaching and learning is the lowest (mean = 3.07, sd = 0.88).

Table 2: *Level of Student Learning Engagement*

ITEM	N	Mean	SD	LEVEL
My students enjoy performing inquiry exploration activities	367	3.82	0.63	High
My students can relate what they learned to real life situations	367	3.96	0.57	High
My students became more active in learning activities	367	3.89	0.56	High
My students can answer the questions correctly	367	3.54	0.63	High
My students also use STEM videos outside the classroom	367	3.07	0.88	Moderate
My students' understanding of STEM topics improved	367	3.46	0.67	Moderate
My students can reflect on their learning	367	3.54	0.62	High
My students show a collaborative attitude while doing practical work	367	3.79	0.63	High
My students can explain math / science concepts accurately	367	3.59	0.61	High
My students love that I use STEM videos in difficult topics	367	3.66	0.69	High
OVERALL	367	3.63	0.45	High

Indicator: mean 1.00-2.50 low, mean 2.51-3.50 moderate, min 3.51-5.00 high.

9.4 Relationship between the Use of Stem Video in Teaching and Learning and Students' Learning Engagement

The relationship between STEM video use in teaching and learning and students' learning engagement is described in the findings. Table 3 shows the results of the Pearson correlation test between the STEM video use in teaching and learning and student learning engagement. The findings show that there is a relationship between the use of STEM video in teaching and learning and student learning engagement ($r = 0.685$, $sig = 0.00$) and therefore Ho1 was rejected.

Table 3: *Relationships between STEM Video Use in Teaching and Learning and Student Learning Engagement*

		Teaching Using STEM Video	Students' learning engagement
Teaching Using STEM Video	Pearson Correlation	1	.685**
	Sig. (2-tailed)		.000
	N	367	367
Students' learning engagement	Pearson Correlation	.685**	1
	Sig. (2-tailed)	.000	
	N	367	367
**. Correlation significant at the level of 0.01 (2-tailed).			

10. Discussion

The findings show that all STEM teachers use STEM videos in their teaching and learning at a high level. However, the frequency of the use of STEM videos is moderate. This is because the existing video source does not cover all the topics in the syllabus. At the same time, the implementation of the practical activities suggested in STEM video is also at a moderate level. This is likely because the teacher did not refer to the teacher's guide provided in the STEM video. This results in teachers having trouble managing the time suggested of teacher guide section. This finding is in line with the studies of Roslina (2001) and Ros Ayu (2007) who found time to be a major constraint in the implementation of Practical Assessment.

On the other hand, the findings of the study on the effectiveness of teacher teaching process and the relation of STEM concepts to everyday life are high. The justification is that the practical activities in STEM videos are tailored to the real-life situations. This study is in line with the study of Hamizan and Zaid (2014) who found that the concepts of science can be understood clearly and effectively when linked to real life situations. The use of STEM video also makes it easier for

teachers to monitor student activity because of the interactive and student-centered nature of STEM video. This is supported by the findings of this study which show monitoring student activities is high. Similarly, aspects of STEM video that make teaching and learning more interactive are also at a high level. Clearly, STEM video can make teaching more interesting because it is more student-centered than traditional teacher-centered teaching. This study was supported by Meyers and Jones (1993) who found that student-centered learning using video had an impact on increasing motivation for learning.

This study also shows teachers agree to use STEM video in the future. This is shown by the findings of high-level STEM video use. The level of agreement shows that STEM video has a high impact on teachers and students. This is because STEM videos are well organized and systematic to help teachers convey concepts in an interesting, easy to understand and interactive way. The findings also show that students enjoy engaging in inquiry exploration activities. This is because students can engage in a variety of interactive activities including touch, hearing, smell, taste and sight through the activities provided in the STEM video. This finding supports the findings of Zamri Mahamod (2017) which found that students can better learn through cooperative learning rather than using chalk and talk. Through cooperative learning, their level of understanding and academic achievement increases as well as social and intellectual skills. Students also become more involved in learning activities through teaching using STEM videos. Indirectly, learning to use STEM video enhances students' interest in discovering new information and generating ideas for creating something new. In short, STEM video is one of the most interactive, flexible and easy to use.

The findings also show an increase in the level of understanding and critical thinking of science and mathematical concepts among students. Students understand the topic more clearly because the video provided is divided into several segments according to the difficulty level. Student activities can also be associated with daily life. By reinforcing a clear understanding of the concepts of science and mathematics, students are able to reflect accurately. Thus, the use of STEM video can solve the problem of students who think science and math subjects are difficult to be learned (Teng 2002; Rojahan 2004).

The findings of this study also show a high degree of collaborative attitude towards students as they can contribute ideas to solving problems presented in STEM videos and to draw conclusions correctly. However, students are unable to use STEM video outside of the classroom due to internet

access restrictions in a limited area. The problem still exists because not all students have desktops or laptops equipped with internet facilities at home (Hasliza Hashim et al. 2016).

Overall, the use of STEM video in teaching and learning has a positive impact on student learning engagement. This can be proven by the analysis of the correlation between the use of STEM video in teaching and learning to student learning engagement where the coefficient (r) is 0.685. The findings of previous studies also support the findings of this study in which teaching using video has a positive impact on student learning (Harwood et al. 1997; Zhang et al. 2006; Hamizan & Zaid 2014; Ekanayake & Wishart 2014; Guy, R., & Marquis 2016; Mohd Fazly 2016). As such, STEM videos should be widely used in every teacher's teaching and learning process.

11. Suggestion

Based on the findings of the study, there is a positive relationship between the use of STEM video in teaching and learning and student learning engagement. Thus, the following suggestions are presented: (i) increasing the number of STEM videos to accommodate the shortage of existing STEM videos, (ii) increasing the allocation to produce more STEM videos in the future, (iii) provide teachers with skills to develop STEM videos in accordance with established guidelines, (iv) distribute STEM video collections in compact disc (DVD) format to enable teachers to access video content in collaboration with stakeholders, (v) provide STEM video use roadshows to STEM trainers, (vi) ensure school administrators, principals and teachers and senior assistants know and encourage STEM video use in teaching and learning through training of school administrators and (vii) subsequent studies will take into account the application of STEM culture and the improvement in student academic achievement.

12. Conclusion

Using STEM video is one of the best practices in STEM teaching and learning. Through the use of STEM video, students can integrate STEM concepts with daily life activities. Thus, this method can change people's perception of STEM subjects especially in Malaysia. This study might have implications on students, teachers and stakeholders. Teachers need to use STEM videos for students' interest in STEM subjects. When students show interest, learning becomes more meaningful and at the same time improving their academic performance. The stakeholders especially Ministry of Education should also review the educational curriculum involving classroom teaching and learning

strategies. However, this study is limited to the use of STEM videos and STEM subjects only because the development of this video has been designed to facilitate students' understanding of STEM subjects. Thus, further research should involve subjects other than STEM and include experimental studies to determine the effectiveness of video use on students' academic achievement.

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