The Evaluation of The Effectiveness of The Interactive Multimedia Weblog Coursewere in The Learning of Hydrology Engineering

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Abstract

This study aimed to assess the effects of learning using an interactive multimedia weblog courseware with the conventional method in the learning of hydrology engineering. A quasi-experimental study was conducted to evaluate the high-level cognitive skills achievement based on the Bloom and Anderson taxonomies. The study sample comprised 105 students who were taking the hydrology engineering course. The ANOVA analysis showed a significant difference in the high-level cognitive skills achievement which were high-level short-term memory and high-level long-term memory. The conclusion was that the study findings indicated that the interactive multimedia weblog courseware was more effective as an alternative learning method compared to the conventional method; in fact its usage could support an abstract and complex learning approach which could contribute positively towards learning achievement in hydrology which had been viewed as a difficult to score course.

Keywords: - Weblog, interactive, multimedia, hydrology engineering, cognitive

1. Introduction

The transformation of the Technical and Vocational Education and Training is necessary in opening job opportunities in the engineering field. Engineering is a field which is rapidly expanding in line with the growth of Information and Communication Technology. The engineering field involves graphics, visuals via activities such as the designing and preparation of engineering, technical and geometric drawings. As such, the skill of thinking visually and sharing visually with other people is vital in the designing process for it to be transferred into the real world (Bhaduri and Matusovich, 2017). The engineer should have oral communication skills, graphic language and mind visualisation skills to develop products in the real world. These abilities dominate the technical, vocational and mathematics education as well as the career world (Devereux, 2013). Realistically, the ability to understand graphic and visual language is an important foundation as the skills to design mental images for an abstract object such as size, form, texture, point, straight line and location of an object in a specific space is difficult to be delivered verbally (Jing, 2017).

In line with the development of technology, teaching and learning methodology has also transformed towards the use of multimedia technology usage as an alternative to the conventional method. Via this technology, the students' visualisation process develop through the building exercises using geometry tools manually and automatically (Ariffin et al., 2017 and Yang et al., 2018). A few approaches in computer-assisted learning have been identified such as cube modelling (Zarei et al., 2016), parametric modelling (Kouyoumdjian, 2012), 3-dimensional computer modelling and computerised animation (Suwandi & Istiyono, 2013), learning courseware (Liu, 2017), virtual reality, internet, web or online (Armani, 2016) and rapid prototype (Mendez and Mendez, 2019). These approaches have directly contributed to students through visual experience and able to attract students' attention in learning.

1.1 Study Objective

The main study objective was to assess the difference in high level cognitive effects in an interactive multimedia weblog courseware with the conventional method in the learning of Hydrology Engineering.

1.2 Problem Statement

Based on the study objectives, the research questions to be answered are listed below:

i. is there a significant difference in terms of high-level short-term memory achievement scores which utilised the interactive multimedia weblog courseware compared to the conventional method?
ii. is there a significant different in terms of

high-level long-term memory achievement scores which utilised the interactive multimedia weblog courseware compared to the conventional method?

1.3 Research Hypothesis

Based on the study questions, the study hypotheses are listed as below:

Ho1- There is no significant difference in terms of high-level short-term memory achievement scores in the group which utilised the interactive multimedia weblog courseware compared to the conventional method.

Ho2- There is no significant difference in terms of high-level long-term memory achievement scores in the group which utilised the interactive multimedia weblog courseware compared to the conventional method.

Ho3- There is no significant difference in terms of high-level short-term memory achievement scores in the group which utilised the interactive multimedia weblog courseware with the conventional method.

Ho4- There is no significant difference in terms of high-level long-term memory achievement scores in the group which utilised the interactive multimedia weblog courseware with the conventional method.

2. Literature Review

In order to produce enough human capital in science and technology, the Technical and Vocational Education and Training (TVET) had also increased student intake and built universities based on technical and vocational education to fulfill the increasing job market. The re-structuring of the technical and vocational system had been implemented to increase the intake from 10 percent to 20% in 2020 (Othman et. al., 2013). However, the problem of students' achievement in the technical field may arise due to some factors in teaching and learning. These factors include aspects such as technical content which is too abstract and complex, examination focus, the teachers' weakness in mastering high level thinking skills and lack of teachers in the technical field (Lammi and Beaker, 2013).

The students' decreasing achievement and acceptance in the learning process were attributed to the teachers' inefficiency in giving understanding and channeling the right knowledge. As such, a mistake in the teaching and learning process would be the main problem which caused teachers to fail in applying their knowledge in the actual teaching. Farhad et. al. (2013) stated that a teacher's positive attitude could help to increase the skills in students' achievement; it was also noted that problems could result from the teachers' weakness in presenting the teaching and learning (Wiley et al., 2014). As such, the lecturers should equip and master the latest skills such as interactive media skills so that the teaching and learning process becomes more effective for students to be interested in mastering the knowledge.

In this modern era, traditional learning has been attributed as being less effective to a classroom's teaching and learning process (Korbach et al., 2016). The oral delivery method seems to be less impactful for disseminating visual information to students as they would face difficulties to picture that information in their minds. The failure to understand the correct concepts would cause students to only memorise them without understanding the subject content, making them unable to explain the concepts in test and quizzes. A limited resource list would cause the students' cognitive load to increase during self-learning concepts. An excessively heavy load in the work memory would cause some information to be lost and students face the difficulty to store the information in long-term memory during the self-learning process (Kalyuga, 2011).

However, Kuo et al. (2017) stated that there was no significant difference between multimedia software-based learning with the traditional method. A thorough study by the Perbadanan Multimedia Malaysia (MDEC) found that the multimedia courseware did not fulfill the teaching and learning needs in schools (MDEC, 2008). As such, the multimedia development and improvement could not be continued. On the other hand, it was discovered that the use of interactive media could contribute towards the development of students' high-level cognitive skills (Lam et al., 2016). A meta-study by Liao (Zarei et al., 2016) showed that the multimedia courseware usage was more effective compared to the traditional learning method.

3. Methodology

This section discusses the study design, study sampling, study variables, research instruments, research procedure and data analysis utilized to achieve the study objectives. The study was quantitative in design with a quasi-experimental approach using a pre-test and post-test (Creswell, 2014).

The quasi-experimental strategy was conducted by dividing the existing group into the conventional and treatment groups for the pre-test and post-test for both groups. The pre-test was conducted for both groups and then the two groups received two learning; this was followed by the short-term memory test as soon as the students ended their study sessions. The high-level long-term memory test was administered after 30 days of the students'

reception of both learning modes. The research design is shown in Figure 1 below.

Group	Pre test	Treatment	Post test	Post test
WMI	O_1	→ X_1X_2 →	O_2 →	O_3
PKK	O_1	→ X_1X_2 →	O_2 →	O_3

Figure 1: Research design

O_1: Pre-test
X_1: Conventional Method Learning (PKK)
O_2: High-Level Short-Term Memory Test
X_2: Interactive Multimedia Weblog Learning (WMI)
O_3: High-level Long-Term Memory Test

This study utilized the simple sampling method (Azura et al., 2012). The study population was selected from students who were studying in the Civil Engineering Diploma course in Malaysian polytechnics. The researcher had selected Kuching Polytechnic in Sarawak as the experiment sample. The study sample comprised 105 male and female students chosen from the existing lecture groups. These groups were then chosen randomly to ascertain the groups which would undergo the Interactive Multimedia Weblog Learning treatment. A lecture group was also selected as the control sample where the students were taught using the conventional method.

The study variables were the independent and dependent variables. The independent variables were the two learning modes to be utilized: (1) The treatment group with the Interactive Multimedia Weblog courseware (KWI). The first group of students were selected to undergo the hydrology engineering learning using the Interactive Multimedia Weblog courseware (n = 55), (2) The second group which utilized the conventional method in learning hydrology engineering (n=50) and this was also the control sample. Additionally, there were 2 dependent variables utilized: (1) Students' high-level short-term memory scores acquired via the post-test and this was administered as soon as the students completed their learning using the Interactive Multimedia Weblog courseware. (2) Students' high-level long-term memory scores acquired via the high-level long-term memory test administered after 30 days of the students' acceptance of the treatment using the Interactive Multimedia Weblog courseware.

The data collection procedure was conducted using a pre-test, a high-level short-term memory test and a high-level long-term memory test. The pre-test was administered before the treatment group students went through the Interactive Multimedia Weblog courseware and the control group students went through the conventional method. The pre-test consisted of pen and paper tests which would test the students' knowledge of hydrology engineering. The time period for the pre-test was 30 minutes. The high-level short-term memory test and the high-level long-term memory test were also pen and paper tests. the students had to answer in the space provided. The time for these tests were 120 minutes. Meanwhile, the high-level long-term memory test was administered after 30 days of the students' treatment using the Interactive Multimedia Weblog courseware and the control group had gone through the conventional method (Rosinah, 2012).

The study instruments used were the pre-test, high-level short-term memory test and high-level long-term memory test which were constructed by the researcher with the help of the expert lecturers who were teaching the hydrology engineering courses. The question content from topic 1 to 6 was divided into Section A – Structure Questions and Section B – Essay questions. The combination of questions was based on previous research (Chua, 2012) following the Blooms taxonomy level of difficulty as shown in Table 1. The breakdown of questions could be seen in Table 2. All questions were constructed to test the students' knowledge and skills using the Blooms Taxonomy difficulty level. The time given was 120 minutes. The content validity and reliability of the test items were checked by 2 experts who had 5 years' experience. The high-level long-term memory test was administered after 30 days of the students' treatment using the Interactive Multimedia Weblog courseware and the control group had gone through the conventional method. This time period was chosen based on the Ebbinghaus memory curve and previous studies related to memory retention (Azraai and Othman, 2015).

Table 1: Blooms Taxonomy (Revised version) (Anderson & Krathwohl, 2001).

Cognitive Process (Original)	Cognitive Process (Revised)	Cognitive Level
Knowledge	Remembering	Low
Understanding	Understanding	Low
Application	Application	High
Analysis	Analysis	High
Synthesis	Evaluation	High
Evaluation	Creation	High

The study implementation procedure was started with 105 students who were chosen from the existing lectures and they had to sit for the pre-test 14 days before the Interactive Multimedia Weblog treatment. The 14 days period between the pre-test and the treatment was to ensure that there was no remaining memory of the pre-test questions on the post-test scores. The run test was conducted to ensure that there were no technical issues related to the installed courseware. The students were instructed to start their learning with the interactive multimedia weblog courseware. The learning process was 120 minutes. The post-test which

contained questions for the high-level knowledge short-term memory test was administered as soon as the students had gone through the treatment. After 30 days, the students then sat for their high-level long-term memory test.

Table 2: Breakdown of Test Questions According to Blooms Taxonomy.

Type of Question	Question Number	Cognitive Process Dimension	Cognitive Level
Structure	Question 1	Application	High
	Question 2	Application	High
	Question 3	Application	High
	Question 4	Analysis	High
	Question 5	Analysis	High
	Question 6	Analysis	High
Essay	Question 7	Evaluation	High
	Question 8	Evaluation	High
	Question 9	Creation	High
	Question10	Creation	High

The SPSS software with the M*ultiple Analysis of Covariate* (MANCOVA) analysis method would be utilized for the data analysis procedure. The pre-test scores would be used as the covariate.

The MANCOVA method was chosen as the study involved two dependent variables (Chua, 2012) which were the high-level knowledge short term memory test scores and the high-level knowledge long term memory test scores. The covariate method was chosen to ensure that the two groups were equivalent in terms of their existing knowledge.

4. Finding and Analysis

The quasi-experiment was conducted to assess the difference in the effects of using an interactive multimedia weblog courseware compared to conventional method with dependent variables. The data analysis method for the testing of all hypothesis was done using MANCOVA and ANOVA (Chua, 2012). A total of 105 respondents were divided randomly into 2 groups of different learning modes based on the existing classes.

4.1 Covariate Analysis

The covariate analysis was administered before the implementation of the experiment by making the pre-test as the co-variate. The Alpha Cronbach reliability value for the pre-test was 0.882 showing that the covariate was in an acceptable reliability range (Pallant, 2011). Meanwhile, the Pearson's test at a meaningful level of 0.05 was conducted to ascertain the relationship between dependent variables and the covariate. The Pearson's test showed that the two variables were significant with the scores for the high-level short-term memory test ($r=0.425$, $p<0.05$) and the scores for the high-level long-term memory test ($r=0.267$, $p<0.05$). Additionally, a one-way variance analysis was also conducted to test whether the two groups were homogeneous in terms of the basic knowledge of hydrology engineering. The analysis showed that there was no significant difference in terms of the basic knowledge of the respondents for the two groups ($F=0.361$, $p=0.659$).

Table 3: The Pre-Test Results with One-Way ANOVA According to The Learning Modes.

Source	Average Square $\bar{x}$	Total sum squared $\sum_k^n = 0^{x^2}$	*df*	*f*	*Sig.*
Between group	2.449	2.449	1	0.36	0.659
In Group	8.217	1002.73	104		
Total		1005.86	104		

4.2 MANCOVA Assumptions

The usage of MANCOVA in this study referred to the pre-test as the covariate which showed that there was no significant difference in terms of basic knowledge for both learning modes (Chua, 2012). The usage of MANCOVA must fulfill three assumptions which are:

i. The assumption should not be dependent; each respondent in group should be different.
ii. The variance-covariance matrix should be equivalent for the treatment group; this assumption is determined using the Box's M test was not significant ($p>0.001$).
iii. All dependent variables fulfill the multivariate normal distribution, the normal distribution for every dependent variable using the multivariate distribution in the Kolmogorov-Smirnova and Shapiro-Wilk tests. This test showed that ($p<0.05$) was significant and thus fulfilled the normal distribution.

Table 4: Results of Box's M Covariate Matrix Equivalent.

Box's M	79.708
f	1.745
df1	40
df2	25876.535
Sig.	0.002

4.3 Hypothesis Testing

Ho1-There was no significant difference in terms of the high-level short-term memory scores in the group which went through the interactive multimedia weblog courseware and the conventional method.

Table 5: Findings of Normal Distribution Test.

Dependent variable	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistics	*df*	*Sig.*	Statistics	*df*	*Sig.*
High level Short-term memory test	0.196	105	0.000	0.769	105	0.025
High level Long-term memory test	0.157	105	0.010	0.994	105	0.000

Based on Table 6, the ANOVA univariate analysis findings conducted showed a significant difference for the high-level short-term memory scores in the group which received the interactive multimedia weblog courseware treatment and the conventional method (F=5.235, p=0.003). The significant difference in the group which received the interactive multimedia weblog courseware treatment and the conventional method indicated that the first hypothesis H01 should be rejected.

Table 6: ANOVA Findings with Learning Mode with Pre-Test as Covariate.

Learning mode (Difference test)	Dependent variable	*df*	*f*	Value of *Sig.*	H_n	Results
Conventional method and Interactive multimedia Weblog courseware	High level Short-term memory test	1	5.235	0.003	H_O1	*Sig.*
	High level Long-term memory test	1	3.731	0.001	H_O2	*Sig.*
	High level Short-term memory test	1	7.457	0.003	H_O3	*Sig.*
	High level Long-term memory test	1	5.953	0.001	H_O4	*Sig.*

Ho2-There was no significant difference in terms of the high-level long-term memory scores in the group which went through the interactive multimedia weblog courseware and the conventional method.

The ANOVA univariate analysis conducted showed a significant difference for the high-level long-term memory scores in the group which went through the interactive multimedia weblog courseware and the conventional method (F=3.731, p=0.001). The significant difference in the group which received interactive multimedia weblog courseware and the conventional method indicated that the second hypothesis Ho2 should be rejected.

Ho3- There was no significant difference in terms of the achievement of the high-level short-term memory scores in the group which went through the interactive multimedia weblog courseware and the conventional method.

The ANOVA univariate analysis conducted showed a significant difference for the achievement of high-level short-term memory scores in the group which went through the interactive multimedia weblog courseware and the conventional method (F=7.457, p=0.003). The significant difference in the group which received interactive multimedia weblog courseware and the conventional method indicated that the third hypothesis Ho3 should be rejected.

Ho4-There was no significant difference in terms of the achievement of the high-level long-term memory scores in the group which went through the interactive multimedia weblog courseware and the conventional method.

The ANOVA univariate analysis conducted showed a significant difference for the achievement of the high-level long-term memory scores in the group which went through the interactive multimedia weblog courseware and the conventional method (F=5.953, p=0.001). The significant difference in the group which received interactive multimedia weblog courseware and the conventional method indicated that the fourth hypothesis Ho4 should be rejected.

4.4 Discussion of Finding

The main aim of the study was to assess the effects of the usage of the interactive-me multimedia weblog courseware which had been developed with the conventional method in the learning of hydrology engineering. The experiment using the achievement test was conducted to assess the effects of learning using the courseware and the conventional method on the achievement of the high-level short-term memory test and the high-level long-term memory test in hydrology engineering. The high-level short-term memory test was conducted as soon as the students had completed their learning for both learning modes. On the other hand, the high-level long-term memory test was measured using the learning mode which had been administered after 30 days.

The experiment findings showed that there was significant difference in the high-level short-term memory test scores and the high-level long-term memory test for the group which received the courseware treatment and the conventional method. This was due to the features of interactivity and exploration which assisted the students to learn the hydrology engineering course by lessening the extra cognitive load. A smaller cognitive load would enable the working memory to utilize the working memory capacity in doing active processing. A significant cognitive load difference would explain why the group which received the courseware treatment had better impact in the students'

acquisition of high-level knowledge.

The high-level knowledge acquisition focuses on the students' ability to answer high-level cognitive questions according to Bloom's taxonomy which includes the levels of application, analysis, evaluation and creation. The factors which contributed towards a significant difference between the high-level knowledge acquired using interactive multimedia weblog courseware and the conventional method was the teaching strategy to acquire higher level knowledge. According to Liu (2017), learning which involves many components being processed simultaneously in the working memory and the students can handle non-routine learning like reasoning, transferring and combining procedures from many sources would be categorized as acquiring high-level knowledge. This is supported by Fleck (2012) who stated that tasks such as solving problems required students to coordinate the connecting of information in the working memory.

Based on the findings, the reduced cognitive load in the interactive multimedia courseware learning through the interactive and exploring features could help students in acquiring high-level cognitive knowledge. This statement is supported by Yung and Pass (2015) who stated that existing mastery or good schemata could help in the application and solutions in the classroom. Improper control of usage would reduce the learning for students with low knowledge in a user-controlled learning (Stull and Hegarty, 2015). This is supported by Buckley et al., (2019) who stated that high-level cognitive skills are not only acquired through technical teaching, but they should also be followed with exercises and examples of problem solutions. Additionally, the high-level cognition acquisition is also influenced by instructional strategies integrated in the prepared multimedia.

This study findings supported the view of Omrod who explained that long-term memory depends on the students' existing knowledge. The pre-test showed that both groups had almost the same level of existing knowledge. The existing knowledge influences the students' ability to store better learning materials as they need the knowledge during the receptive information process in the working memory. The students would be able to produce a maximum coherent connection when they can connect the information received through the visual and aural channels with the existing knowledge stored in the long-term memory (Mayer, 2014).

5. Conclusion

The aim of this study was to develop and assess the difference of the effects of the interactive multimedia weblog courseware compared to the conventional method in the learning of hydrology engineering. The dependent variables were the high-level short-term memory test and the high-level long-term memory test. The quasi experiment conducted showed that there was a significant difference for the high-level short-term memory test with students who went through the courseware treatment receiving better scores compared to those who went through the conventional method. The comparison with the high-level short-term memory test also showed a significant difference between the two learning modes.

The findings indicated that the usage of the interactive multimedia weblog courseware showed more positive results compared to the conventional method to assist in the learning of hydrology engineering. Based on the findings, it was suggested that there should be more courseware utilizing interactive multimedia technology to support learning in difficult, abstract and complex subjects such as hydrology engineering, geology, meteorology, medicine, chemistry, physiology and other engineering disciplines. The interactive multimedia weblog technology is suitable to be utilized in teaching and learning to support students to achieve better based on the high level of cognition in Bloom's taxonomy (Anderson and Krathwohl (2001).

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