Enhancing Performance of Student in Web Programming using Digital Educational Comics

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***Abstract*—With the increasing demand for web developers when current and future applications are stored and accessed through the World Wide Web (WWW), web programming has become a highly rewarding career for ICT students. Hence, educators in higher education need to apply effective method in teaching web programming skills. In web programming course, retaining students' engagement due to the breadth and depth of web technology remains as one of the classroom challenges. This caused students to convey disinterest and negative attitude toward web programming subject and resulted with low performance. Therefore, this study aims to improve performance of students by implementing digital educational comics as a teaching reflection tool for the subject. An experimental study was conducted, and the findings reveal that the experimental group performs better than the controlled group in overall academic performance and pre-post test results.**

***Index Terms*—Digital Educational Comics; Student Performance; Web Programming; WWW.**

I. INTRODUCTION

Theoretical advances in cognitive science are shaped by multimedia instruction of how words and pictures facilitate teaching [1]. Comparably, comics narrate a story through a combination of image and text in sequence [2]. These characteristics clearly signify the capability of digital comics as educational tools. Thus, it was not surprising that empirical research of comics in complementing the traditional method of learning has begun since the 1940s [3], [4]. Since then, besides being undoubtedly entertaining, comics have shown to instantaneously generate students' interest to become more intellectually and aesthetically engaged [5]. Comics not only proved to have the upper hand to both heavily-illustrated novel and traditional novel [6], in fact, some conventional tools are unable to present certain themes as effective as comics [7]. Furthermore, comics are capable of addressing almost any subject, fiction and nonfiction, and all range of audiences' age [8]. As a result, comics have been embraced in massive areas from language, literary, history [9], mathematics [10], engineering [11], computer science [12], economy [13], to ethics [14]. Eventually, academic libraries continue to provide comics as useful learning and teaching resources [15].

Meanwhile in Malaysia, an analysis towards students' reading habits, Khairul Hamimah's findings [16] revealed that comics are the second most preferred reading material close to the mystery and fashion-themed content. Nurtured by numerous Malaysian readership behaviour which utterly associates reading with academic tasks [17], Khairul Hamimah's findings indicated that there is a substantial potential of utilizing comics in Malaysian tertiary institution [16]. This is because, as a form of edutainment, factors such as information recall and learning engagement contain in comics, a more engaging, rather than passive, curriculum can be potentially developed for students [18]. As learning is a productive process, edutainment provides learners having a good time with the way of creating and experiencing [19].

Accordingly, several local researchers have attempted to incorporate comics in teaching science [20], history [21], and Japanese language [22]. Overall, positive educational impact was demonstrated by the Malaysian students who participated in the mentioned studies. Determinedly, Leong and Amir Hamzah [20] stated that future comic integrated classroom activities should focus on applying constructivism methods. Hence, it is implied that digital educational comics embodies the transformation of local education landscape by aligning with Malaysian National Institute of Translation's program that endorses comics as a flexible approach to learn critical subjects and nurture creative thinking skills [23]. Thus, in assisting Malaysian students to experience constructive learning through the production of digital content, more investigation should be performed to galvanize the application, assess, and adoption of developing comics.

In summary, the emerging of comics as a solid research field, educational tool, and local support have motivated to the initiation of this study. The purpose of this research is to investigate the impact of digital educational comics as a reflection tool towards students' performance in Web Programming of BSc. Multimedia students at School of Multimedia Technology and Communication (SMMTC), Universiti Utara Malaysia (UUM). The important issues of web programming course and digital educational comics are addressed in the following section.

II. PROBLEM AND MOTIVATION OF THE STUDY

A. Overview of Web Programming Course

Web programming is a very useful skill and a rewarding career for ICT students. This is due to the increasing demand for web developers as current and future applications are stored and accessed through the World Wide Web (Web). Hence, web application development courses have mostly

become compulsory to ICT students, which not only require them to master related theories, but also competence in web programming skills and problem-solving abilities [24]. With the rapid rise of the Web, it has become critical for decision-makers in higher education to apply the effective method in teaching web development skills. Currently, on-campus students at SMMTC, UUM attend two-hour lectures followed later in the week by a two-hour practical class with computers. Different categories of web application development topics are covered consisting of web programming features, methods, and skills.

B. Problem Background

Each week, students undertake computer-based exercises, in lectures and practical, to reinforce the material for the week. The lectures complement the online materials available in UUM Online Learning portal. Online discussion is encouraged to allow further questions and explanations. Despite these efforts, students remain to find the course frustrating and demotivating. As a result, the students performed poorly in the subject (as indicated in SMMTC's grades for Web Programming subject).

This implication is resulted by the several challenges of executing of Web Programming course. First, the difficulty is caused by the breadth and depth of web technology itself [25]. In BSc. MM's Web Programming subject, it is a requisite for students to acquire skills on several web programming languages such as HTML, SGML, JavaScript, VBScript, Active X, and Real Audio technology. With a lot of web technology materials that need to be shoe-horned into a single semester program, this leads to surface learning on modern web application development.

In contrast, web programming involves successive developmental reorganizations not only of the students' naive understanding of the scripting and programming language being learned, but also of the web application as a whole [26]. Consequently, with lack of approach for deep learning that incorporates students' higher order thinking skills to transfer and make connections, students convey disinterest and negative attitude to Web Programming subject.

The second drawback is related to retaining students' engagement in Web Programming subject. As beginner students believe that learning programming is cumbersome [27], a guided reflection strategy should persuade them to deem otherwise. Although self-directed learning was previously implemented in Web Programming course, without an approach that concerns with students' interest, they would not actively participate or reflect their comprehension meaningfully. Therefore, it is proposed that the integration of didactic visual media is a potential reflection tool in maintaining students' motivation and participation in Web Programming class.

C. Proposed Solution and Motivation

To improve educational environment and engage BSc. MM students into the learning process, this study proposes an approach to incorporate digital educational comics as a motivation and reflection tool in Web Programming subject. The motivation of this project originates from the advantages of digital educational comics reviewed in past literature. There are increasing volumes of comics utilized in higher education for teaching, and the related researches have been exhibited by the recent publications in academic journals [28], [29].

Besides being undoubtedly entertaining, comics have shown to instantaneously grasp students' interest to become more intellectually and aesthetically engaged. Plus, some conventional tools are unable to present particular subject matter as efficacious as comics [30]. As a result, comics are not only a vastly motivating medium for learning language, historical and literary material [31] but they have also been embraced in science [31]-[33], mathematics [34], engineering [35], computer science [36], and many other areas. However, despite massive educational research on comics devoted to improving students' motivation, few have simulated the applicability of digital educational comic as a student-centered approach in web programming subject.

Furthermore, recent advances in comic authoring tools (software to design and develop comics) enable ubiquitous attempts for educators and students to design their own personalized comics [37]. This opens opportunity for students to design digital educational comics without artistic restrictions. Therefore, based on the discussed rewarding evidence of digital educational comics, this project intends to explore the potential of this media to improve the performance of in Web Programming students.

III. METHODOLOGY

This study adopted quasi-experimental non-equivalent control group design methods in one semester (14 weeks) duration. Purposive sampling was used, in which the sample was confined to the specific types of subject [38]. In this methodology, the study was most interested in determining whether the two groups are different after the intervention. The participants with a total of 87 undergraduate students were assigned into two groups: the experimental group that received the treatment (digital educational comic intervention) where 57 students participated in this group; on the other hand, the control group (30 students) acted as a comparison group that was not given the treatment but with typical group discussion for reflection in their classes. Figure 1 shows the overall design of the methodology implemented in this study.

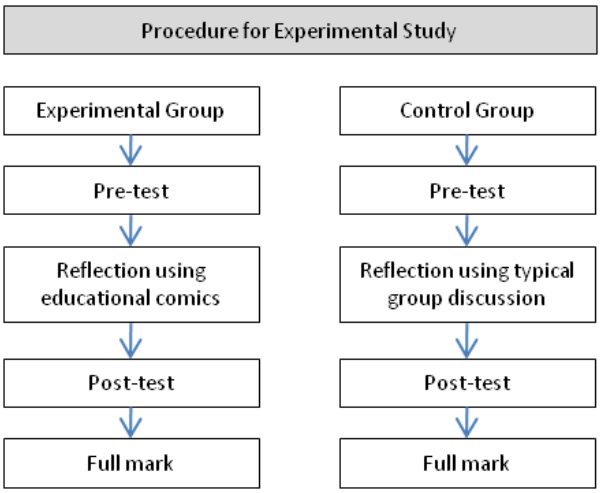

Figure 1: Overall design of the methodology.

A. Implementation of Educational Comics for Reflection

The experimental group (57 students that worked in group of 3 or 4) was instructed to use BitStrips for School comic authoring tool in producing digital educational comics (see Figure 2 and Figure 3).

Figure 2: Examples of students' submitted digital educational comics

In the digital educational comics, participants presented their understanding on selected topics (e.g. server-side script and client-side script) in web programming subject. Based on what they have learned so far in official lecture and lab sessions, the participants may refer to additional books and online resources to help them reflecting and organizing their overall idea about the topic. As reported by Engler, Hoskins, and Payne [39], since students were unable to complete their digital educational comics within the remaining class time, the composing process using BitStrips for School were preceded as home assignment.

Figure 3: Examples of students' submitted digital educational comics.

B. Data Collection

Pre-test and post-test (equal quiz-style questions to assess students' comprehension on web programming content) were conducted for both groups. The data collections were administered to the students in both groups for pre-test and post-test. The purpose was to observe if there is a significant difference in their pre-test and post-test results between groups.

Aside from that, participants' overall end semester results (Full Marks) in web programming subject were also compared for both experimental group and control group. This was to detect if there is a significant difference of Full Marks between participants who take part in digital educational comic intervention and vice versa. Essentially, results of Full Marks, pre-test and post-test are the primary criteria used to determine the impact of digital educational comics towards students' performance in web programming.

IV. Data Analysis and Findings

In general, about 64.9% of the participants were female and the remainder were male with range of age between 21 to 25 years. All students stated that they did not have any background knowledge on web programming previously.

Firstly, the data normality was assessed through Shapiro-Wilk test because of the small sample size [40]. The obtained results are shown in Table I for experimental group and Table II for control group. All sets of data are assumed not normally distributed because all the p values are less than .05. Besides that, the frequency distributions for the data are graphically skewed. Therefore, non-parametric tests were used in data analysis.

Table 1
Results of Shapiro-Wilk Test for Experimental Group

Data Set (n=57)	W	df	Sig.
Pre-test	.944	57	.009
Post-test	.949	57	.016
Full marks	.959	87	.044

Table 2
Results of Shapiro-Wilk Test for Control Group

Data Set (n=30)	W	df	Sig.
Pre-test	.902	65	.019
Post-test	.909	63	.026
Full marks	.921	78	.034

As an assessment of the findings in Table III shows there is a significant difference between the pre-test and post-test scores of the students in the experimental group (Z=-2.86, p=.004<.05). The sum of their negative ranks for the students' scores was found to be 45.50, while their sum of positive ranks is 230.50. On the basis of the results obtained, it could be argued that the use of the digital educational comics for reflection is significantly increased the academic achievement levels of the experimental group students.

Table 3
Results of Wilcoxon Signed Rank for Pre-test and Post-Test for Experimental Group

	N	Mean Rank	Sum of Ranks
Negative Ranks	6[a]	6.50	39.00
Positive Ranks	16[b]	14.41	230.56
Ties	35[c]		
Total	57		

	Post-Test - Pre-Test
Z	-2.862[b]
Asymp. Sig. (2-tailed)	.004

As seen in Table 4, findings from a Wilcoxon Signed-Ranks Test demonstrates there is no significant difference between the pre-test and post-test scores achieved by the participants in the control group (Z=-1.012, p=.052>.05). The sum of their negative ranks for the students' scores was found to be 44.00, while their sum of positive ranks is 249.12. The results show that academic achievement level of the control group students is not significantly improved.

Table 4
Results of Wilcoxon Signed Rank for pre-test and Post-test for Control Group

	N	Mean Rank	Sum of Ranks
Negative Ranks	8[a]	5.50	44.00
Positive Ranks	16[b]	15.57	249.12
Ties	6[c]		
Total	30		

	Post-Test - Pre-Test
Z	-1.012[b]
Asymp. Sig. (2-tailed)	.052

Table 5
Results of Mann-Whitney U for Full Marks in comparison between Groups

	N	Mean Rank	Sum of Ranks
Experimental Group	57	49.69	2832.33
Control Group	30	33.95	1018.50

	Full Marks
Mann-Whitney U	549.500
Wilcoxon W	984.500
Z	-2.717
Asymp. Sig. (2-tailed)	.007

Lastly, the Full Marks academic achievement scores of the students in the experimental and control groups were compared also using the Mann Whitney U test. An analysis of the findings (refer to Table V) shows that the results of the experimental and control groups reveal a statistically significant difference at the level of Z=-2.717; p=.007<.05. The rank average of the Full Marks scores of the experimental group students is 49.69, which is higher than the students in the control group that had a Full Marks score rank average of 33.95. Therefore, on the basis of the results obtained, it could be argued that the use of digital educational comics as a reflection tool has significantly improved students' performance in web programming course.

V. CONCLUSION

The findings from the study are expected to open up new means for UUM lecturers to improve classroom engagement. Digital educational comic as a reflection tool denotes that students will be encouraged to think more deeply about the meaning of a particular topic. Hence, the outcome of this study could be hypothetically adapted into different classroom setting or disciplines.

21st Century education recognizes the critical need for developing 21st-century skills, which is interdisciplinary, integrated within a project-based curriculum. Instruction comic as a reflection tool is an affiliated strategy to develop critical thinking and problem-solving. By highlighting the potential of digital educational comic development as a reflection tool, it may answer to several pedagogical principles, useful to teach concepts of each level of complexity and raise standards of teaching achievement more effectively.

In conclusion, the study revealed that the use of comics as reflection tool is found to be helpful in increasing the students' performance of web programming subject. Generally, there are few interesting insights of utilizing digital educational comics as a reflective tool in Web Programming class. In this study, reflecting learning meaningfully by presenting educational material in a way that learner can extract meaning into the story in comics has exhibited an encouraging educational potential. Principally, this strategic approach of aligning web programming course by narratively framing knowledge in artefact of comics has shown positive results. These conditions suggest that further investigation should be carried out to determine precisely which feature of digital educational comic development are most effective in helping students making connections for deep learning and higher-order thinking.

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