The Effects of Geography Information System (GIS) Based Teaching on Underachieving Students' Mastery Goal and Achievement

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Abstract
Recent studies indicate that the number of students electing to study Geography in Malaysian upper secondary schools, and their level of achievement in the subject, has declined. The main factor appears to be a lack of motivation. Yet there has been little research into the impact of instructional methods on Geography students' motivation and their learning outcomes. This study applies a concurrent triangulation mixed method model to determine the effect of GIS based teaching on underachieving students' achievement and their motivation to learn Geography. The quantitative data were collected through a quasi-experimental design while the qualitative data were collected through students' interviews. The treatment groups included 44 students and control group with 40 students. For the treatment group, a unit on the type and distribution of world vegetation was given with GIS-based lesson material. For the control group, the same subject matter was presented using the traditional teaching methods. The quantitative evaluation showed the mastery goal and achievement post-test mean score of experiment group student participants' are significantly higher than control group student participants. The evaluations of student participants' interviews are consistent with quantitative findings. The triangulation of the quantitative and qualitative data reveals that GIS-based teaching had a more positive effect as compared to traditional teaching methods in enhancing participants' mastery goal learning motivation and achievement in the topics being taught in the classroom. Thus, it is possible to draw overall conclusion that GIS based teaching has positively impact the student participants' achievement and motivation to learn Geography.

Keywords: GIS-based teaching, underachieving students', motivation, mastery goal, achievement

INTRODUCTION

In 1988, the Malaysian Ministry of Education introduced the integrated secondary school curriculum as a continuation of curriculum changes initially introduced in the primary school. These changes impacted the profile of Geography in secondary schools, with Geography becoming a compulsory subject at the lower secondary school level but offered as an elective subject at the upper secondary school level. As a result, fewer schools in Malaysia offer Geography at the upper level today. In 1999, the Ministry of Education also established the Smart School Program that emphasizes the use of technology as an important aid in the learning and teaching process. However, the integration of Information and Communications Technology (ICT) has been prioritized in subjects deemed critical only, namely; Science, Mathematics, and English. As a result, Malaysian students in upper secondary schools are now avoiding studying Geography. Furthermore, of the remaining students who do continue to study Geography, the percentage that passes the exam is declining each year. Singh (2013) reported that the major factor correlated to this issue was that Malaysian students are not motivated to study Geography and increasingly perceived it as a dry subject with little opportunity to use technology.

EFFECTS OF ICT, GIS ON STUDENT MASTERY GOAL

In the 1990s and 2000s**,** there was a growing acceptance of the value of ICT in primary and secondary schools and universities. It was acknowledged that Integrated ICT-based learning in educational practice could yield significant benefits in terms of knowledge, development of skills and attitudes. In recent decades too, a large and growing body of literature has indicated that ICT integrated learning increases students' motivation to learn (Agudo, Rico, & Sánchez, 2016; Aladag, 2010; Daungcharone, 2016; Y.-T. Lin & Jou, 2013; Luo & Yang, 2016; Meluso, Zheng, Spires, & Lester, 2012; Omwenga, 2016; Park, Park, & Kim, 2011; van der Meij, van der Meij, & Harmsen, 2015; Vos, Van der Meijden, & Denessen, 2011). The studies demonstrated that the use of ICT in teaching activities provides more fun in an authentic learning environment, while increasing learning autonomy, interaction, and collaboration; it is therefore a rich opportunity for motivating students to study.

Midgley (2002) stressed that mastery goal plays an important role in shaping student academic interest. Based on this claim, numerous studies have been conducted to examine the relationship between ICT integrated teaching and students' mastery goal (Beckers, Dolmans, & van Merriënboer, 2016; Z.-H. Chen, Liao, Cheng, Yeh, & Chan, 2012; Dori, Rodrigues, & Schanze, 2013; Erhel & Jamet, 2015; Lorenzo, 2016; Su & Cheng, 2015; Yıldız-Feyzioğlu, Akpınar, & Tatar, 2013). The findings of these studies indicated that ICT and technology integrated learning have favourable effects on students' mastery goal. These outcomes resulted from the fact that ICT and technology integrated learning enhanced the student participants' interest, curiosity, and excitement in learning the content of the topic, which in turn, encouraged them to set a goal to learn the content of the topic. This is further reinforced by Beckers et al. (2016); Su and Cheng (2015), who posit that new technology-based learning environments motivate students to engage in the learning process and create competing motivations for task completion, along with enhance their need for recognition and self-valuation.

Although a growing body of research has specifically examined the relationship between ICT integrated learning and goal orientation motivation for school children, there is scarce research on the relationship between ICT integrated learning in primary and secondary schools and student goal orientation motivation. In particular, there is no research mediating the role of ICT integrated learning on underachieving students' mastery goal. Mayers (2014); Obergriesser and Stoeger (2015) and Fong and Krause (2014) affirmed that underachievers have very low confidence in their abilities. Consequently, they try to avoid challenging tasks when there is a risk of failure. On the other hand Wang, Teng, and Chen (2015), Bouzid, Khenissi, Essalmi, and Jemni (2016) posits that the integration of ICT and multimedia technology in teaching and learning raises a student's learning interest, ability and confidence, and allows students to involve themselves in the subject matter and generation of ideas and think creatively. It is therefore important to investigate the effect of ICT integrated learning on underachieving students' goal orientation motivation.

EFFECTS OF ICT, GIS ON STUDENT ACHIEVEMENT

Much research in recent years has focused on identifying the key factors that promote academic achievement among students. The explosion of ICT has influenced the development of society, and current pedagogy has given researchers new directions to explore the effects of ICT integrated teaching on student academic achievement. A large and growing body of literature has investigated the effects of ICT integrated teaching on students' achievement and has proven that ICT is a useful tool for supporting and transforming teaching, and for enhancing student achievement (Alibrandi & Goldstein, 2015; Dalal, 2016; Gungadeen, 2015; Hwang, Chiu, & Chen, 2015; Q. Li & Ma, 2010; Prieto-Rodriguez, 2016; Rutten, van Joolingen, & van der Veen, 2012; Skryabin, Zhang, Liu, & Zhang, 2015; Yang & Wu, 2012; K.-H. Yang, 2014; Y.-T. C. Yang & Chang, 2013). Several studies also have been carried out to examine the effectiveness of ICT tools on students' achievement in Geography in primary and secondary schools (Asaolu, 2012; Cowan & Butler, 2015; Diab, Diab, & Awada, 2016; Z. Li, 2012; Ong, Ho, & Teow, 2011; Solari, Demirci, & van der Schee, 2015; Zivkovic, Jovanovic, & Ivanovic, 2010). The findings of these studies demonstrated that the utilisation of ICT in teaching and learning activities in the classroom enhances students' achievement in Geography. These results may be attributable to the students finding working with computers interesting and that three-dimensional images and interactive maps attract their interest in the classroom lesson. In addition, ICT integrated teaching engaged the student participants in the learning process by encouraging them to gather the necessary and important information, search for solutions to the problem and attain the right solution(Diab et al., 2016; Gungadeen, 2015; Hwang et al., 2015) . The activities conducted in a GIS integrated class encouraged students to use the internet resources actively to find information to complete their mapping projects compared to their counterparts in the control group who passively accepted information from teacher(Alibrandi & Goldstein, 2015; Delparte, Richardson, Eitel, Matsaw, & Cohn, 2016; Stonier & Hong, 2016). As a consequence, the student participants could understand the content of topics taught in the class easily and scored good grades in the post- test (Z. Li, 2012; Rutten et al., 2012; H.-C. Yang & Chang, 2016; K.-H. Yang, 2014)

Over the past three decades, GIS has become a central tool for natural resources management, disease mapping and monitoring, crime analysis, and city and regional planning. Therefore, GIS use has become so pervasive that it is emerging in secondary school education and is being integrated into Geography classes in a number of countries (Oppong & Ofori-Amoah, 2012). Aladag (2010) and Artvinli (2010) asserted that the introduction of GIS in Geography classes has a positive effect on students' attitudes towards Geography lessons. This view is strongly supported by Kaya's (2012) research on Grade 6 primary school students in Turkey. His research addressed how GIS integrated lessons promoted academic success among high risk failure and low motivation students in Social Studies. Supporting his findings are numerous studies that have attempted to explain the effects of GIS integrated lessons and Geospatial technology on students' achievement. For example, Shin (2007) reported that GIS integrated lessons have helped Grade 4 primary school students engage in more difficult tasks, enhancing their Geographic content knowledge mapping skills and achievement. Similar findings were also reported by Aladag (2010); Demirci (2011); Favier and Van der Schee (2014); Goldstein and Alibrandi (2013); Kaya (2011); and (Blank, Almquist, Estrada, & Crews, 2016; Delparte et al., 2016); Liu, Bui, Chang, and Lossman (2010). In summary, GIS has been recognised as an effective tool in classrooms because it promotes students' Geography skills and leads to more dynamic learning in Geography, thus enhancing students' achievement. Similarly, Milson and Earle (2008) and Liu et al. (2010) emphasised that GIS not only enhances students' skills but also provides students opportunities to work with actual data that deals with their local area. Therefore, they concluded that GIS is an effective tool to teach Geography in primary and secondary schools. However, the effectiveness of GIS in teaching and learning Geography remains arguable because to date not a single study has investigated the effects of GIS with underachieving students in primary and secondary schools.

METHODOLOGY

This study employs a mixed method research design, namely the Convergent Parallel Design (concurrent triangulation mixed method design) to address the research questions. The main reasons for using this design are that data collected from supplies works to offset the weaknesses of the other form, and that a more complete understanding of a research problem results from collecting both quantitative and qualitative data (Creswell, 2012, p. 540). This mixed method research design gives equal priority to both forms of data, the collection of which were undertaken concurrently or simultaneously during the research. The collected data was analysed separately and the findings compared and triangulated in the interpretation section.

Quantitative research design

This study employed an experimental research design, which is well known as a powerful method to determine cause and effect relationships (Fraenkel, Wallen, & Hyun, 2012, p. 265). More specifically, a non-equivalent quasi-experimental control group design was employed to determine the cause and effect relationship that was due to difficulties in randomly assigning two groups of underachieving Geography students. The experimental design used in this study manipulated different instructional methods in order to determine the effect on a subject's performance in achievement and motivation tests. This approach also consisted of giving both the experiment and control groups a pre-test and then a post-test after the experimental treatment condition had been administered upon the experiment group. The responses of the two groups were then analysed by comparing the pre-test to post-test differences in scores of the two groups (Johnson & Christensen, 2012).

Qualitative research design

This study employed an intrinsic case study research design, which is well known for developing an in-depth understanding of the research issue (B. Johnson & Christensen, 2012, p. 408).The intrinsic case study was conducted to understand the effect of GIS-based teaching and traditional teaching methods on student participants' achievement and motivation to learn Geography.

Sample

The specimen population of this study comprised Form 4 (Grade 10) underachieving Geography students from the two rural secondary Smart Schools in Sabah. A ppurposive sampling method was used to select the school with the highest number of low achievers in Geography. The above method also aided in the selection of student participants who had special characteristics (underachievers in Geography) and could better understand the research phenomena to answer the research questions. The identification of low achievers in the subject was carried out by the respective Form 4 Geography teachers, based on the E (fail) grade obtained in the *Penilaian Menengah Rendah* (Malaysian Lower Secondary Certificate of Education) by the student participants in the previous year. Overall, 84 student participants were chosen from a potential research population of 185. The experiment and control groups consisted of 44 and 40 student participants respectively. A random sampling method also was used to select five students from each group for the interviews.

Instruments

The personal achievement goal orientation item, drawn from The Pattern of Adaptive Learning Scale (PALS) instrument, was used to measure participants' perception of their achievement goals. This instrument was originally published in 1997 and refined over time by a group of researchers (Midgley et al., 2000). The revised version by Midgley et al. (2000), which focuses more on the Goal Orientation Theory, examines the relationship between the learning environment and students' motivation and behavior. The personal achievement goal orientation consists of 14 items and is divided into three sub-scales: Mastery Goal Orientation, Performance Approach Goal Orientation, and Performance Avoidance Goal Orientation. However for this study only mastery goal orientation which consists 5 items was used.

The pre-test and post-test instruments were designed to evaluate respondent understanding and achievement of the targeted Form 4 (Grade 10) Geography topic of ' The Distribution of the Forests and Wildlife in the World', using 20 multiple choice questions, which are known to have a high degree of reliability (Haladyna, 1999). The questions were designed based on the multiple choice *Sijil Pelajaran Malaysia* (Malaysian Certificate of Education) Geography exam paper. The pre-test aims to identify the range of student participants' existing knowledge of the topic, while the post-test, administered after the eight weeks of intervention treatment, hoped to determine the respondents' achievement in the topic in the intervening period. The students' results in the pre-test and post-tests were then converted into percentages, by multiplying the correct number of questions by five. Marks obtained were then converted to overall scores to determine the level of each student.

The quantitative data was collected through standardized, open-ended interviews, which required all respondents to answer the same question; to examine the effect of GIS and traditional teaching methods on interviewees' achievement and mastery in learning Geography. The interviews were conducted on a one-to-one basis in the school administrative meeting room. Each interview session began with a brief description of the structure of the interview to be conducted, and ended with the researcher thanking the student for their participation and ensuring them of the confidentiality of their responses. Every interview session lasted between 50 and 60 minutes and was audio-taped.

Quantitative data analysis

In this study, a parametric statistical test was used to analyze the quantitative data. Normal distribution, homogeneity of variances and independence of observation tests were conducted to ensure all of the variable scores in this study met the general assumption for a parametric test. The test revealed that the variable scores in this study met the general assumption for the parametric test as described above. This shows that the sample from which the score was obtained came from a population of equal variance and was normally distributed. A repeated measures ANOVA were used to test the study hypotheses because by collecting data from the same student participants under different conditions (GIS-based teaching and traditional teaching methods) and repeated conditions (pre-test and post-test), the individual differences could be eliminated or reduced as a source of between-group differences (Field, 2013, p. 549)

Qualitative data analysis

In the current study, a thematic analysis method was used to analyse the qualitative data. The qualitative data in the current study was analysed based on the six phases of thematic analysis suggested by Braun and Clarke (2006). Firstly, the audiotapes of the student participants in the experiment and control groups were transcribed verbatim. The transcribed versions were then checked against the tapes for accuracy. Further to this, the transcriptions were imported into NVIVO version 10 software for analysis. In the second phase, open coding was used to create categories or related codes from the initial points, this having been identified in the data familiarization process. The focus of the coding draws on The Goal Orientation theory, which proposes that mastery goal-oriented students are more concerned with learning and understanding the subject or topic taught in the classroom (Anderson & Lawton, 2014). Thus, all of the student participants' conversations that indicated their interest in learning and understanding the topic taught in the classroom were observed and coded. The researcher gave equal attention to each data item during the coding process. The open coding feature of NVIVO allowed the researcher to generate many initial codes for potential themes and patterns by tagging and naming selections of text within each data item. The initial codes created during the open coding were refined in Phase 3. The refined codes were then analysed with a view to re-arrange and collate the different codes in potential themes. In the fourth phase, the initial themes were reviewed again to refine, combine or separate them to generate overarching themes. In this phase, more attention was focused on gaining internal homogeneity (the data within each theme should cohere meaningfully together) and external heterogeneity (the data should be clear and apparent between the themes). The fifth phase started with examining the validity of the themes with respect to the data set as a whole by moving back and forth between the data extracts and themes. The researcher ensured that the themes accurately represented the data set by noting and working through similarities

and contradictions with and between themes. The researcher further reviewed the final set of themes to ensure that these themes satisfactorily addressed the research question. The findings were reported in Phase 6 and were based on the themes using direct quotations from the data set.

GIS-based instruction

For the experiment group, a GIS-based instruction unit composed of eight lessons was designed using ArcGIS 10.0 software. The unit focused on the topic of 'The Distribution of the Forests and Wildlife in the World'. Teaching activities were conducted in a computer laboratory for eight weeks, where one lesson weekly was conducted for 80 minutes. However, an extra two weeks (two lessons) were devoted to the experiment group to introduce the GIS software to student participants. The instructor started to teach the subject content in the third lesson, using a desktop and projector to present. Each lesson began with induction set activities of between five to ten minutes to probe the student participants' existing ideas, continuing for the next 40 minutes with class activities in accordance with the daily lesson plans. These lesson activities focused on creating the data, inserting the hyperlink, tracing the forest area, and comparing and labeling the forest areas on the world maps. The instructor also devoted 10 to 15 minutes to classroom exercises, ending the lesson with 10 minutes of question and answer activities followed by a conclusion.

Traditional teaching methods

For the control group, eight traditional teaching instructions were developed using paper maps and the Form Four (Grade 10) textbook. The unit focused on The Distribution of the Forests and Wildlife in the World. The teaching activities, based on the traditional teaching method, were conducted in a regular classroom for the control group. One lesson was allocated for each week, with each lesson lasting 80 minutes (double period). Teaching activities in the group were based on traditional methods. The instructor used paper maps, the Form 4 Geography textbook, charts and posters to deliver the subject content. Most of the lessons were presented in a conventional manner and were more teacher-centred than those conducted in the experiment group. Lessons typically began with an introduction of the topic during the first 10 minutes of the lesson time. This was followed by 45 to 50 minutes of class activities that had been pre-planned for the session. Then, 10 minutes of each lesson was devoted to evaluate the student participants' understanding of the subject content. After this there was 10 minutes of question and answer activities, followed by the conclusion of the lesson.

EFFECTS ON STUDENT MASTERY GOAL

Quantitative analysis

A 2 X 2 mixed model analysis of variance (ANOVA) was conducted to investigate the effects of the treatment on experiment and control group student participants' mastery goal.

Table 1: One-Way Repeated ANOVA Mastery Goal Variable Test of Within-Subject Effects

Variable	Source	Type III Sum of Squares	Mean Square	F	Sig	Partial Eta Squared
Mastery Goal	Time	243.203	243.203	30.18	.001	.269
	Time*Treatment	34.632	34.632	4.29	.041	.050

Analysis of the data tabulated in Table 1 indicates that there was a significant main effect for time, with both groups showing an increase in mastery goal scores across the two time points. According to Cohen's (1988, p. 284) effect
size classification, .01 is considered a small effect, .06 a medium effect, and .14 a large effect. Thus, the significant main effect for mastery goal is classified as a large effect. This suggests that there is a difference in mastery goal scores within the experiment and control groups.

To investigate the significant difference further, the researcher examined within-group differences with pairwise comparison at α of .05. The analysis reveals that the control group's post-test mean scores (M = 18.48, SD = 3.33) were higher than the pre-test (M = 16.93, SD = 3.79). This difference, -1.50, BCa 95% CI [-2.889, -.111], was significant: F (1, 39) = 4.77, p = .035, and represents a medium sized effect, η_p^2 = .109. The experiment group's post-test scores (M = 20.39, SD = 2.86) were higher than the pre-test scores (M = 17.07, SD = 2.13). This difference, - 3.318, BCa 95% CI [-4.440, -2.196], was significant F (1, 43) = 35.58, p = .004, and represents a large sized effect, η_p^2 = .453. This reflects that there is a significant difference in the effect of treatment within the experiment and control groups on student participants' mastery goals.

Table 2. One-Way Repeated ANOVA Mastery Goal Variable Test of Between- Subject Effects

Variable	Source	Type III Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Mastery Goal	Intercept	55529.067	1	55529.067	5191.973	.000	.981
	Group	46.400	1	46.400	4.338	.040	.050
	Error	877.005	82	877.005			

The analysis in Table 2 shows that the main effect in comparing the two groups was significant and represents a small effect. This suggests that there is a significant difference in mastery goal scores between the control and experiment group student participants. In addition, the analysis of data in Table 1 shows that there was a significant

interaction effect between mastery goal and time and this represents a small sized effect. This suggests that the mastery goal scores of the student participants frequently changed between pre- and post-tests and differed between experiment and control groups.

To examine the significant interactions further, the researcher examined between-group differences with a simple effect test using a Bonferonni correction. The results in Table 3 show that there was no significant difference in mastery goal scores between the experiment and the control groups at pre-test. The analysis shows that there was a significant difference in mastery goal scores between the experiment and control groups at post-tests. The mean for the experiment group was significantly higher than for the control group's. Based on guidelines proposed by Cohen (1988), there was a medium-sized effect of GIS-based teaching on the experiment group student participants' mastery goals to learn Geography.

Table 3. Pre-test, Post –test, Mean Scores, Standard Deviation, p values, end Effects Sizes For Mastery Goal Variable

	Group	N	M	SD	*P*	Partial Eta Squared
Pre-test	Experiment	44	17.07	2.13	.829	.005
	Control	40	16.93	3.79		
Post-test	Experiment	44	20.39	2.86	.005	.093
	Control	40	18.48	3.33		

Quantitative analysis

Student participants'interviews.

The interviews were conducted in the experiment and the control schools after eight weeks of implementing the intervention program. Five student participants from the experiment school: Shah, Adri, Jacson, Siti, and Alfera (pseudonyms), and five student participants from the control school: Fazilah, Robin, Kim, Josh, and Aldi (pseudonyms), who obtained the highest scores in the achievement post-tests, were selected for interviews. In the following, the questions and students' responses are provided.

1. What is your main reason for and goal in participating in this class?

Interestingly Shah, Adri, Jacson Siti and Alfera form experiment group stated that:

> *We wanted to learn a new topic and this was the first time we heard about GIS. Therefore, we were looking forward to learning Geography using GIS. Thus, our main goal was to learn and understand the content of the topic through GIS. However, the first time we attended the class, we were worried that we would not able to learn anything in this class. However, in the second lesson, we were motivated and excited to learn more about GIS by exploring the tool ourself. At the end of the class, we realized that we had managed to learn and understand the topic taught in class.*

Fazilah, Robin, Kim, Josh, and Aldi from control group explained :

> *I wanted to learn and enhance my knowledge in the Geography subject. It is important for me to answer exam questions. So my main goal for attending this class and take part actively in every activity was to learn, enhance my Geography knowledge, and score good grades on the exam.*

2. Do you think that you have achieved your goal in this class and believe that activities conducted in this classroom integrated) has enhanced your learning goals in Geography study?

All of the interviewed participants from experiment group (100%) said that they have achieved their main goal in the class. For example Shah said:

> *Yap… I strongly agree that I have achieved my goal in this classroom. I managed to learn and understand the content of the topic well. As a result, in the first test I only got 45 marks and in second test I improved and got 87 marks. So I can say that I have achieved my goal. Emm… learning through GIS is really fun and challenging. This has enhanced my goal and motivated me to learn more and understand the content of the topic*

Fazilah, Robin and Kim from control group added:

> *In the first and second lessons we could not understand much on the topic taught in the class. However, we started to set our goal to learn and understand the topic in the third lesson. Thus, we always asked the teacher if we could not understand about the topic taught in the classroom. Finally, we could understand well the entire topic taught in this class. As a result, we could score good marks in the last test. In addition, the activities conducted in this class have enhanced our learning goal. Therefore, we can say that my main goal in this class to learn and understand the content of the topic has been achieved.*

By contrast, Josh and Aldi from the control group had this to say:

> *Our main goal in this class was to understand the content of the topic and score a good grade on the exam. Nevertheless, we were having difficulty in understanding most of the topics taught in this class. However, we still managed to score 80 marks on the test because we did review this topic many times to make sure that I understood the content well. Thus, we conclude that we did not achieve 100% of our learning goal and the activities conducted in this class were unable to motivate us or enhance our learning goal.*

The experiment group student interviews revealed they were excited to learn about GIS. This was because they participated actively in every activity conducted by the teacher in the classroom. Involvement in classroom activities helped students to understand the topic and achieve their goals. Similarly, the control group student participants agreed that the activities conducted in the classroom had enhanced their learning goal. However, two of the participants confessed that they were unable to achieve their learning goal because they were unable to understand the lessons delivered in the classroom. This indicated that traditional teaching methods had a moderate effect on the student participants' mastery goal in learning Geography.

Triangulation

The quantitative analysis showed that there was a significant effect of GIS-based teaching and traditional teaching methods on experiment and control group student participants' mastery goal mean scores, indicating that both teaching methods enhanced the student participants' mastery goal to learn Geography. However, the quantitative analysis showed the experiment group student participants' mastery goal mean score was significantly higher than that of the control group student participants. This suggests that GIS-based teaching had a more positive effect on student participants' mastery goal to learn Geography. Responses from the experiment and control group student participants' interviews suggest that these participants achieved their learning goal. In addition, the interviews with the teacher participants in the experiment group revealed that the GIS-based teaching activities enhanced the student participants' mastery goal to learn Geography and helped them achieve their learning goal.

EFFECTS ON STUDENT ACHIEVEMENT

Quantitative analysis

Table 4: One-Way Repeated ANOVA Achievement Variable Test of Within-Subject Effects

Variable	Source	Type III Sum of Squares	Mean Square	F	Sig	Partial Eta Squared
Mastery Goal	Time	8485.63	8485.63	187.85	.001	.696
	Time*Treatment	3704.05	3704.05	88.83	.001	.520

The analysis of data tabulated in Table 4 reveals that there was a significant main effect for time, with both groups showing change in achievement scores across two time periods. This reflects that there was a significant

difference in the effect of treatment within experiment and control groups on student participants' achievement scores. According to Cohen's (1988, p. 284) effect size classification, the effect size was large. To investigate the finding of the significant difference further, the researcher investigated within-group differences with pairwise comparison at α of .05. The analysis revealed that the control group post-test mean scores (M = 44.01, SD = 7.55) were higher than the pre-test (M = 39.57, SD = 10.09). This difference, -4.45, BCa 95% CI [-6.61, -2.28], was significant F (1, 39) = 17.27, p = .001, and represents a large sized effect, η_p^2 = .307. The experiment group post-test scores (M = 65.75, SD = 9.34) were higher than the pre-test scores (M = 41.74, SD = 9.15). This difference, - 24.02, BCa 95% CI [27.49, -20.54], was significant F (1, 43) = 194.03, p = .001, and represents a large sized effect, η_p^2 = .819.

The analyses tabulated in Table 5 prove that the main effect in comparing the two groups was significant, and represents a large effect. This suggests that there is a significant difference in achievement scores between control and experiment group student participants.

Table 5: One-Way Repeated ANOVA Achievement Variable Test of Between- Subject Effects

Variable	Source	Type III Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Mastery Goal	Intercept	382477.46	1	382477.46	3184.661	.000	.975
	Group	5989.52	1	5989.52	49.871	.001	.378
	Error	9848.19	82	9848.19			

The analyses of data in Table 4 also show that there was a significant interaction between achievement score and time and this represents a large sized effect. This suggests that the achievement test scores of the student participants frequently changed between pre-test, post-test and differed between control and experiment groups. To examine the findings of the significant interactions further, the researcher examined group differences with a simple effect test using a Bonferonni correction.

Table 6: Pre-test, Post –test, Mean Scores, Standard Deviation, p values, end Effects Sizes For Mastery Goal Variable

	Group	N	M	SD	*P*	Partial Eta Squared
Pre-test	Experiment	44	41.74	9.15	.304	.012
	Control	40	39.57	10.09		
Post-test	Experiment	44	65.75	9.34	.001	.623
	Control	40	44.01	7.55		

The results in Table 6 showed that there was no significant difference in achievement test scores between the experiment and control groups at pre-test. However, post –test analysis revealed that there was a significant difference in achievement scores between the experiment and control groups. The mean score for the experiment group was significantly higher than for the control group at post-test, and this signifies a large sized effect.

Quantitative analysis

Student participants' interviews.

To enable further investigation into the post-test results that indicated the positive effect of both GIS-based teaching and traditional teaching methods on student participants' achievement in the classroom, five student participants were selected randomly from the experiment (pseudonyms; Shah, Adri, Jackson, Siti, Alfera) and control (pseudonyms; Fazilah, Robiah, Kim, Josh and Aldi) schools respectively. The purpose of the interviews was to examine the experiment and control group student participants' understanding of the topic content taught. In these interviews, they were asked three fixed questions based on the content of the topic that had been taught earlier. The student participants were provided no clues to guide them towards the correct answer, and were asked to asked to give clear answers.

Interview Question 1.

Pre-test question

What is the tropical rainforest?

Post-test question
What do you understand about the tropical rainforest?

Question 1 was designed to probe the experiment and control group student participants' understanding of tropical rainforests. In this question, the researcher expected responses for the definition of a tropical rainforest to be "a forest occurring within 28 degrees north or south of the equator and the ecosystem experience (ing?) high average temperature and heavy rainfall" (Ahmad & Osman, 2011, p. 145).

In the pre-test, most of the experiment group student participants had difficulty giving the correct definition of a tropical rainforest. When the researcher asked why they could not remember the topic that they had learned in the class, the students replied the lesson was very boring and difficult to remember. However, Adri was able to give the correct answer. When the researcher asked how he knew the answer, Adri's reply was as follows:

> I learned this topic two weeks ago in the classroom and yesterday I saw the documentary about the tropical rainforest. Thus, I have a little bit of knowledge about the tropical rainforest.

The above responses show that before the intervention, experiment group student participants could not understand nor remember the content of the topic that had been taught in the classroom.

For the control group, only Kim was able to give the correct answer for the definition of a tropical rainforest. When asked how he remembered the answer, Kim's reply was as follows:

> I learned about the tropical rainforest in the classroom last month. However, I could not understand much. I learned about this topic again in the tuition class last week. I remembered that the tropical rainforest received very heavy rain. If I'm not mistaken, it averages around 2600 millimetres a year. Aaa… the forest grows within 28 degrees north or south of the equator. The ecosystem experiences very high temperatures.

The above response shows that Kim remembered the definition of the tropical rainforest and that it was a part of his existing forest knowledge. However, his explanation about the temperature was wrong. He mistakenly stated that the tropical rainforest experiences very high temperatures, indicating that he could not fully understand everything about the tropical rainforest. The correct answer is that the tropical rainforest maintains average temperatures.
Fazilah, Robiah, Josh, and Aldi from the control group had some ideas about the tropical rainforest, but they confused it with the monsoon forest, even though he Form 4 Geography textbook it clearly differentiates between monsoon and tropical rainforests. For example, Aldi stated that tropical rainforests "drop their leaves in the dry season". The description given by Aldi is a characteristic of the monsoon forest. This suggests that Fazilah, Robiah, Josh, and Aldi had difficulty defining the tropical rainforest because of a lack of knowledge. In the post test interviews, the experiment and control student participants had no difficulty giving the correct definition of the tropical rainforest. This suggests that the student participants were able to learn and remember the content of the topic which had been taught using GIS-based teaching and traditional teaching methods.

Interview Question 2
Pre-test question
Can you tell me the areas covered by the monsoon forest?

Post-test question
Could you list the areas covered by the monsoon forest?

The above question was designed to investigate the student participants' ability to identify the location of forest growth on the world map. To answer this question, the student participants needed to know and remember the forest types and distributions on the world map. The correct answer for this question is: Thailand, India, Zambia (Africa), and Myanmar.

For the pre-test, four of the experiment group student participants were only able to list one area covered by monsoon forests. However, Alfera was able to list all three areas correctly. The student participants' responses suggest that they could not remember and had a lack of knowledge about the locations covered by monsoon forests on the world map. As further investigation, the researcher asked student participants the reason why they could not remember the locations covered by the forest. Their response was that they had difficulty in

remembering the content of the topic that they had been taught in the classroom because they weren't given adequate practical exercises such as drawing, plotting, and labelling the types and growth of the forest areas on the world map. This prevented the student participants from understanding and remembering the exact area covered by monsoon forests on the world map.
For the control group, Fazilah was able to recall one of the areas covered by the monsoon forest, whereas Kim was able to remember two areas. However, Robiah, Josh, and Aldi were unable to answer the question. The responses indicate that the control group student participants had a lack of knowledge of the location of the forest.

In the post-test, all the experiment student participants were able to give the correct answer. Surprisingly, Jackson and Siti could list two different areas covered by monsoon forests, which were not taught in the classroom. For further investigation, Jackson's response to why he could easily remember and list the growth areas of the monsoon forest was:

> Using GIS mapping in teaching Geography has enhanced our understanding of the type and area of forest growth on the world map. In addition, we were given a project to create our own forest map. I took this opportunity to trace, plot, and label my map, and to find extra information about the forest by creating the hyperlink icon on my map. This activity has enriched my knowledge of the type and area of forest growth on the world map.

Similary, in the post-test, Fazilah and Kim from the control group of student participants were able to list all of the locations covered by monsoon forest correctly. Josh, Robiah, and Aldi were able to list three of the locations correctly. The analysis demonstrates that Robiah showed positive improvement in memorising the forest areas. When the researcher asked how she could remember the location so well, Robiah replied:

> In this class, the teacher used the world map to teach us the type and distribution of the forest and followed up with shading and labelling the forest area on the blank world map. The activities were fun and helped me to remember the location easily.

These above responses suggest that the intervention activities conducted in the classroom enhanced the experiment and control control group student participants' understanding and knowledge of the locations of the forest.

Interview Question 3
Pre-test question
Could you tell me what kinds of animal live in the steppe?

Post-test question
Can you write the names of the animals that live in the steppe?

Question 3 was designed to probe student participants' understanding of the types of wildlife that live in the steppe. Based on the Form 4 (Grade 10) Geography curriculum in Malaysian schools, the student participants were expected to remember four of the wildlife types in the area, namely corsac fox, saiga, badger, and rabbit.

In the pre-test interviews, the student participants were asked to verbally name the above four steppe wildlife types. The experiment student responses revealed that only Adri was able to name the types of wildlife correctly. Shah and Jackson were able to answer three, Siti stated one type and Alfera was unable to answer the question. This shows that most of the student participants had difficulty remembering the wildlife that live in the steppe.

The control student participants' responses show that only Fazilah and Robiah were able to name one of the wildlife types that live in the steppe correctly; whereas, Kim, Josh, and Aldi were unable to answer the question. This seems to indicate that most of the student participants had difficulty identifying the wildlife that lives in the steppe forest.

In the post-test, the student participants were asked to write the names of wildlife that live in the steppe. The students were given 5 minutes to complete the task. Interestingly, Alfera, Siti, and Jackson from the experiment group who had difficulty answering in the pre-test interviews, were able to list all of the wildlife correctly.

More surprisingly, Shah could finish this task within 3 minutes. When the researcher asked how he could remember and complete the task so quickly, Jackson responded:

> One of the activities conducted in this classroom was to drag and drop. For this activity the student needs to find the wildlife symbol or picture and locate them on the map according to the forest in which they live. The activity was fun. Thus, I could remember the animal faces and their names easily.

In contrast, student participants from the control group only got one of these names correct.

In summary, the pre-test interviews revealed that before the intervention, the experiment and control group student participants demonstrated a poor level of knowledge of the topic. The student participants also remarked that the lesson conducted in the classroom was boring and difficult to understand. However the post-test interviews showed that the experiment student participants acquired an understanding of the topic taught in the classroom. In addition, the number of correct answers for simple as well as difficult questions after the intervention increased significantly. In contrast, the control group student participants' post-test suggests that the student participants were unable to answer questions which required them to analyses, elaborate and explain in more detail, or those questions that required a deep level of understanding of the topic taught. This suggests that GIS-based teaching had positive effects on the student participants' achievement in the topic taught in the classroom.

Triangulation

The quantitative analysis revealed a significant effect of GIS-based teaching and traditional teaching methods on the experiment and control group student participants' achievement. It indicates that both teaching methods enhanced the student participants' achievement in the topic taught in the classroom. However, the experiment group student participants' achievement mean score was significantly higher than that of the control group counterparts', which suggests that GIS-based teaching had a more positive effect on student achievement. The experiment and control group student participants' pre- and post-test interviews revealed that GIS-based teaching had favourable effects on student participants' achievement in the topic. However, the traditional teaching methods were only able to enhance student participants' surface understanding and knowledge of the classroom topic, indicating that the GIS-based teaching activities had a more affirmative impact on the student participants' achievement. On the basis of the consistent findings of the quantitative analysis and student participants' interviews, it is possible to infer that GIS-based teaching had a more positive effect compared to traditional teaching methods in enhancing participants' achievement in the topics taught in the classroom.

DISCUSSION

The primary aim of this study is to investigate the effect of GIS-based teaching and traditional teaching methods on student participants' mastery goal in learning and achievement in Geography. The analysis presented in this paper shows that the GIS-based teaching and traditional teaching methods enhanced both the experiment and control groups student participants' mastery goal to learn Geography. However, the results of the quantitative analysis reveal that GIS-based teaching had a greater effect on student participants' mastery goal to learn Geography as compared to traditional teaching methods. Moreover, its triangulation with the student participants' interviews suggests that GIS-based teaching had a more positive effect compared to traditional teaching methods in enhancing participants' mastery goal to learn Geography. Thus, it seems that GIS-based teaching can be a useful teaching tool to enhance underachieving students' mastery goal in learning Geography.

The findings of this study cannot be compared with the results of other studies because to date there are no studies measuring the effect of GIS-based teaching on high school or primary students' mastery goal in learning Geography. However, several studies have asserted that ICT integrated learning environments have a positive correlation with students' mastery goal orientation. For example, Lawlor, Marshall, and Tangney (2016) study of 425 secondary school students aged between 15 and 17 year old proved that learning through technology mediated learning develops higher motivation and learning goals in learning. Similarly, Ghanizadeh and Razavi (2015) study of eight graders students in Mashhad, Iran revealed that teaching integrating with multimedia elements as animation, cartoons and power points presentation enhanced their experiment group student participants' English learning goal.

One explanation for the findings of this study may be that learning through GIS-based teaching enhanced the student participants' interest, curiosity, relatedness, autonomy and excitement in learning the content of the topic, which encouraged them to set a goal to learn the content of the topic. In addition, GIS-based teaching encourage student to generate new ideas and build their own interest in learning the content of topic. These findings are supported by Anderman and Patrick (2012); Lawlor et al. (2016), who asserted that the individual

will only set a learning goal if the teaching activities are enjoyable, fun in learning and can help them to achieve their learning goal. As a result, the student participants tried to focus more on teaching, learning activities, developing new skills, improving their competence, and gaining understanding of the content of the topic and increase their task values. This view is supported by Gray, Chang, and Anderman (2015); Hatlevik, Ottestad, and Throndsen (2014), who posited that mastery goal-oriented students are more focused in the classroom and try to improve their competence. In the current study context, the results from classroom observations indicate that the experiment group students were trying very hard to grasp the content of the topic through GIS, and understand the class work which had been assigned by the teacher.

These findings are in line with Anderman and Patrick (2012) ; W.-W. Chen and Wong (2015) and yi Li and Shieh (2016) studies, which stressed that mastery goal-oriented student are cognitively engaged in the learning activities, where the learner is willing to exert the necessary effort to understand and master complex phenomena. yi Li and Shieh (2016) also argued that mastery goal-oriented students are behaviourally engaged in activities such as expending effort, discussing school work with other students, and seeking help when needed. In addition, the current study's findings show that the integration of GIS in teaching and learning created a self-regulated learning process in the classroom, which helped the student participants to set and achieve their mastery goal. For example, the comments from the student participants' interviews show that one of their main goals was to understand the content of the topic well, and the GIS integrated learning process encouraged them to actively participate in their own learning process. Here, the learning processes in the GIS environment involved students seeking help and discussing with their friends to ensure that they could understand the content of the topic well and achieved their goal. This finding is supported by Kramarski (2013); Lai, Shum, and Tian (2016); J. W. Lin, Huang, and Chuang (2015), who stressed that technology learning environments positively enhanced the self-regulated learning process among lower achieving students in the classroom.

The triangulation of the quantitative and qualitative analyses in the present study also suggests that the GIS-based teaching method enhanced student participants' achievement in the classroom topic more positively than traditional teaching methods. These results may be attributable to students finding working with computers to be interesting and that three-dimensional image and interactive maps attracted their interest in the lesson taught in the classroom. (Cowan & Butler, 2013; Delparte et al., 2016; Stonier & Hong, 2016). GIS-based teaching engaged the student participants in the learning process by encouraging them to explore and gather the necessary and important information, search for solutions to the problem, and attain the right solution. The activities conducted in a GIS-based class encouraged students to actively use internet resources to find information and data to complete their mapping projects compared to their counterparts in the control group who passively accepted information from teacher. As a consequence, the student participants could understand the content of topics taught in the class easily and scored good grades in the post- test (Alibrandi & Goldstein, 2015; Blank et al., 2016; Delparte et al., 2016; Z. Li, 2012; Rutten et al., 2012; K.-H. Yang, 2014). The findings of this study support the preliminary work undertaken by Kerski (2001), which indicated that the students who were using GIS scored higher in the performance test compared to their counterparts who were using traditional methods. Similar results have also been reported by Aladag (2010), Berglund (2008), Chun (2008), Alibrandi and Goldstein (2015); (Blank et al., 2016); Cowan and Butler (2013); Delparte et al. (2016) and Favier and Van der Schee (2014).

LIMITATIONS

A major strength of this study is the mixed method research examination of the effect of GIS integrated teaching on student motivation and achievement in Geography. However, a number of limitations prevail in the current study. First, this study was conducted using a mixed method design with a small sample size. Due to time and resource constraints, this study only involved two Smart Schools located in Sabah. The small sample reduced the statistical power to detect small effect sizes. It also potentially limited the extent to which findings can be generalised to other underachieving Geography students located in different Smart Schools. Thus, a larger study is needed to generalise the effect of GIS integrating teaching on student achievement and motivation in learning Geography.

Secondly, the evaluation of student achievement in Geography was created by the researcher, based on a set of multiple choice questions drawn from a previous year's exam paper. The researcher believes that students' achievement on the content of topics taught in the classroom would be measured more accurately by using more varied sources of questions (Talib, 2006). For instance, the teacher could combine multiple choice and short essay questions to test the students' knowledge and understanding of the content of the topic.

CONCLUSION

Overall, the results of this study study showed that GIS-based teaching has much to offer as an innovative teaching method that can be utilised by Geography teachers to stimulate students to adopt mastery goal in learning Geography. Moreover, the GIS integrated method used in this study did not require a high level of technical skills, for the teachers were able to learn and use the GIS software within two weeks of training. The results of this study also demonstrated that the GIS integrated method can be utilised to enhance the performance of the underachieving student achievement. Therefore, it is hoped that the findings of this study will be promoted and will inspire teachers to integrate GIS into their teaching of Geography.

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