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The Effect of Blended Learning in Mathematics Course

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ABSTRACT
With the advent of the digital age, traditional didactic teaching and online learning have been modified and gradually replaced by "Blended Learning." The purpose of this study was to explore the influences of blended learning pedagogy on junior high school student learning achievement and the students' attitudes toward mathematics. To investigate the outcomes of the combination of Moodle online teaching platform and traditional instruction, a quasi-experiment was conducted using a pre-test–post-test control group design. ANCOVA and MANCOVA analyses showed that the blended learning experience benefitted students in the experimental group by having a positive effect not only on the learning outcomes, but also on their attitudes toward studying mathematics in a blended environment. Preliminary results indicated that male students and high-ability students were more motivated in the blended learning environment. Students gave positive feedback on the use of the Moodle learning platform for mathematics after experiencing blended learning.
Keywords: ability differences; blended Learning; gender; mathematics attitude; Moodle.

INTRODUCTION

Didactic teaching is one of the primary methods applied to large class teaching. However, the biggest problem is that it fails to allow close tutorial supervision, reducing opportunities for interactive learning. To address this problem, a new teaching method called "Blended Learning" can be used. The blended learning model combines traditional classroom teaching and an e-learning system (Zou, 2005). In this model, a teacher may teach the first few sessions in a classroom. After the students have established a general idea of the course, they can then proceed to online learning and interaction.

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State of the literature

- The blended learning model combines traditional classroom teaching and an e-learning system. The application of Moodle as a learning platform enhances educational interaction and helps teachers understand students' personal aptitudes and academic achievements.
- Scholars argue that learning attitudes and efficiency are the key points of research in computer-mediated instruction.
- From the literature, there have been inconsistent findings on the gender effect on mathematics learning. In addition, the ability may influence mathematics learning. Therefore, further studies should be undertaken to gender and ability variables to investigate the effect of blended learning pedagogy and traditional teaching of mathematics.

Contribution of this paper to the literature

- This paper provides a critical literature review about blended learning pedagogy by combing the Moodle online teaching platform with traditional instruction.
- This paper provides a significant contribution in literature, regarding on-line learning's use in secondary mathematics education.
- It highlights that blended learning pedagogy showed a significant positive effect on attitude toward mathematics. And the results indicated that male students and high-ability students were more motivated.
- We suggest that Moodle online learning in blended learning pedagogy should be widely used to enhance students' active learning and to construct knowledge with peers.

Ideally, if we can combine the advantages of classroom teaching and e-learning, the learning effects will be enhanced and extended in a blended model.

Teachers would be able to give instruction to individual students who encounter learning difficulties in class, while other students could work independently on the contents that require simple reasoning and memory. Students can achieve the aim of study only when they analyze, speculate, and explore problems independently to obtain options or alternative answers to questions. Through this new teaching method, teachers can guide students to progress steadily, because self-study and the attitude of independence are fundamental to the motivation for research and creativity. Owing to the rapid development of network techniques in recent years, many multimedia teaching platforms, such as Moodle, have been in use.

Moodle, which was constructed on a Course Management System (CMS) to support e-learning, offers students' opportunities for online group discussion and self-examination, while providing teachers with information about students' learning processes and opinions. The application of Moodle as a learning platform enhances educational interaction and helps teachers understand students' personal aptitudes and academic achievements to improve teaching quality and efficiency. This study aims to examine whether different teaching methods could lead to different learning attitudes and have positive effects on students. In addition, based on different genders and abilities, different teaching methods may show variations in students' learning attitudes and mathematics performances.

LITERATURE REVIEW

A Study of Teaching Models

Traditional teaching

Traditional in-class teaching methods include explanation and demonstration of teaching materials, and arrangement of learning activities such as observation, experiments, outdoor activities, group discussion, practice, presentations, and classroom questioning and answering. These activities emphasize in-class interactions, student participation in cooperative learning, and formative assessments such as quizzes and tests, practice and school work exercises, and assignment correction. After-school activities include project reports, documentary research, and remedial classes (Chen & Lai, 2005).

In challenging courses such as mathematics and science, struggling students often become frustrated and despondent. Courses taught using the traditional method move all students through the curriculum at the same pace, regardless of mastery. The classroom teacher often has little time to assist individual students, and students often have no one at home to turn to for assistance. The end result is student frustration, leading to incomplete homework assignments and subsequent poor performances on assessments. Such repeated experiences often result in low academic self-efficacy and loss of interest and effort (Bandura, 1977). Thus, the theoretical basis of this research relies on an analysis of the pedagogical methods of traditional teaching.

Blended learning

Because of recent advances in technology, traditional didactic teaching and online learning have been modified and gradually replaced by "Blended Learning." The concept of blended learning, which unites multiple teaching models, has recently received much attention. Marsh and Drexler (2001) and Willett (2002) claimed that blended learning represents all teaching models that are integrated with technology, such as e-mails, streaming media, and the Internet, and can be combined with traditional teaching methods. In the United States, blended learning has been applied by some professors to traditional face-to-face instruction by replacing one or two lessons of the weekly curriculum with e-learning courses (Zou, 2005). According to published research, significant academic progress is made when traditional teaching is combined with computer-assisted teaching (Dalton & Hannafin, 1988). Therefore, when traditional didactic teaching complements computer-assisted teaching methods, it may be employed in junior high school mathematics teaching. Instead of fully adopting computer-assisted teaching methods in class, teachers could incorporate certain elements to improve traditional didactic teaching, which emphasizes teacher-centered lectures. In this study, Moodle online learning refers to blended learning pedagogy that incorporates online teaching with traditional elements.

Meaning and Content of the Moodle Learning Platform

Content and functions of the Moodle learning platform

Moodle is a free educational web application designed for e-learning (http://moodle.org) based on a constructivist and social constructionist approach to education, which emphasizes that learners can contribute to the educational experience in many ways (Dougiamas, 1998; Wu, 2008). Moodle includes flexible features including the layout, course management, assessment strategy quizzes, and cooperative learning (Wu, 2008). The e-learning website for Kaohsiung Compulsory Education Advisory Group—the school website chosen for this experimental research—states that Moodle contains several functional modules: website management, learning management, course management, school work module, charting module, voting module, forum module, test module, resource module, questionnaire module, and topic discussion module.

The application of Moodle instruction

Using the functional modules of the Moodle learning platform, teachers can conduct interactive activities for online group discussion, examinations, and assessments. It provides a means to collect students' opinions and information on their learning process and helps teachers understand students' personal aptitudes and academic achievements to enhance teaching quality and efficiency.

(a) The "learner-centered" pedagogical model allows students to learn about Moodle without limits of time and distance.

(b) The use of online computer-assisted assessment not only reduces teachers' workloads, but also meets the demands for instant diagnostic results of student learning. It also has the advantages of meeting the consensus in environmental protection, lowering the costs of paper-based assessment, enhancing teaching efficiency, and delivering instant feedback to the students.

Owing to greater flexibility with respect to location and timing, computer-assisted teaching methods have evolved and changed the traditional in-class teaching style whereby students unilaterally gain knowledge from teachers. Incorporating scientific technology with education creates interactive discussions not only between the teachers and students but also between the students, thus making the learning process active, multi-faceted, and flexible; enhancing learning quality; and motivating the students to engage in self-directed and responsible learning. Students become active learners, rather than knowledge receivers (Baillie & Percoco, 2000; Chen, Lou, & Luo, 2001).

The Moodle learning platform demonstrates teaching materials with thorough explanations using text and pictures or graphics. However, students often misunderstand abstract mathematical concepts. In this new era of advanced digital technology, students need to consolidate their comprehension of mathematical concepts through visual pictures and graphics, for which Moodle provides a humane interface. Through the representation of text and pictures and the connection to the Internet, teachers can provide students with clues and evidence to strengthen the students' capacity of comprehension. By transferring illustrations, graphics, charts, and pictures to computer screens, teachers are always ready to satisfy the needs of students who prefer visual approaches to learning (Neal & Moore, 1992). Adopting the approach of computer-mediated presentation, teachers can guide students to understand abstract and unintelligible concepts and facts (Osborn, 2001) and stimulate students' interest and motivation for learning. Hence, scholars argue that learning attitudes and efficiency are the key points of research for computer-mediated instruction (Alavi, Marakas, & Yoo, 2002).

The effectiveness of Moodle instruction in Secondary Education

Previous research found the benefits from the use of Moodle in the secondary education (Kok, 2008; Lu, & Law, 2011; White, 2010). Moodle had pedagogical advantages since it was built in accordance with the teaching approach which emphasizes the construction of knowledge through active and interactive learning, and learning multi-sensory experience through multimedia. The design of Moodle was based on socio-constructivist pedagogy (Palinscar, 1998; Brandl, 2005; Shachar, & Neumann, 2010). This means its goal is to provide a set of tools that support an inquiry and discovery-based approach to online learning and it is employed to create an online course that is used to enhance and supplement face-to-face classroom instruction in several ways. Furthermore, it purports to create an environment that allows for collaborative interaction among students as a standalone or in addition to conventional classroom instruction and allows users to be active learners, actively participating in the online learning process (Zakaria, & Daud, 2013).

There has been significant research in recent years on the effectiveness of Moodle instruction. Studies have shown that an important aspect of this approach is the enhancement of students' mathematical achievements (Atanasova-Pacemska, Pacemska, & Zlatanovska, 2012; Awodeyi, Akpan, & Udo, 2014; Šumonja, Veličković, & Šubarević, 2015). This method could help them easily catch on mathematic courses and expressed their view of points (Li, 2010). Moreover, it improved learners' interest and positive attitude (Martinblas, & Serranofernandez, 2009; Somenarain, Akkaraju, & Gharbaran, 2010; Kotzer, Shulamit, & Elran, 2012; Zakaria, & Daud, 2013).

Learning Efficiency

Piccoli, Ahmad, and Ives (2001) considered that the effectiveness of learning refers to the end result of teaching, including learner changes in cognition, affect, and skills. Nowadays, relevant studies on digital learning use numerous indicators, such as learning achievement and learning attitude, to evaluate the effectiveness of computer-mediated instruction (Chou & Liu, 2005; DeTure, 2004; Leidner & Fuller, 1997; Piccoli, Ahmad, & Ives, 2001).

Academic achievement

Academic achievement refers to student assessment measured by tests and examinations during the learning process. Merrill (1994) mentioned that academic achievement is usually measured by "achievement tests." Therefore, this research uses learning performance indicated by achievement test scores as a dimension factor to evaluate learning efficiency.

Mathematics attitude

The second indicator of learning effectiveness is attitude. Based on Aiken's (2000) definition, attitude is "a learned predisposition to respond positively or negatively to a specific object, situation, institution, or person" (p. 248). Therefore, attitude affects what people do and reflects who they are, and is thus a determining factor of people's behavior.

In the field of mathematics education, research on attitude has been motivated by the belief that it plays a crucial role in mathematics learning (Neale, 1969). Among student variables, attitudes are regarded by several researchers as an important factor to consider when attempting to understand and explain variability in student performance in math (Köğce, Yıldız, Aydın, & Altındağ, 2009; Mato Vázquez & de la Torre Fernández, 2009; Mohamed & Waheed, 2011; Nicolaidou & Philippou, 2003).

According to Tan (1992), the definition of mathematics attitude indicates a person's ideology, perspectives, and practices regarding mathematics, or a person's preference of mathematics (Wei, 1988). Other scholars have declared that students' attitude toward mathematics is a concept that combines the belief and confidence in mathematics (Tsaur & Chou, 1997). With references to the perspectives of international scholars, the analyses of mathematics attitude in this research was divided into six dimensions: (a) confidence in learning mathematics, which refers to students' perspectives of their mathematic capacity and performance; (b) attitude toward success in mathematics, which refers to students' expectation to succeed in mathematics; (c) usefulness of mathematics, referring to student's viewpoints regarding the practicality of mathematics; (d) motivation for exploring mathematics, which refers to the extent of students' active efforts to explore mathematics; (e) mathematics anxiety, which refers to tense feelings aroused in the process of learning mathematics that interferes with and lowers students' mathematic performance (Fennema & Sherman, 1967); and (f) attitude of important others (e.g., parents and teachers) to mathematics, referring to the perception and expectations parents and teachers have of students' performances in mathematics.

The influence in a blended learning setting

In the teaching and learning of mathematics, we encounter problems that are difficult to solve in a face-to-face teaching framework for the beginners. They may lack the interest, motivation and positive attitude, some are not intended to specialize in it, and thus, they pay little or no attention to understanding basic mathematics concepts (Abramovitz, Berezina, Bereman, & Shvartsman, 2012). Therefore, utilizing a blended learning approach can improve learners' interest and positive attitude. Blended learning facilitates active learning and interactivity between learners and the mediator in the learning environment. Also, the use of blended learning helps to diversify the instructional delivery in mathematics curriculum, as well as, exploring the benefits of web-based technologies in mathematics education (Awodeyi, Akpan, & Udo, 2014).

The study revealed that using a blended learning approach improved students' achievement scores as compared to other approaches (Awodeyi, Akpan, & Udo, 2014) and had improvement effects on students' attitudes toward mathematics (Aiken, 1976; Collins, 1996; Iozzi, & Osimio, 2012). Also, students using the blended learning approach might have benefited from the mediator as more time was spent on learning the task at their own pace. Al-Quhtani and Higgins (2012) reported that blended learning can support students learning more effectively than e-learning or face-to-face learning alone (Awodeyi, Akpan, & Udo, 2014). Instruction combining online and face-to-face elements had a large advantage relative to purely face-to-face instruction than did purely online instructions (Means, Toyama, Murphy, Bakia, & Jones, 2009).

Empirical Studies on Moodle Online Instruction and Effectiveness

Almost all empirical studies on the application of Moodle online instruction and learning achievement have shown that the use of digital learning platform results in higher achievement and improved students' learning attitude (Aiken, 1976). However, research on the application of digital learning platforms and learning achievements has not shown consistent results: some students demonstrated higher performances in learning (Hung, 2007; Liu, 2010; Wang & Yu, 2012; Wiginton, 2013), while others failed to show significant improvements (Hsu, 2010; Lin & Chen, 2007). Regarding the correlation between the gender variable and academic achievement, some studies have found that females perform better than males (Chang, 2007; Chen, 2007), while other studies have found that males perform better than females (Fennema & Sherman, 1976; Lin & Chen, 2007; Sriampai, 1992). Some researchers have argued that gender does not influence academic achievement (Chen, 2012; Corbo, 1984; Li, 2010; Lindberg, Hyde, Petersen, & Linn, 2010; Liu, 2010; Samuels, 1983; Scafidi & Bui, 2010). Different results have been found for the correlation between ability and the improvement of academic achievement. Some studies have found a significant difference in learning performance among students with different abilities (Hooper, 1992; Li, 2010; Tsai, 2000); however, the learning attitudes among those students have not been found to associate with learning performance (Li, 2010; Tsai, 2000). In addition, high-ability computer-assisted learning in groups can facilitate learning benefits for students (Claire & Gratt, 1995).

Research Hypotheses

From the literature, there have been inconsistent findings on the gender effect on mathematics learning. In addition, ability may influence mathematics learning. Therefore, gender and ability variables were included in this study to investigate the effect of blended learning pedagogy and traditional teaching of mathematics. The relationships between teaching methods, gender, and ability were explored. Taking the main purpose of this study into consideration, the following research hypotheses were developed:

H1: A significant difference exists between the experimental group and the control group in the academic achievement in mathematics.

H2: A significant difference exists between the experimental group and the control group in the attitude toward mathematics.

H3: A significant difference exists between genders in terms of academic achievement in mathematics after experimental treatments.

H4: A significant difference exists between genders in terms of attitude toward mathematics after experimental treatments.

H5: A significant difference exists between students with different abilities (high ability, medium ability, and low ability) in terms of academic achievement in mathematics after experimental treatments.

H6: A significant difference exists between students with different abilities (high ability, medium ability, and low ability) in terms of attitude toward mathematics after experimental treatments.

METHODS

This study evaluates the effectiveness of a blended learning strategy and assesses whether incorporating the Moodle online learning platform with traditional instruction improves seventh grade students' academic achievement. The study also evaluates the students' attitudes toward mathematics and reaching the goal of educational excellence.

Moodle Course Management

Multiple instructional courses and activities were posted by the teacher on the online learning platform, which were activated or deactivated according to the timing or instructional needs. The "Teaching Resource" area of the course website included quick links to websites, digital learning materials, and homemade videos (**Figure 1**), which provided choices for delivering out-of-class instruction. To ensure that students could access the online instruction, a teaching schedule was constructed and organized by sequence and timing (**Figure 2**). The students needed to upload the assigned homework to a specified website location such as the "teaching activities" area, i.e., the area for students to submit assignments, share opinions, and join group discussions, before the due date for correction and grading (**Figure 3**).

Teachers raised questions related to the content of the courses for class discussion and then provided guidance in a timely manner. Students participating in the group discussions received extra points for encouragement (**Figure 4**). The "information" section included messages about new courses, a chat room, and opinion survey, thus providing an opportunity for students to share personal views and communicate via the website. The course website allowed teacher-student, student-student, and one-to-one asynchronous interactions, and a simple opinion survey was also conducted (**Figure 5**). The area for tests and drills gathered exam questions (including multiple-choice, short-answer, matching, and fill-in questions), which were classified into beginner, intermediate, and advanced levels. In order to assess students' exam responses and learning efficiency, students were required to answer the questions given on the website for correction and grading before a deadline (**Figure 6**). There platform also provided a "mathematic games" area and a "recommended websites" area for self-study.

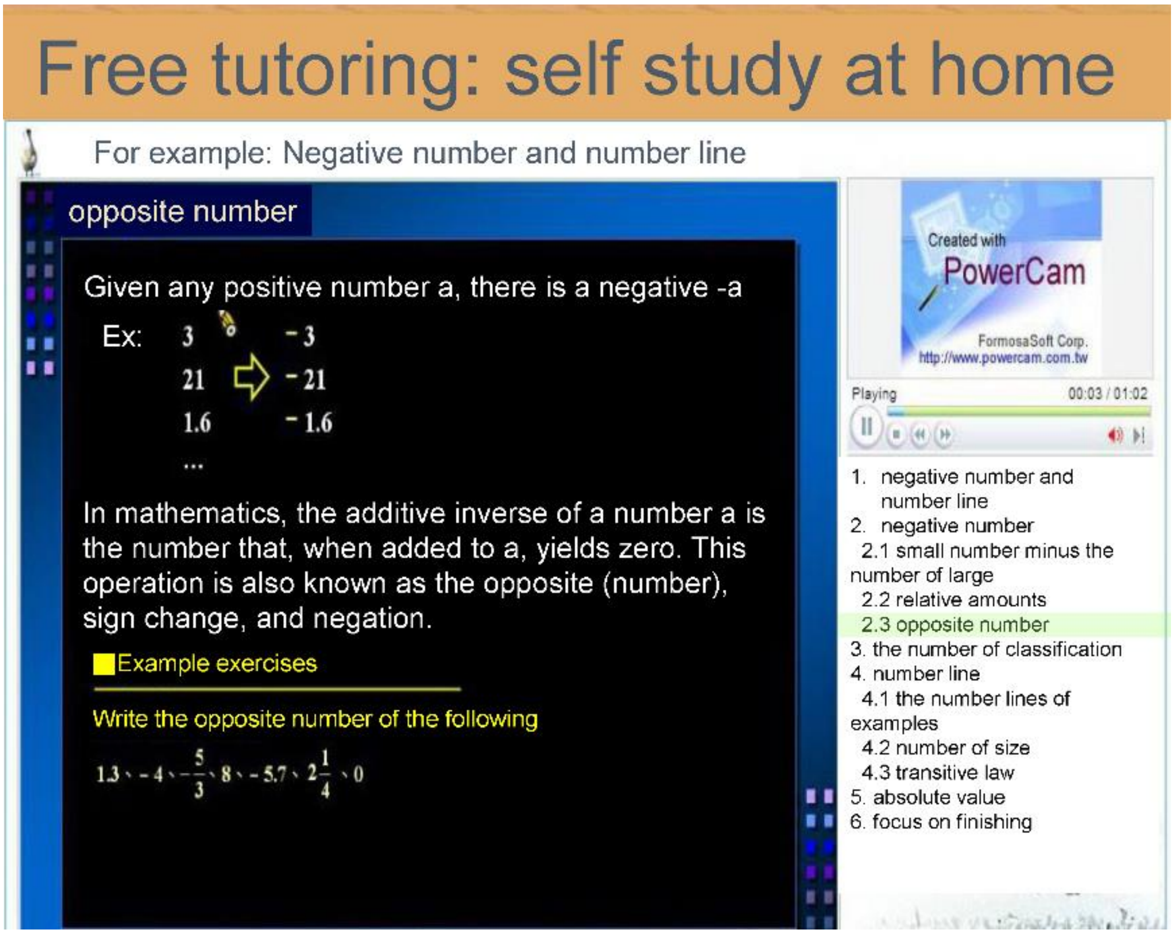

Figure 1. Digital learning materials and homemade videos.

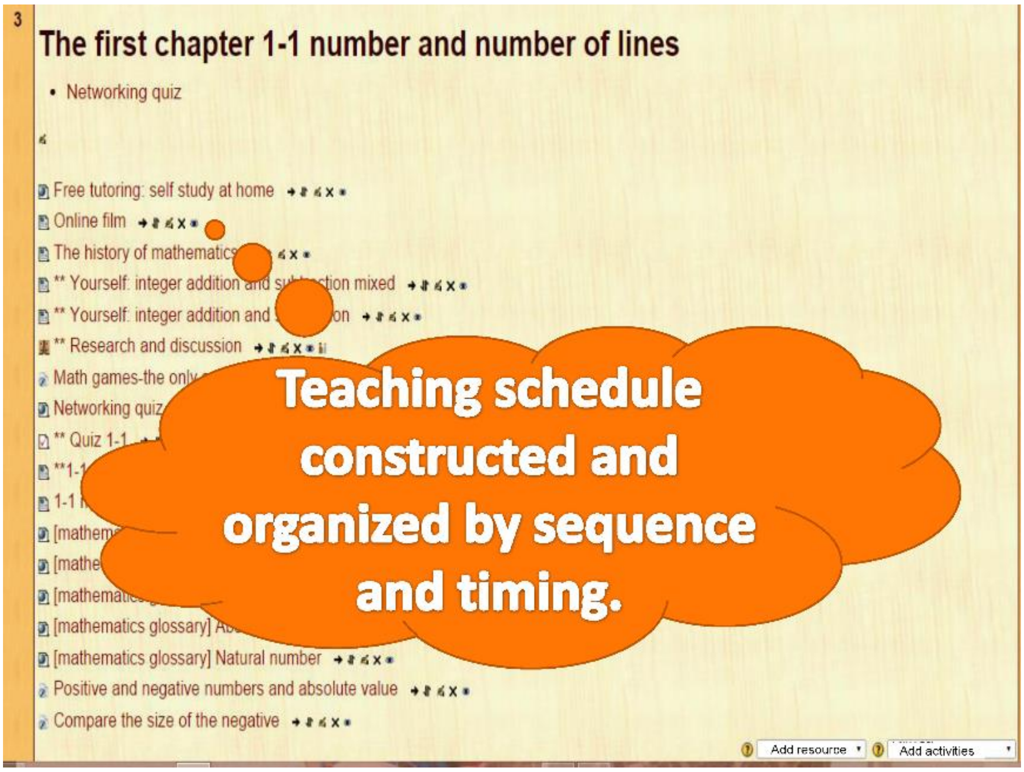

Figure 2. Teaching schedule constructed and organized by sequence and timing.

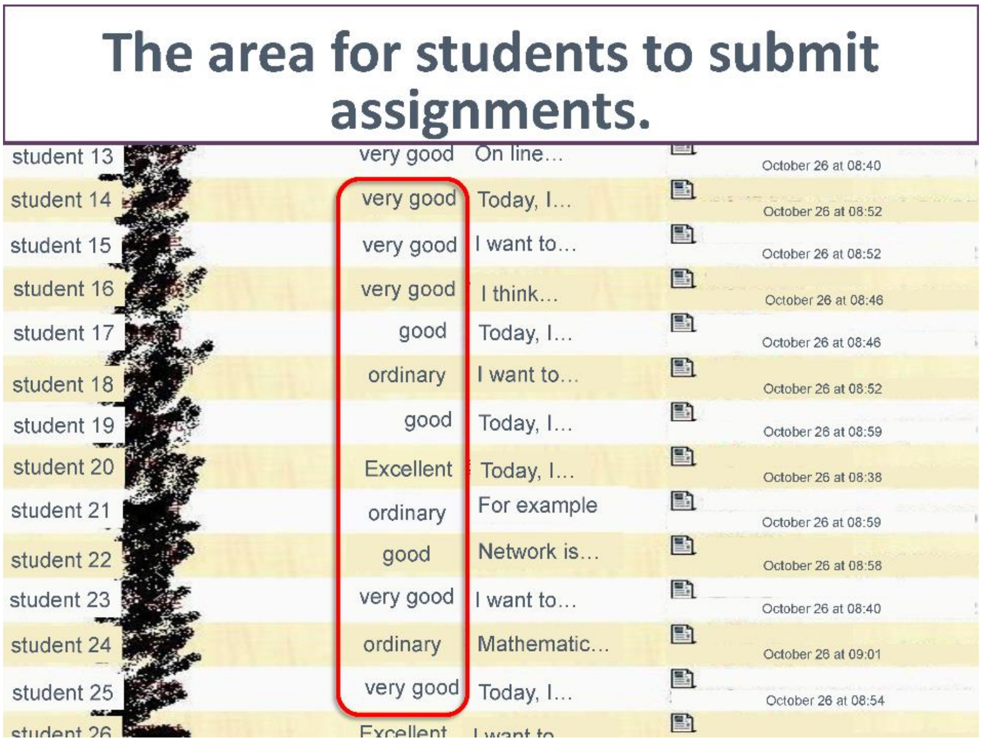

Figure 3. The area for students to submit assignments.

Figure 4. Teachers raised questions related to the content of the courses for class discussion.

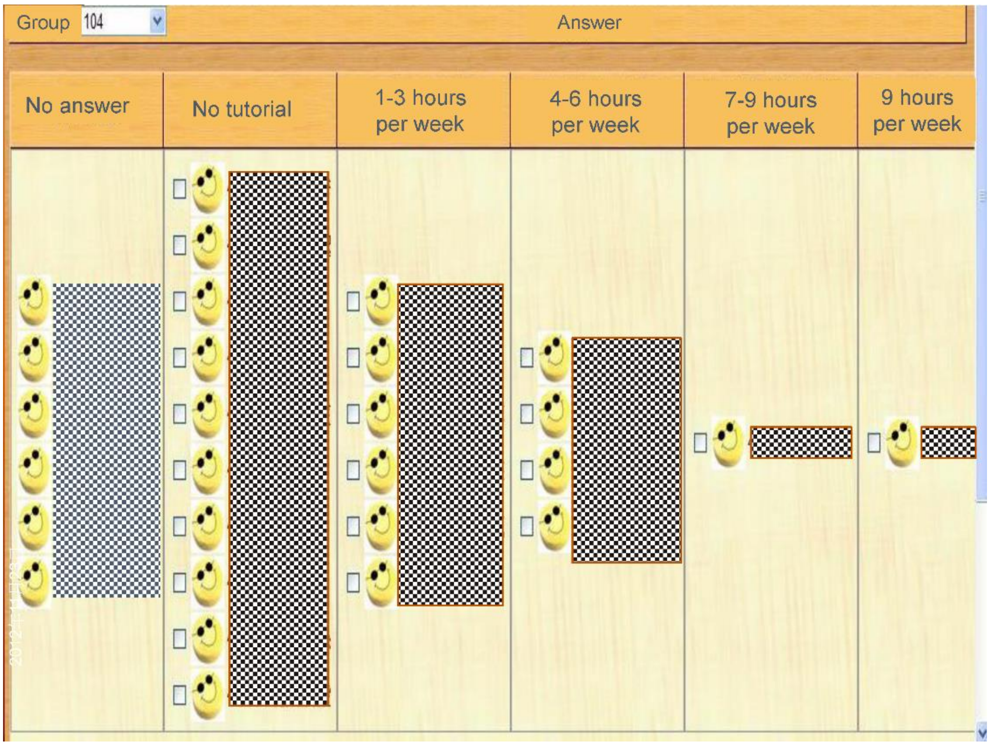

Figure 5. A simple opinion survey was conducted.

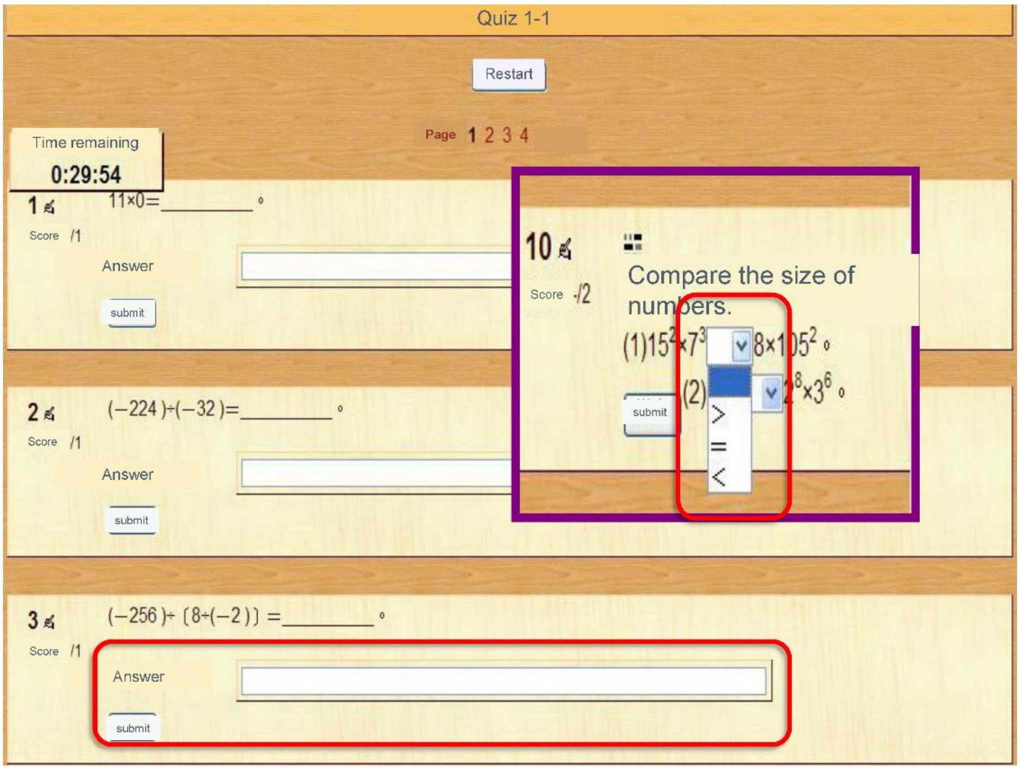

Figure 6. Students were required to answer the questions given on the website.

Respondents and Experimental Design

The respondents of this research were students enrolled in the school where the researcher works. The subjects in this study were 54 seventh grade students (12–13 years of age, in two different classes) from a junior high school in Kaohsiung, Taiwan, who were mostly below intermediate level in learning achievement. This study employed an untreated control group design with pre- and post-tests (Cook, Campbell, & Day, 1979). As shown in Table 1, a pre-test was conducted before the experimental instruction, followed by a post-test. For the experimental group, the blended learning method with Moodle was used as the teaching method. For eight months during one whole semester, students in the seventh grade took five mathematics courses each week in a computer laboratory. Teachers recorded the teaching materials as videos or looked for Internet resources, such as films, to assign to the students for homework before attending each class. Students could also watch the videos when they had time at school. Students received a set of guiding questions to answer before each class, and they were asked to prepare one or two questions to ask in class after watching the assigned videos. During class, students were requested to take notes and share their perspectives to facilitate class discussion. During the process, when the teachers discovered problems that students had encountered, they would explain more explicitly and spend more time on problem-solving activities. After further explanation, the student online assessment was delivered. Students were classified into high-, medium-, and low-ability groups based on their previous knowledge, achievement pre-test scores, and the teachers' overall evaluations. For the control group, a traditional method based on whole class teaching was used. In this setting, the teachers were asked to use their regular instruction method, including unit presentation, individualized practice activities, and quizzes.

Table 1. ***Quasi-Experimental Study Design***

Group	Pre-test	Experimental treatments	Post-test
Experimental group	O_1	X_1	O_2
Control group	O_3	X_2	O_4

X_i: Experimental treatments at i, i = 1, 2.
O_i: Mathematics achievement test at i, i = 1, 2.
O_i: Attitude towards mathematics scale at i, i = 3, 4.

Research Tools and Methods

The research tools for this survey included three achievement tests and the Mathematics Attitude Scale. At the end of the experimental instruction, open-ended surveys were administered to all participants in the treatment group to establish if they believed that the blended learning approach impacted on their learning.

Achievement tests

To verify the validity of the experimental instruction, pre-test and post-test scores were calculated and compared, as monthly exam scores were used as the standard of measurement for pre-test and post-test. The two exams were intended to assess students' knowledge and skills in math at the Grade 7 level. It included four types of questions, which required understanding basic math concepts, performing routine procedures, using complex procedures, and solving novel problems. A panel of researchers and school teachers who had experience teaching math constructed and reviewed the items to ensure the content validity, clarity, and grade-level appropriateness of the assessment instrument in the local context. A pilot study was conducted to select items from the item pool on the basis of their psychometric quality such as item difficulty, item discrimination, and functioning of distracters. A final set of 30 items was selected and administered in the present study. In the final scoring, two items that did not register adequate psychometric quality were dropped. The 28 items were used for final scoring. Both the pre-test and post-test were examined for reliability using Cronbach's Alpha (α= .73 and .87) and analysis had high reliability. This was used to test the internal consistency reliability of the questions on the instruments. So the tests had good reliability and validity. The exams needed to answer within 55 minutes. The exam scores were collected and estimated to evaluate students' academic achievements in the learning process.

Validity analysis of the mathematics attitude scale

The mathematics attitude scale designed for elementary students by Tsaur and Chou (1997) was modified and used before and after the experiment in this study. The modified version of the mathematics attitude scale has good face validity, since one of the expert scholars in a related academic field, two junior high school mathematics teachers, and some junior high school students participated in the wording and syntactic correction of the scale.

The modified version of the mathematics attitude scale contained 55 items with six dimensions included (a) confidence in learning mathematics (items 1–9); (b) usefulness of mathematics (items 10–18); (c) motivation for exploring mathematics (items 19–26); (d) attitude toward success in mathematics (items 27–34); (e) attitude of important others (items 35–46); and (f) mathematics anxiety (items 49–55). Satisfaction data were gathered using a 4-point scale, ranging from 1 = strongly disagree to 4 = strongly agree. The sum of the six subscales' scores were equal to the total scale; the higher the score, the more positive were the participants, and vice versa.

Prior to administering the mathematics attitude scale, a scale validity check was conducted with a pre-test sample. Purposive sampling was employed in the pre-test sample. Eight classes were randomly selected from 7-9 grade students in five schools. Surveying time lasted approximately 20-30 minutes (all surveys were paper-based questionnaires). The pre-test questionnaire items were then analyzed and the validity analysis performed. After the best theoretical structure and appropriate topic were found, the revised scale based on the pre-test was obtained. A total of 234 samples was received. After adjusting for invalid questionnaire samples, 218 samples remained (females, n = 110; males, n = 108). After the pre-test, the factor structure of the mathematics attitude scale was analyzed using principal component analysis and factor analysis to examine the internal structure of the scale and construct validity. The six-factor solution for lateral trust explained 50.8 per cent of the total variance, and received an acceptable value on the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO=0.870). Cronbach's α for the scale was 0.931, and Cronbach's α for each subscale was 0.827, 0.807, 0.710, 0.717, 0.819, and 0.767 (**Table 2**), respectively. Wu (2003) argued that any validity coefficient greater than 0.90 suggested that the tests or scales were reliable, and any validity coefficient greater than 0.6 were trustworthy. Therefore, the subscales and whole scale in this research showed high internal consistency.

Table 2. Reliability of the Mathematics Attitude Scale (N=218)

Mathematics Attitude	Cronbach's α	
Confidence in learning mathematics	0.827	0.931
Usefulness of mathematics	0.807	
Motivation of exploring mathematics	0.710	
Attitude toward success in mathematics	0.717	
Attitude of important others to mathematics	0.819	
Mathematics anxiety	0.767	

Statistical analysis

All quantitative statistical analyses were conducted using SPSS 18.0. Descriptive statistics were obtained, and ANCOVA and MANCOVA were conducted on the scores from the achievement tests and mathematics attitude scale. Before the ANCOVA and MANCOVA analyses, assumptions of parametric statistics (i.e., normality, homogeneity of variances, linearity, and multicollinearity) were tested visually, numerically, and statistically. In the ANCOVA analysis, post-test scores of the achievement tests were used as the dependent variables. In the MANCOVA analysis, post-test scores of the mathematics attitude scale were used as the dependent variables. Gender and ability were the independent variables, and the pre-test scores in the achievement tests and mathematics attitude scale were used as the covariance. Post-hoc analyses were conducted where the variances were equal according to Levene's test for equal variances (Garson, 2005). After analyzing and comparing the differences of each group by Cohen's d or ω^2 test, the validity of the experimental results was verified. Cohen suggested that d = 0.2 represents a "small" effect size, d = 0.5 represents a "medium" effect size, and d = 0.8 represents a "large" effect size (Cohen, 1988), and $\omega^2 < .01$ represents a low effect, $.01 > \omega^2 > .0138$ represents a moderate effect, and $\omega^2 > .138$ represents a high effect.

Qualitative data

To find out students' opinions about the functioning of the studying process of the students in the learning groups, a questionnaire including 4 open-ended questions which the teachers (the researcher and colleague) who taught the unit established the content and face validity of the test questions was carried out. The aim was to find out students' opinions regarding the blended learning approach impacted on their learning. They were invited to comment on questions:

1. Do you think that the blended approach helped you with your learning? Give reasons.
2. Do you think that Moodle improved your results in Mathematics? Give reasons.
3. Do you believe that it is a good idea to supplement in class learning with teacher developed websites such as Moodle? Give reasons.
4. What are your thoughts on the online tests?

The data obtained after students' opinions were transferred to Excel program and their descriptive analyses were made.

RESULTS

From the results on the achievement test and the mathematics attitude scale, this research aimed to prove each hypothesis in the following paragraphs.

Comparison of Pre-test and Post-test Scores on the Achievement Tests

To test the hypothesis that the experimental instruction can enhance academic achievement, two sets of monthly examination scores of the students in the experimental group were compared with the scores of students in the control group, and analyzed using one-way ANCOVA (**Table 3**). A nonsignificant Levene's test, indicated a lack of evidence that the homogeneity of homogeneity of variance assumption was violated. In addition, tests for the homogeneity of regression for ANCOVA stepdown analyses showed that the homogeneity of regression assumption was met for all the dependent variables (p>0.05). No univariate or multivariate outliers were evident and ANCOVA was considered to be an appropriate analysis technique. Students under different teaching methods were significantly different in terms of academic achievement ($F_{(1,\ 51)}$ =5.23, p=.03). Post-hoc comparisons showed that the post-test scores of students in the experimental group (M=64.30, SD=24.39) were significantly higher than the post-test scores of students in the control group (M=54.70, SD=28.58), thus confirming hypothesis **H1**. However, ω^2 = 0.020 shows a weak relationship, meaning that the differences were small. Although the average scores for the pre-test were similar between the experimental group and the control group, the post-test scores showed that the experimental group improved significantly compared to the control group.

Table 3. ANCOVA Results for Experimental and Control Students for Academic Achievement in Mathematics

	Class	Dimensions	Pre-test		Post-test		Levene's test		Homogeneity of Regression	
Descriptive statistics		***N***	***M***	***SD***	***M***	***SD***	***F***	***p***	***F***	***p***
	Experimental	27	42.67	26.81	64.30	24.39	0.04	.84	0.00	.99
	Control	27	41.19	29.16	54.70	28.58				
	Total	54	41.93	27.75	59.50	26.76				
ANCOVA	**Source**	***SS***	***df***	***MS***	***F***	***p***	**ω²**	**1-*β***	**Post-Hoc**	
	Between	946.67	1	946.67	5.23	.03	0.02	0.61	1>2	
	Within	9240.86	51	181.19						
	Total	37947.50	53							

Note. 1=Experimental students; 2=Control students.
$^{*}p$<.05, $^{**}p$<.01, $^{***}p$<.001

Comparison of Pre-Test and Post-Test Scores of Mathematics Attitude Scale

One-way MANCOVA was conducted to assess the change in students' attitudes toward mathematics, and the results are shown in **Table 4**. A nonsignificant Box's M, indicated a lack of evidence that the homogeneity of variance-covariance matrix assumption was violated. No univariate or multivariate outliers were evident and MANOVA was considered to be an appropriate analysis technique. The post-test scores on "confidence in learning mathematics" were significantly higher than the pre-test scores. In addition, post-test scores on "usefulness of mathematics," "motivation for exploring mathematics," "attitude toward success in mathematics," "attitude of important others to mathematics, "and "mathematics anxiety" were also notably higher than for the pre-test (**Table 4**). The results show positive effects of experimental instruction on students' attitudes toward mathematics, which confirmed hypothesis **H2,** and ω^2 for each dimension was 0.809, 0.645, 0.364, 0.468, 0.617, and 0.698, respectively, indicating significant differences.

Table 4. MANCOVA Results for Experimental and Control Students for Attitude Toward Mathematics

	Class		Con		Use		Mot		Suc		Imp		Anx	
		N	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Descriptive statistics	Experimental	27	2.56	0.57	3.18	0.29	3.00	0.49	2.51	0.37	2.76	0.35	2.81	0.33
	Control	27	2.30	0.61	2.23	0.51	2.69	0.65	2.13	0.47	2.01	0.45	2.27	0.46
	Total	54	2.43	0.60	2.71	0.63	2.85	0.59	2.32	0.46	2.38	0.55	2.54	0.48

Box's M=50.424 *p*= .063

MANCOVA									**ANCOVA**							
Source	***df***	**SSCP**						**Λ**	**Source**		***SS***	***df***	***MS***	***F***	**Post -Hoc**	**ω²**
Between	1	1.74	4.64	1.75	1.91	3.65	2.60		**Between**	Con	1.74	1	1.74	22.26***	1>2	0.809
		4.64	12.40	4.68	5.12	9.75	6.96			Use	12.40	1	12.40	76.98***	1>2	0.645
		1.75	4.68	1.77	1.93	3.68	2.63	16.43***		Mot	1.77	1	1.77	6.94**	1>2	0.364
		1.92	5.12	1.93	2.12	4.03	2.87			Suc	2.12	1	2.12	16.14***	1>2	0.468
		3.65	9.75	3.68	4.03	7.67	5.47			Imp	7.67	1	7.67	56.69***	1>2	0.617
		2.60	6.96	2.63	2.87	5.47	3.90			Anx	3.90	1	3.90	48.84***	1>2	0.698
Within	46	3.59	0.32	-0.43	-0.28	1.03	0.93		**Within**	Con	3.59	46	0.08			
		0.32	7.41	0.06	2.15	3.82	2.07			Use	7.41	46	0.16			
		-0.43	0.03	11.72	2.47	1.03	0.82			Mot	11.72	46	0.26			
		-0.28	2.15	2.47	6.03	1.93	1.29			Suc	6.03	46	0.13			
		1.03	3.82	1.03	1.93	6.23	2.03			Imp	6.23	46	0.14			
		0.93	2.07	0.82	1.29	2.03	3.68			Anx	3.68	46	0.08			

Note. Con=confidence in learning mathematics; Use=usefulness of mathematics; Mot=motivation for exploring mathematics; Suc=attitude toward success in mathematics; Imp=attitude of important others; Anx=mathematics anxiety; 1=experimental students; 2=control students. $^{*}p$<.05 · $^{**}p$<.01 · $^{***}p$<.001

Gender Differences on the Achievement Test

Students were divided by gender (13 males and 14 females). A one-way ANCOVA was conducted using post-test scores on the achievement test as the dependent variable, gender as the independent variable, and pre-test scores of achievement test as the covariate (**Table 5**). Before the analyses, assumptions of parametric statistics were tested visually, numerically, and statistically. All assumptions were met. Students of different gender did not differ significantly in their performances ($F_{(1, 24)}$ =0.420, p>.05) on the achievement test. The result corresponds to the findings of Li (2010), Liou (2010), and Chen (2012). Therefore, hypothesis **H3** was not confirmed, suggesting that gender does not influence academic achievement.

Table 5. ANCOVA Results for Gender Differences in Academic Achievement in Mathematics

Descriptive statistics	Sex	Dimensions	Pre-test		Post-test		Levene's test		Homogeneity of Regression	
		N	*M*	*SD*	*M*	*SD*	*F*	*p*	*F*	*p*
	Male	13	45.23	28.35	67.38	25.57	0.000	.993	0.034	.854
	Female	14	40.29	26.13	61.43	23.84				
	Total	27	42.67	26.81	64.30	24.39				
ANCOVA	**Source**	***SS***	***df***	***MS***	***F***	***p***	**ω^2**	**1-*β***	**Post-Hoc**	
	Between	92.513	1	92.513	0.420	.523		0.095		
	Within	5291.96	24	220.498						
	Total	18180.7	26							

Note. Only ANCOVA results with significant differences were examined using ω^2 analysis and post-hoc tests.
$^{*}p<.05$, $^{**}p<.01$, $^{***}p<.001$

Gender Differences on Attitude toward Mathematics

A one-way MANCOVA was conducted using the post-test scores of the mathematics aptitude tests as the dependent variable, gender as the independent variable, and scores on

Table 6. MANCOVA Results for Gender Differences on Attitude toward Mathematics

Descriptive statistics	Sex		Con		Use		Mot		Suc		Imp		Anx	
		N	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
	Male	13	2.37	0.54	3.28	0.32	2.79	0.48	2.53	0.39	2.91	0.37	2.72	0.35
	Female	14	2.73	0.56	3.08	0.24	3.20	0.42	2.49	0.37	2.62	0.28	2.90	0.29
	Total	27	2.56	0.57	3.18	0.29	3.00	0.49	2.51	0.37	2.76	0.35	2.81	0.33

Box's M=24.584 *p*= .643

Source	*df*	SSCP						Λ	Source		*SS*	*df*	*MS*	*F*	Post -Hoc	ω^2
Between	1	0.02	-0.06	0.07	0.01	-0.07	0.04		**Between**	Con	0.02	1	0.02	0.47		
		-0.06	0.19	-0.23	-0.04	0.24	-0.12			Use	0.19	1	0.19	2.32		
		0.07	-0.23	0.28	0.04	-0.29	0.14	1.36^{*}		Mot	0.28	1	0.28	1.36		
		0.01	-0.04	0.04	0.01	-0.04	0.02			Suc	0.01	1	0.01	0.08		
		-0.07	0.24	-0.29	-0.04	0.30	-0.15			Imp	0.30	1	0.30	4.95^{*}	1>2	0.650
		0.04	-0.12	0.14	0.02	-0.15	0.08			Anx	0.08	1	0.08	0.79		
Within	19	0.65	-0.68	0.20	-0.17	0.05	0.19		**Within**	Con	0.65	19	0.03			
		-0.68	1.56	0.41	0.22	0.53	-0.16			Use	1.56	19	0.08			
		0.20	0.41	3.86	0.78	0.87	1.02			Mot	3.86	19	0.20			
		-0.17	0.22	0.78	1.68	-0.02	0.51			Suc	1.68	19	0.09			
		0.05	0.53	0.87	-0.02	1.13	0.16			Imp	1.13	19	0.06			
		0.19	-0.16	1.02	0.51	0.16	1.82			Anx	1.82	19	0.10			

Note. Con=confidence in learning mathematics; Use=usefulness of mathematics; Mot=motivation for exploring mathematics; Suc=attitude toward success in mathematics; Imp=attitude of important others; Anx=mathematics anxiety; 1=male; 2=female. $^{*}p<.05$ · $^{**}p<.01$ · $^{***}p<.001$

the mathematics attitude scale as the covariate (**Table 6**). A gender difference was observed for "attitude of important others to mathematics," which was statistically significant (p<.05). This indicated that the post-test scores of "attitude of important others to mathematics" were significantly different for male and female students, i.e., male students scored significantly higher than female students on "attitude of important others to mathematics" (ω^2=0.650). This result therefore confirmed hypothesis **H4**.

Differences in Students with Different Abilities on the Achievement Tests

Based on the pre-test scores for the achievement tests, students were divided into three groups of high ability (8 students), medium ability (10 students), and low ability (9 students). A one-way ANCOVA was conducted using post-test scores of achievement tests as the dependent variable, ability as the independent variable, and pre-test scores on achievement test as the covariate (**Table 7**). As students of different abilities did not show significantly different performances on the achievement tests ($F_{(1, 24)}$ =0.452, p>.05), hypothesis **H5** was not confirmed. The results suggest that neither gender nor ability influences the results of achievement tests.

Table 7. ANCOVA Results for Different Ability (high, medium, and low) Students with Academic Achievement in Mathematics

	Sex	Dimensions	Pre-test		Post-test		Levene's test		Homogeneity of Regression	
Descriptive statistics		*N*	*M*	*SD*	*M*	*SD*	*F*	*p*	*F*	*p*
	High	8	75.50	11.60	91.50	6.70	2.546	.099	0.179	.838
	Medium	10	42.00	13.50	65.60	11.99				
	Low	9	14.22	4.94	38.67	15.87				
	Total	27	42.67	26.81	64.30	24.39				
ANCOVA	Source	*SS*	*df*	*MS*	*F*	*p*	ω^2	1-β	Post-Hoc	
	Between	203.715	2	101.857	0.452	.642		0.115		
	Within	5180.76	23	225.25						
	Total	18180.7	26							

Note. Only ANCOVA results with significant differences were examined using ω^2 analysis and post-hoc tests.
$^{*}p$<.05, $^{**}p$<.01, $^{***}p$<.001

Comparison between Students of Different Abilities on Attitude toward Mathematics

A one-way MANCOVA was conducted using post-test scores of mathematics aptitude tests as the dependent variable, ability as the independent variable, and scores on the mathematics attitude scale as the covariate (**Table 8**). Post-test scores on "attitude of important others to mathematics" between students with different abilities were statistically significant (p<.05). High-ability students scored significantly higher than medium-ability students on "attitude of important others to mathematics" (ω^2=0.705). However, factors of ability and "attitude of important others to mathematics" were not significant. Therefore, the hypothesis H6 was not verified.

Table 8. ***MANCOVA Results for Different Ability (high, medium, and low) Students for Attitude Toward Mathematics***

	Ability		Con		Use		Mot		Suc		Imp		Anx	
		N	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Descriptive statistics	High	8	2.11	0.36	3.26	0.27	2.82	0.50	2.57	0.45	2.96	0.41	2.82	0.12
	Medium	10	2.57	0.31	3.12	0.26	2.97	0.40	2.50	0.29	2.71	0.31	2.65	0.43
	Low	9	2.94	0.68	3.16	0.36	3.21	0.53	2.47	0.41	2.64	0.31	2.99	0.24
	Total	27	2.56	0.57	3.18	0.29	3.00	0.49	2.51	0.37	2.76	0.35	2.81	0.33

Box's M=87.904 p=.103

Source	*df*	SSCP						Λ
Between	2	0.02	0.02	-0.01	0.05	0.08	0.09	
		0.02	0.02	0.00	0.08	0.03	0.06	
		-0.01	0.00	0.00	0.00	-0.03	-0.02	
		0.05	0.08	0.00	0.30	0.02	0.14	2.973**
		0.08	0.03	-0.03	0.02	0.47	0.41	
		0.09	0.06	-0.02	0.14	0.41	0.40	
Within	18	0.65	-0.75	0.27	-0.21	-0.10	0.14	
		-0.75	1.72	0.18	0.11	0.74	-0.33	
		0.27	0.18	4.13	0.83	0.62	1.19	
		-0.21	0.11	0.83	1.39	-0.09	0.38	
		-0.10	0.74	0.62	-0.09	0.95	-0.40	
		0.14	-0.33	1.19	0.38	-0.40	1.49	

Source		*SS*	*df*	*MS*	*F*	Post-Hoc	ω^2
Between	Con	0.02	2	0.01	0.31		
	Use	0.02	2	0.01	0.12		
	Mot	0.00	2	0.00	0.00		
	Suc	0.30	2	0.15	1.96		
	Imp	0.47	2	0.24	4.46	1>2	0.705
	Anx	0.40	2	0.20	2.43		
Within	Con	0.65	18	0.04			
	Use	1.72	18	0.10			
	Mot	4.13	18	0.23			
	Suc	1.39	18	0.08			
	Imp	0.95	18	0.05			
	Anx	1.49	18	0.08			

Note. Con=confidence in learning mathematics; Use=usefulness of mathematics; Mot=motivation for exploring mathematics; Suc=attitude toward success in mathematics; Imp=attitude of important others; Anx=mathematics anxiety; 1=high-ability; 2=medium-ability; 3=low-ability. *p<.05, **p<.01, ***p<.001

The Interaction Effect between Genders and Abilities

A two-way ANCOVA was conducted using post-test scores as the dependent variable, gender and ability as the independent variables and pre-test scores as the covariate (**Table 9**). There was no significant interaction on students' achievement tests and attitude toward mathematics between the gender and different abilities.

Table 9. Two-Way ANCOVA Results for Gender Differences and Different Ability Students in Academic Achievement in Mathematics and Attitude toward Mathematics

Test	Source	*SS*	*df*	*MS*	*F*	ω^2	Post-Hoc
Academic Achievement	gender(A)	9.462	1	9.462	0.070		
	ability (B)	288.569	2	144.285	1.064		
	A×B	60.820	2	30.410	0.224		
	error	2711.096	20	135.555			
	total	15471.630	26				
Con	gender(A)	0.028	1	0.028	0.862		
	ability (B)	0.005	2	0.002	0.074		
	A×B	0.052	2	0.026	0.815		
	error	0.643	20	0.032			
	total	8.354	26				
Use	gender(A)	0.129	1	0.129	1.473		
	ability (B)	0.075	2	0.038	0.429		
	A×B	0.145	2	0.072	0.824		
	error	1.754	20	0.088			
	total	2.242	26				
Mot	gender(A)	0.515	1	0.515	2.407		
	ability (B)	0.268	2	0.134	0.628		
	A×B	0.061	2	0.031	0.143		
	error	4.276	20	0.214			
	total	6.154	26				
Suc	gender(A)	0.085	1	0.085	0.816		
	ability (B)	0.058	2	0.029	0.278		
	A×B	0.156	2	0.078	0.748		
	error	2.079	20	0.104			
	total	3.562	26				
Imp	gender(A)	0.527	1	0.527	5.423 *		
	ability (B)	0.489	2	0.244	2.515 *		
	A×B	0.086	2	0.043	0.442		
	error	1.943	20	0.097			
	total	3.233	26				
Anx	gender(A)	0.207	1	0.207	2.841		
	ability (B)	0.237	2	0.118	1.619		
	A×B	0.234	2	0.117	1.603		
	error	1.460	20	0.073			
	total	2.770	26				

Note. Only ANCOVA results with significant differences were examined using ω^2 analysis and post-hoc tests; Con=confidence in learning mathematics; Use=usefulness of mathematics; Mot=motivation for exploring mathematics; Suc=attitude toward success in mathematics; Imp=attitude of important others; Anx=mathematics anxiety.

$^{*}p<.05$, $^{**}p<.01$, $^{***}p<.001$

Attitude Questionnaire to Blended Learning

An open-ended survey was administered to determine the extent to which students believed that the blended approach helped them with their learning. The first question was: "Do you think that the blended approach helped you with your learning?"

The majority of the students (89%) commented in their responses that such an approach facilitated their learning for various reasons such as the layout of the content, the quality of the examples, and the online tests. The content provided is short and concise, making it easier to learn.

The responses also showed how instructional methods helped them with their learning:

- *"Multiple choice tests helped. If I got a question wrong, I could look back at the work and analyze why it was wrong."*
- *"The summaries and multiple-choice tests really helped me to revise what I had learnt over the term. The practice complex reasoning questions were a big help."*
- *"I was able to listen to the same activities and repeat them several times. Thus, I understood and learned better. It was good for me."*
- *"Sometimes, I leave some subjects uncompleted at school, or I may be lost in thought or be in a bad condition. If so, I may find the same educational conditions and repeat subjects at home when I feel better."*

The second question was: "Do you think that Moodle improved your results in Mathematics? Give reasons." The majority of the experimental group (72%) reported that Moodle improved their results, commenting that Moodle contains worked examples that helped them to better understand the work completed in class. Through Moodle, shy students who never asked questions in normal class were able to ask for and receive feedback from teachers and their classmates. The students reflected their thinking through informal discussions with their classmates. In addition, the tests at the end of each page helped with their revision before examinations. However, 20% of the experimental group did not think that Moodle improved their results for various reasons (e.g., no time to commit to lessons, or students learn the materials by cramming before exams) and approximately 6% were unsure. In this group, none of the students saw the design of the website as a factor that prevented them from achieving higher scores for the subject.

The third question asked was: "Do you believe that it is a good idea to supplement in class learning with teacher developed websites such as Moodle? Give reasons." More than 80% responded positively, stating that such an approach was a good idea because individuals could learn at their own pace rather than at the teacher's pace. Other reasons included:

- *"Personally, I find it hard to follow lectures. Without the online notes, I had to write as the teacher spoke and that can become a frustrating task when I cannot keep up."*
- *"Moodle improved my results without a shadow of doubt because it provides students with two different learning environments."*
- *"I enjoyed working at an individual pace, but struggled with falling behind."*

The fourth question asked was: "What are your thoughts on the online tests?" Ninety percent of the students in this group had at least one positive comment about these tests. A variety of reasons are outlined as follows:

- *"It provides an excellent opportunity to test what you know."*
- *"They help to make your understanding of the lesson more solid and in the long term it is easier to prepare like this for an examination."*
- *"Tests were an excellent way of understanding what you have just been taught."*

DISCUSSION

As discussed earlier, many studies have indicated that the blended learning method has positive impacts on learning outcomes. For instance, Hung (2007), Liu (2010), Wang and Yu (2012), and Wiginton (2013) have found that the blended learning method is more effective in terms of academic achievement than traditional methods. The reason may be that in teacher-based learning, students cannot progress at their own pace, and if they become distracted, it is difficult to catch up on what they have missed. When each student has their own computer with access to teaching resources, they can control their learning progress and they can learn without being interrupted. Students can browse learning materials as much as they need and repeat exercises to understand the content. Online assessment and immediate feedback can help to improve learning effectiveness.

The results of this study showed that the blended learning method was more effective than traditional methods in terms of improving attitude toward mathematics. This corresponds to the findings in previous studies that have found positive results from the blended learning method in terms of attitude toward mathematics (Aiken, 1976; Collins, 1996). The results indicated that the attitudes of the experimental group were significantly positively changed, whereas the control group failed to show a similar result. Similarly, the results showed students in the experimental group experienced a more positive attitude toward mathematics, more enjoyment of mathematics, and more motivation to do mathematics than students in the control group. This model facilitates mathematics learning through a virtual online classroom. It is helpful for facilitating students to present their opinions. Moreover, it improves the interaction among peers, and between students and teachers. Students benefit from group discussions and collaborative learning.

The results indicated significant gender differences in attitudes toward mathematics. This result is similar to Fennema and Sherman (1976), Sriampai (1992), and Lin and Chen (2007). Further, this study found significant gender differences in the attitude of important others, i.e., male students scored significantly higher than female students on "attitude of important others to mathematics." Two possible reasons are (a) males may have an advantage in mathematics because of their previous experience from hobbies and games, and (b) greater motivation, interest, and positive attitude toward science is fostered by gender stereotypes that science is a male domain (e.g., Erickson & Erickson, 1984; Erickson & Farkas, 1991; Johnson, 1987; Jovanovich & King, 1998; Kelly, 1988). Evidence suggests that the attitude of important others to mathematics is significantly different between males and females, and the attitude of important others for mathematics achievement has a significant impact (Cain-Caston, 1993; Power & Rock, 1999; Tsai & Walberg, 1983). Therefore, parents and teachers should adopt an active and positive attitude, especially for male students, to encourage and cultivate a positive attitude toward mathematics to promote achievement. In contrast, mathematics teachers should pay attention to increasing female students' self-confidence and interest in mathematics.

No significant gender difference was found in the post-test results for achievement in mathematics. After the experiment, the mean of the groups slightly increased, but the mean differences between the two groups were not significant. This corresponds to previous studies which found that achievement in mathematics does not differ significantly between males and females (Chen, 2012; Corbo, 1984; Echols, 1992; Jenson, 1994; Li, 2010; Lindberg et al., 2010; Liu, 2010; Samuels, 1983; Scafidi & Bui, 2010). This similarity in performance between males and females was clear in the meta-analysis conducted by Lindberg et al. (2010), with data from 242 studies representing 1,286,350 people, indicating no gender differences ($d = 0.05$) and almost equal variances for males and females. The reason behind may be asynchronous environments afford thoughtful discussions in the convenience of one's home at any time (Ally, 2004). This would dramatically open up opportunities for students to not only contact teachers, but to pull ideas and questions from other class members. A "forum" would be common ground where anyone could join in and offer up thoughts; it would allow peer interaction that might otherwise be awkward and difficult, especially if students do not know each other well. Bringslid (2002) mentioned that the improvement of understanding mathematics by using interactive and personalized documents on the web could reverse bad trends. Thus, male and female could utilize equal opportunities provided by technology-based instruction; blended learning and online learning, and function effectively in learning mathematics.

Another variable that has been shown to influence achievement is the ability. The post-test results of the attitude toward mathematics showed a significant difference between students at different levels of ability (high ability, medium ability, and low ability). After the experiment, high-ability students had significantly more positive attitudes of important others toward mathematics, and they scored significantly higher than medium-ability students. This result is consistent with the findings of Claire and Gratt (1995), which may be because high-ability students thrive in a dynamic teaching environment, and they are more likely to speculate and get the right idea. Therefore, there is a more positive attitude toward blended learning compared to traditional in-class teaching methods, which tend to be one-way transmissions. Several authors have concluded that a significant difference exists in achievement in mathematics between students with different abilities (Hooper, 1992; Li, 2010; Tsai, 2000). However, this study did not find that the blended learning method had an impact on interest.

The fact that no significant interaction on students' achievement tests and attitude toward mathematics between the gender and different abilities. This corresponded to previous studies in their performances on the achievement test and attitude toward mathematics did not differ significantly (Corbo, 1984; Lindberg, Hyde, Petersen, & Linn, 2010; Samuels, 1983; Scafidi, & Bui, 2010).

The majority of the students believed that the blended learning approach helped them with their learning (89%), and consequently had a positive impact (74%) on their learning outcomes. They also believed that web-based learning supplemented in-class learning (80%), and that online quizzes (90%) were an effective way to receive feedback and facilitate reflection. Therefore, online tests are also popular with students as an aid to learning and revision. Regular formative and summative testing with instant feedback are useful tools to improve student engagement and drive student learning.

Moreover, students actively used Internet resources, rather than passively accepting information from teachers, to acquire knowledge and learn mathematical concepts. During the course, teachers aided the students, increased their involvement, and assisted them in completing tasks. This process enhanced student learning of mathematical concepts, cultivated their abilities to solve related problems, and enabled the students to contemplate and organize mathematical problems. Interactions between the teachers and students, and between the students, have been neglected in traditional instruction, resulting in inefficiencies in courses. After this process, students expressed that they became interested in the activities and their attitudes toward mathematics improved.

CONCLUSIONS AND IMPLICATIONS

The main purpose of this research was to examine the effect of blended learning pedagogy by combing the Moodle online teaching platform with traditional instruction and analyzing the outcomes of this new teaching approach for learning attitude and performance of seventh grade students. Based on gender and ability with different teaching methods, students were expected to show variations in their learning attitudes and achievements in mathematics. Based on the results of this study, the following conclusions can be made: (a) the application of blended learning showed a significant effect on academic achievement for seventh grade students, and achievement was not different because of gender and ability; (b) blended learning pedagogy showed a significantly positive effect on attitude toward mathematics for seventh grade students. Most students in the experimental group were in favor of blended learning. This method can help them to learn mathematics at their own pace and express their opinions. Moreover, it improves the interaction between students and teachers, and facilitates group discussion and collaborative learning.

Since the sample was limited to one school with middle-class students over eight months, any generalizations drawn from this study should be considered with caution. Awareness of the differential effects of gender, ability, response formats, and learning outcomes in student achievement can help teachers who want their instruction to be effective.

We suggest that Moodle online learning in blended learning pedagogy should be widely used to enhance students' active learning and to construct knowledge with peers. Students can independently explore the blended learning environment to expand their learning and knowledge of mathematics beyond the limitations of knowledge found in the conventional classroom and presented lectures. Different learning strategies can be provided to students with different learning backgrounds to create successful learning experiences.

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