Blended Learning: A Strategy for Improving the Mathematics Achievement of Students in a Bridging Program

Maxima J. Acelajado
acelajadom@yahoo.com
De La Salle University
Manila, Philippines

Abstract

Two groups of 20 students each from the Bridging Program of the College of Saint Benilde, De La Salle University, who were enrolled in Algebra during the Second Term, SY 2009-2010, served as respondents in this study. The groups were alternately exposed to the blended learning strategy and the traditional face-to-face classroom instruction strategy. A pretest and a posttest together with a perceptions inventory related to the use of blended learning were administered to the respondents to gauge and compare their achievement in each topic and to capture their reactions regarding the use of blended learning strategy. Findings revealed that there is a significant difference in the mean achievements of the two groups in all topics under consideration in favor of the blended learning strategy. Students' general reactions to using the blended learning strategy point to the merits of having several alternatives in learning, the improved attitude and confidence in mathematics, and the increased motivation and enjoyment afforded by this strategy in understanding the lessons.

1. Introduction

Despite the fact that no one doubts the importance of mathematics in almost all concerns of science, the technological fields and in everyday life, mathematics has remained unpopular to a number of students. Many students still perceive that mathematics is a difficult subject and they look forward to learning the subject the easy and enjoyable way. The teachers, on the other hand, are continually looking for better approaches to meet students' demands for exciting ways to gain mathematical knowledge.

The advent of technology has given birth to several new approaches to learning, namely: online learning, using the internet, computer-assisted learning, web-based distance learning and blended learning which is continuously gaining popularity in education. Recent mathematics reforms strongly endorse the use of technology in teaching. Proficiency in the use of technology and the ability to design curriculum and instruction that takes full advantage of the available technological resources are two of the main goals for mathematics teachers. Information and communication technology (ICT) may be infused into the classroom activities through the use of interactive learning objects for instruction, enrichment and remediation. Interactive learning objects engage the students by appealing to their visual, kinesthetic and auditory learning styles.

Dreyfus and Eisenberg [1] asserted that technology can provide mechanisms to sustain assistance to mathematics teachers in implementing mathematics education reforms in their classes. Owston [2], Fetterman [3] and Ferrucci and Carter [4] indicated that educators have stated optimism with respect to the educational potential of ICT such as the Internet and the World Wide Web (WWW) in developing and implementing various classroom activities. Moreover, Windschitl [5]

emphasized the importance of disseminating information regarding the use of Internet in the classroom for the purpose of informing practice.

Mathematics teacher educators, therefore, should engage in extensive experimentation with computers and a variety of available educational software so that they are able to appreciate their usefulness in teaching mathematics. Activities, projects and problems that replicate real-life situations are effective resources for learning technology. With technology, students will learn how to determine which processes, tools and techniques to use and when to use them.

2. Related Literature and Studies on the Blended Learning Strategy

Educators, nowadays, have shown considerable interest in blended learning, commonly described as a form of teaching combined with technology. The concept of blended learning is rooted in the idea that learning is not just a one-time event; learning is a continuous process. The classroom is considered as a learning set-up where the students are given the autonomy to control their learning environment and the teacher's main concern is to provide learners with a variety of examples and problems, high level interaction, and challenging activities.

Whitelock & Jelfs [6], Dzakiria, Mustafa & Abu Bakar [7] and Driscoll [8] considered blended learning as the combination of (1) traditional learning with web-based online approaches; (2) media and tools deployed in a learning environment; and (3) a number of pedagogical approaches regardless of the technology used in each case.

Reganit & Diaz [9], Waterhouse [10] and Som Naidu [11] indicated that blended learning is essentially learning done in an independent fashion using packaged course materials whereby students get to learn even when they are outside the confines of their classrooms. It provides greater success to all educational activities as it frees learners from the constraints of time and place and offers flexible learning opportunities to individuals and groups of learners working online or offline and uses the web to enhance face-to-face learning.

Inasmuch as students have different learning styles, Singh [12], Graham [13] and Heinze [14] emphasized that a single mode of instructional delivery may not provide sufficient choices, engagement, social contact, relevance, and context needed to facilitate successful learning and performance and, consequently, recommended the use of blended learning strategy.

On the other hand, Yushau [15] argued that even if blended learning transforms teachers from being information sources to information guides, the conventional method of teaching-learning will continue to be on top of the educational system and no technology can replace this method since technologies are only gadgets meant to enhance the existing teaching-learning process

In the study conducted by Valdez [16], she found that there was a significant difference in the performance of the partial blended learning and the full blended learning groups and concluded that the partial blended learning strategy was a more effective pedagogical method for the low performing students. Similarly, Robles [17] conducted a six-week quasi experiment to determine the effect of blended learning on the performance in Algebra of 87 first year Computer Science students of Hercor College. These student-participants were randomly assigned to the control and experimental groups, which were taught using the lecture method and the blended learning method,

respectively. Results showed that there was a significant difference between the pretest and posttest scores of each group, although no significant difference was found between the posttest mean scores of the two groups.

Moreover, using a causal-comparative design, Rovai and Jordan [18] concluded that the blended learning strategy produced the strongest sense of community among students as compared to traditional classrooms and fully online higher education learning environments.

As of this writing, very little is known about the achievement of students' using the blended learning strategy in a bridging program. This strategy was used in the bridging program to increase students' access and flexibility in the level of active learning strategies, peer-to-peer learning strategies, and learner-centered strategies and to address their clamor for more exciting and challenging mathematical activities that would eliminate boredom and bring out active learning. In the light of the preceding discussion, this study was conducted with the hope of helping teachers in determining the feasibility of implementing a Virtual Learning Environment to improve students' mathematical achievement and lead them to like and love mathematics.

3. Objectives of the Study

Specifically, this study has the following objectives: (1) to determine the effectiveness of blended learning compared to the traditional face-to-face classroom instruction in improving the mathematical achievement of 40 students in the Bridging Program and (2) to ascertain the students' reactions to the use of blended learning in understanding selected topics in Algebra.

4. Respondents of the Study

To address its objectives, this study considered as respondents two intact classes of 20 students each of the Bridging Program of De La Salle University, College of Saint Benilde, who were enrolled in Algebra during the Second Term, SY2009-2010. These intact classes were composed of students who did not pass the College Entrance Test, but opted to enroll in the Bridging Program of the college. The program requires students to enroll in basic subjects, specifically Mathematics and English and other general education subjects in preparation for admission to the program of their choice in the same college. This bridging program is also known as the Learning Enhancement and Adjustment Program (LEAP).

4. Methodology

This study used the experimental design with switching replication; that is, the two classes, designated here as Group 1 and Group 2, were alternately exposed to the blended learning strategy and the traditional face-to-face classroom instruction strategy in the delivery of selected topics in Algebra, namely, Algebraic Expressions, Special Products and Factoring, Rational Expressions and Linear Equations and Inequalities in One Variable. In the process, conscious effort was exercised to insure that nobody among the respondents knew that an experiment was in progress.

Both groups were exposed to the blended learning strategy and the face-to-face classroom instruction strategy. During the first five weeks of the experiment, Group 1 was exposed to the blended learning strategy and Group 2 was exposed to the traditional face-to-face classroom instruction strategy in the delivery of the first two topics and then in the succeeding five weeks,

Group 1 was exposed to face-to-face classroom instruction strategy while Group 2 was exposed to the blended learning strategy in the delivery of the last two topics.

The pretest was administered to all respondents at the beginning of the experiment while the posttest on each topic was administered immediately after finishing each topic. The perceptions inventory was administered to Group 1 after finishing the first two topics and to Group 2, after finishing the last two topics. Verification of responses to the perceptions inventory was done through an unstructured interview with a random sample of respondents.

In this study, the blended learning strategy considered the use of the internet to access prescribed websites and the learning materials posted on a network folder such as PowerPoint presentations, downloaded materials, course materials, worksheets and assignments. Accessing of online learning resources in the intranet and internet and solving problems were some of the activities carried out by the group exposed to the blended learning strategy. The respondents were also asked to access materials related to the topics covered in this study and to upload them in their yahoo group's folder for additional input about the topics covered in this study. Only the members of the group using the blended learning strategy were given the password to access the materials posted on the network portal. A face-to-face encounter between the teacher and the students using the blended learning strategy was held after finishing each topic for clarification purposes.

On the other hand, the group exposed to the traditional face-to-face classroom instruction strategy met regularly with the teacher leading the discussion and providing the students with seatwork and boardwork exercises similar to those that can be accessed online. The activities of the two groups were closely monitored to insure that the topics covered for the day were the same. Below is the schedule of activities followed during the experiment.

<table>
<tr><th colspan="3">Schedule of Activities During the Experiment</th></tr>
<tr><th>Date</th><th>Group 1</th><th>Group 2</th></tr>
<tr><td rowspan="2">September 15, 2009</td><td colspan="2">Orientation</td></tr>
<tr><td colspan="2">Pretest</td></tr>
<tr><td>September 18, 2009 – October 23, 2009</td><td>Blended Learning Strategy</td><td>Traditional Face-to-face Instruction Strategy</td></tr>
<tr><td>Topic 1 (Algebraic Expressions)</td><td rowspan="4">Viewing Power point presentation of the lesson; Accessing Related Materials Online; Answering exercises; Face-to-face meeting with the teacher after finishing each topic</td><td rowspan="4">Regular classroom discussion on the topic; completing worksheets and answering exercises – seatwork and boardwork</td></tr>
<tr><td>Posttest on Topic1</td></tr>
<tr><td>Topic 2 (Special Products and Factoring)</td></tr>
<tr><td>Posttest on Topic 2</td></tr>
<tr><td>October 23, 2009</td><td>Completing the Perceptions Inventory</td></tr>
</table>

October 24, 2009 - December 2, 2009	**Traditional Face-to-face Instruction Strategy**	**Blended Learning Strategy**
Topic 3 (Rational Expressions)	Regular classroom discussion on the topic; completing worksheets and answering exercises – seatwork and boardwork	Viewing Power point presentation of the lesson; Accessing Related Materials Online; Answering exercises; Face-to-face meeting with the teacher after finishing each topic
Posttest on Topic3		
Topic 4 (Linear Equations and Inequalities in One Variable)		
Posttest on Topic 4		
December 3, 2009		
		Completing the Perceptions Inventory

A validated teacher-made pretest and posttest on the topics under consideration were administered to the respondents to gauge and compare their achievements in each topic; the pretest after the orientation at the start of the experiment and the posttest after taking up each topic. Then the t-tests for dependent and independent samples were applied to determine if any significant difference exists between pretest mean scores, pretest and posttest mean scores, and between posttest mean scores of the two groups of respondents. A perceptions inventory was also administered to the respondents to capture their reactions regarding the use of the blended learning strategy in understanding mathematics.

5. Results and Discussion

Below are the tables showing the descriptive statistics for the gathered data and the corresponding discussion.

Table 1
Descriptive Statistics and Comparison of the Respondents' Pretest Mean Scores

Topic	Group 1 (n = 20)		Group 2 (n = 20)		Computed t-value
	$\bar{x}$	s	$\bar{x}$	s	
1. Algebraic Expressions	**33.30***	**11.14**	35.75	12.26	0.661 (NS)
2. Special Products and Factoring	**35.30***	**10.15**	39.55	9.85	1.344 (NS)
3. Rational Expressions	24.45	3.30	**25.95***	**4.44**	1.2133 (NS)
4. Linear Equations and Inequalities in One Variable	36.60	5.92	**33.00***	**11.13**	1.277 (NS)

*Pretest Mean Score under the Blended learning Strategy NS– Not Significant α =0.05 (two-tailed)
$t_{critical}$ = 2.0244 x - mean sd – standard deviation

As reflected in the table, Group 1 registered the highest pretest score in Linear Equations and Inequalities, followed by Special Products and Factoring, Algebraic Expressions and Rational Expressions. On the other hand, Group 2 registered the highest pretest score in Special Products and Factoring, followed by Algebraic Expressions, Linear Equations and Inequalities in One Variable and Rational Expressions. Apparently, the most difficult topic for both groups is Rational Expressions.

When the pretest mean scores of the two groups in all topics were subjected to the t-test for independent samples, no significant difference was found as evidenced by the computed t-values which are all less than the critical t-value at the 5% level of significance. This indicates that the respondents' background knowledge on these topics was generally the same and the groups were comparable at the start of the experiment. Thus, any improvement in their achievement in mathematics can be attributed to the intervention made, that is, the use of blended learning strategy and the traditional face-to-face classroom instruction strategy.

Table 2.
Comparison Between the Respondents' Pretest and Posttest Mean Scores

Topic	Group 1 (n = 20)					Group 2 (n = 20)				
	Pretest		Posttest		t-value	Pretest		Posttest		t-value
	$\bar{x}$	sd	$\bar{x}$	sd		$\bar{x}$	sd	$\bar{x}$	sd	
1. Algebraic Expressions	**33.30***	**11.14**	**81.10***	**6.42**	20.7 (S)	35.75	12.26	76.30	7.69	22.0 (S)
2. Special Products and Factoring	**35.30***	**10.15**	**82.50***	**5.52**	22.87 (S)	39.55	9.85	76.75	11.5	22.7 (S)
3. Rational Expressions	24.45	3.30	73.60	6.27	32.39 (S)	**25.95***	**4.44**	**78.70***	5.04	36.2 (S)
4. Linear Equations and Inequalities in One Variable	36.60	5.92	75.50	11.7	15.64 (S)	**33.00***	**11.13**	**84.48***	6.08	17.4 (S)

*Mean Score under the Blended Learning Strategy S – Significant
$\bar{x}$ - mean sd – standard deviation α = 0.05 (two-tailed) $t_{critical}$ = 2.093

Table 2 reveals that there is a significant difference between the pretest and posttest mean scores of each group in all topics covered in this study as evidenced by the computed t-values which are all greater than the critical t-value at α = 0.05. Thus, learning took place independent of the method used in teaching, that is, either the blended learning strategy or the traditional face-to-face classroom instruction approach produces learning. It is important to note that for each group the blended learning strategy accounts for the higher mean gain in the respondents' achievement in all the topics under consideration. It can be deduced from the table that higher mean gain was achieved

by Group 2 in the study of Rational Expressions and Linear Equations and Inequalities in One Variable, while Group 1 registered higher mean gain in the study of Algebraic Expressions and Special Products and Factoring, all after exposing them to the blended learning strategy. Findings here support the arguments regarding the merits of blended learning in improving performance as presented in the related literature and studies.

Table 3.
Comparison Between the Respondents' Posttest Mean Scores

Topic	Group 1		Group 2		Computed t-value
	$\bar{x}$	s	$\bar{x}$	s	
1. Algebraic Expressions	**81.10***	**6.42**	76.30	7.69	2.1432 (S)
2. Special Products and Factoring	**82.50***	**5.52**	76.75	9.63	2.3168 (S)
3. Rational Expressions	73.60	6.27	**78.70***	**5.04**	2.836 (S)
4. Linear Equations and Inequalities in One Variable	75.50	11.68	**84.48***	**6.08**	3.051 (S)

*Posttest Mean Score under the Blended Larning Strategy S – Significant
x - mean sd – standard deviation α = 0.05 (two-tailed) $t_{critical}$ = 2.0244

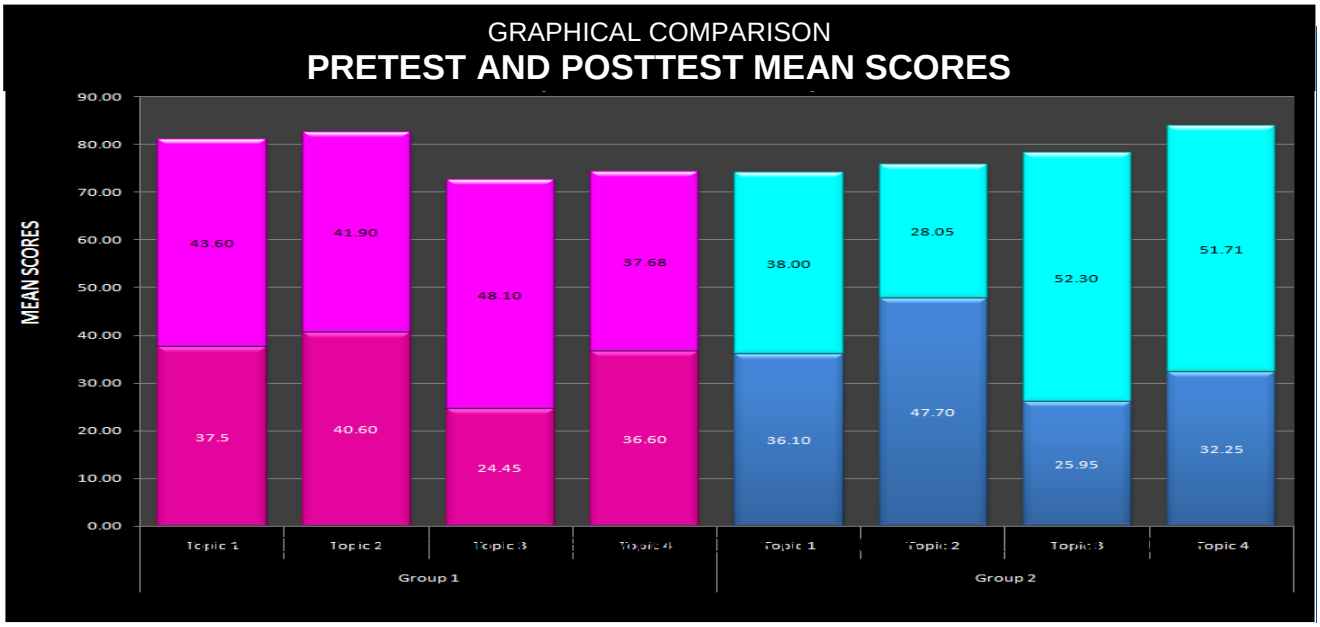
Table 3 shows the results after applying the t-test for independent samples. It can be noted that the posttest mean scores in all topics are significantly different in favor of the blended learning strategy as indicated by the computed t-values. With the blended learning strategy, the students' mathematical achievement in all the topics under consideration has improved a lot better compared to those under the face-to-face instruction strategy.

A clearer presentation of the comparison between the pretest and posttest mean scores of the two groups under the two teaching strategies is shown in Figure 1 on page 349.

It can be noted from the figure that with each teaching strategy – the blended learning and the traditional face-to-face instruction – the respondents were able to improve their achievement in mathematics and that the blended learning strategy accounted for a greater improvement than the traditional face-to-face teaching strategy in all topics under consideration.

Based on the results shown in all the preceding tables, it is very clear that the blended learning strategy improves the respondents' achievement in mathematics. This finding is in agreement with the arguments cited in the aforementioned literature on blended learning.

To ascertain the students' reactions to the use of blended learning in understanding selected topics in Algebra, a perceptions inventory was administered. Table 4 below is the table showing the percentage of respondents who agreed with each item in the inventory.



LEGEND:

Topic 1	**Algebraic Expressions**	**Topic 3**	**Rational Expressions**
Topic 2	**Special Products and Factoring**	**Topic 4**	**Linear Equations and Inequalities in One Variable**
A1	Pretest Mean Score of Group 1 in Topic 1	**A2**	Pretest Mean Score of Group 2 in Topic 1
B1	Posttest Mean Score of Group 1 in Topic 1	**B2**	Posttest Mean Score of Group 2 in Topic 1
C1	Pretest Mean Score of Group 1 in Topic 2	**C2**	Pretest Mean Score of Group 2 in Topic 2
D1	Posttest Mean Score of Group 1 in Topic 2	**D2**	Posttest Mean Score of Group 2 in Topic 2
E1	Pretest Mean Score of Group 1 in Topic 3	**E2**	Pretest Mean Score of Group 2 in Topic 3
F1	Posttest Mean Score of Group 1 in Topic 3	**F2**	Posttest Mean Score of Group 2 in Topic 3
G1	Pretest Mean Score of Group 1 in Topic 4	**G2**	Pretest Mean Score of Group 2 in Topic 4
H1	Posttest Mean Score of Group 1 in Topic 4	**H2**	Posttest Mean Score of Group 2 in Topic 4

Table 4.
Result of the Perceptions Inventory on the Use of the Blended Learning Strategy

The use of the blended learning strategy	Percentage Rating
1. motivates me to study.	86%
2. develops my confidence in solving problems.	88%
3. offers a variety of alternatives in understanding the lesson.	89%
4. improves my creative and critical thinking abilities.	84%
5. affords me the opportunity to understand mathematics better.	89%
6. allows me to participate actively in the learning process and progress independently.	88%
7. offers me powerful ways of dealing with problems in algebra.	83%
8. facilitates my understanding of mathematical concepts.	85%
9. promotes my positive attitudes towards mathematics.	86%
10. strengthens my retention of subject matter.	85%

As gleaned from the table, a great majority of the respondents agreed with the items in the perceptions inventory. Apparently, the blended learning strategy is very much welcomed by the respondents in the bridging program as an alternative teaching strategy. An interview with a random sample of respondents revealed that they were greatly motivated because of the novelty afforded by this strategy and that they enjoyed doing the activities. Also, because of the challenge to search for more related online sources for uploading purposes, they learned the importance of sharing resources and got to improve their social relations with their classmates. They also pointed out that having several alternatives in learning, the opportunity to control their own learning and the chance to do independent study improved their attitude and confidence in doing mathematical activities. In the process, the respondents understood the lessons better.

According to the respondents, the exercises and research report on the applications of mathematics in real-life situations and in the environment made them look forward to having more mathematics subjects using the blended learning strategy. For purposes of maximizing their learning through the blended learning strategy, some respondents suggested that more time be given to them in the process.

6. Conclusions and Recommendations

Using the blended learning strategy for students in the bridging program was an interesting experiment. Inasmuch as significant differences were found between the posttest mean scores of the two groups, it can be concluded that the blended learning strategy is more effective than the traditional face-to-face instruction strategy in all topics considered in this study. Thus, the blended learning strategy apparently improves the mathematics achievement as well as makes mathematics learning an enjoyable and challenging activity for the students in the bridging program.

The Mathematics department can utilize the blended learning strategy in teaching mathematics subjects in the regular program to confirm the finding of this study that the blended learning strategy improves mathematics achievement. Mathematics teachers must, therefore, be provided with extended opportunities to experience and do mathematics in an environment supported by technology Also, the teachers could work together to identify the learning materials and activities that would constitute an enhanced blended learning strategy. Moreover, there should be a continuing research on the effects of blended learning strategy in the mathematics achievement of students in the regular program.

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