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Teaching and Learning Mathematics Using Facebook Group

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Abstract

Almost every organization makes use of a Facebook group. They utilized it to debate themes and other problems concerning their own survival. Numerous mathematics instructors have already embraced its usefulness as a method of providing instructional materials to their pupils in the modern day. With these factors in mind, this research study on the use of Facebook groups in the teaching-learning process of mathematics was performed with the pioneer batch of ABM students at the University of San Carlos – Senior High School in Cebu City, Philippines. Through this amazing and updated communication medium, the kids learnt a new lesson. The statistical study revealed that the use of Facebook groups in the teaching-learning process of mathematics is beneficial. This is shown by the statistical equality of the experimental and control groups' post-test results. This demonstrates that the performance of students in the experimental and control groups is comparable. This is because the experimental groups did not participate in classroom discussions yet fared as well as the controls groups who did. Additional pertinent results from the research are provided in this article.

Introduction

Students are engaged in Web 2.0 technology on a daily basis (i.e. blogs, twitter, podcasts, wikis, social network sites, virtual worlds, video sharing and photo sharing). They are creating online selves that are inextricably linked to their offline selves. Indeed, the internet is becoming increasingly essential not just in students' social lives, but also in their academic lives (Crook & Harrison, 2008). Social networking sites (also known as social networking sites) are rapidly gaining popularity on the Internet. Myspace, bebo, and Facebook are the most popular of these websites (Stelter, 2008).

A social network, most notably Facebook, may be described as an exclusive online service, platform, or location where social contact and/or relationships can be formed and people exchange information incessantly (Tiryakioglu & Erzurum, 2011). As of May 1, 2013, Facebook stated that the site was being used by 1.11 billion users per month, somewhat higher than the 1.06 billion recorded three months before. It is a 23% increase over 2012 (Yahoo! News, May 2013). It has been discovered that Facebook is being used to strengthen existing offline connections (Lampe et al., 2006). As with earlier communication technologies (email, chat rooms, bulletin boards, etc.), social networking sites may find a place in our classroom. To yet, responses to the use of social media platforms for educational purposes have been varied. Facebook's fast adoption among university students in the mid-2000s prompted one media researcher to warn university officials that "Facebook controls your campus" (Stutzman 2006). As such, Facebook provides the most appropriate contemporary online setting for examining how social software sites ‘fit' with higher educational settings and communities of

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educational users, and thus for investigating the current assumptions of (un)enthusiastic practitioners and education technologists about social software and education.

Cohen's (2009) Informing Science paradigm enables analysis of Facebook's function in mediating information exchange among students who alternate between the roles of informants and customers. The usage of Facebook by students strengthens their rights to inform (informer) and be informed (client), and this interaction results in the creation of rich knowledge resources based on diverse perspectives.

Due to the relative youth of social communication networks, research on their educational applications is scarce. Numerous studies indicate that a sizable percentage of students spend significant time in such social networks (Jones et al., 2010). This tendency indicates that educational settings built on social media platforms will capture students' attention more effectively. When this is accomplished effectively, educational experiences are often said to be more effective.

With these factors in mind, the researcher devised a study during the first semester of the 2015 – 2016 school year on using Facebook groups in the mathematics teaching-learning process for the University San Carlos's first batch of Senior High School students. To ensure that the Facebook group was used successfully with the real responders, a trial run of the whole procedure was performed during the second semester of the 2015 – 2016 academic year. The dry-responders run's were first-year accounting students at the aforementioned university. The aforementioned respondents were carefully selected in accordance with the established criteria - a replica of the real respondents, who are Accountancy Business and Management (ABM) students.

The purpose of this research was to determine the effect of using a Facebook group in mathematics teaching-learning processes on ABM students at the University of San Carlos in Cebu City.

Statement of the Problem

This study aimed to establish the impact of the utilization of Facebook group in Mathematics teaching-learning processes to the SHS-ABM students of University of San Carlos. Specifically, this study answered the following questions.

1) What are the processes and procedures conducted during the utilization of Facebook group in Mathematics teaching-learning processes to the SHS-ABM students of University of San Carlos?
2) Is there a difference in the students' attitude towards Mathematics between the controlled group and the experimental group?
3) Is there a difference between the students' perception before the utilization of Facebook group and the students' attitude after the utilization of Facebook group in Mathematics teaching-learning process?
4) Is there a difference among the scores of the experimental and controlled groups on the following: Pre-test; and Post-test?
5) Is there a difference between the Pre-Test and the Post-Test results of the experimental group?
6) Is there a difference between the proportion of students who passed from the experimental group and the two controlled groups?
7) What is the students' perception on the effectiveness of the utilization of Facebook group in Mathematics teaching-learning process?

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Significance of the Study

The study of the use of Facebook in mathematics teaching-learning is very pertinent, since Facebook can be accessed at any time and from any location. The following are the benefits of this study's findings:

Students. This research educates students about cutting-edge methods for studying mathematics via the use of a Facebook group. Additionally, students will learn how to develop/enhance their collaboration abilities in the context of mathematics study.

Teachers. This research will inform instructors about recent advancements in the field of teaching-learning experiences. Additionally, instructors will get new ideas for evidence-based student learning. Additionally, instructors will get training in the most up-to-date assessment and evaluation methods.

Authors of books and/or publishers of textbooks. This research will raise awareness of new methods for improving student learning experiences among book writers and/or textbook publishing firms. Book writers and/or textbook publishers will learn novel methods for using Facebook groups into the creation of instructional materials. Additionally, this course will educate students about contemporary marketing methods and strategies.

Researchers. This study will provide ideas to future researches various research opportunities on the utilization of Facebook group in the teaching-learning process across disciplines. The researches will be enlightened on how to develop future studies relative to Facebook group and teaching-learning process

Methods

The study of the use of Facebook in mathematics teaching-learning is very pertinent, since Facebook can be accessed at any time and from any location. The following are the benefits of this study's findings. This research educates students about cutting-edge methods for studying mathematics via the use of a Facebook group. Additionally, students will learn how to develop/enhance their collaboration abilities in the context of mathematics study.

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Samples and Setting

This research was performed during the second semester of the 2016-2017 academic year at the University of San Carlos – Downtown Campus in Cebu City. The respondents to this study were the first class of grade 11 ABM students enrolled in the Statistics and Probability program. The senior high school at the University practiced the contact period twice a week for an hour and thirty minutes each.

The second semester sectioning of students was determined by the students' overall weighted mean of their first semester grades. During the second semester, there were eight sections (blocks A–H). Block A included the top 40 pupils, whereas Block H had transferees. Top 41–

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46 students were allocated to Blocks B–F, accordingly. Following that, individuals ranked 47–52 were reassigned to Block B–F, accordingly. As a consequence, students in blocks B through F are paired according to their academic achievement. Additional pupils who exceeded the 40-student limit were assigned to Block H.

This research study surveyed three groups of respondents: the experimental group, the controlled group one, and the controlled group two. These groups of pupils were chosen at random from blocks B through F. The experimental group was chosen via a purposive selection method in which all students in the class had cellphones and used Facebook on a regular basis. The remaining two control groups were chosen at random using the fishbowl technique. Both controlled groups had interaction with the experimental group on the same day. The controlled group one contact time was from 4:30 to 6:00pm, immediately after the experimental group's contact period from 3:00 to 4:30pm. The controlled group two contact period was from 7:30 to 9:00pm.

Measures

This study used four distinct sets of research tools. The first set was a survey of students' Facebook accessibility, which was performed during the second semester's first week of courses. The second set of questions focused on students' attitudes toward mathematics and their perceptions of using Facebook groups to teach and study mathematics. This set included a 5-point scale survey that was administered to respondents prior to the commencement of the experimental research. Additionally, the third set included a 5-point scale poll of students' attitudes about using Facebook groups to teach and study mathematics, as well as their judgment of the efficacy of its use. This set was distributed after the experimental research. The fourth set included a pre- and post-test, which served as the primary foundation for determining the effect of incorporating Facebook groups into the mathematics teaching-learning process.

Data-Gathering Procedures

The implementation of this experimental study followed entirely the same processes and procedures of the dry-run during the second semester of the school-year 2015 – 2016. The processes and procedures are presented below.

Preliminaries

A short survey on students' accessibility to Facebook was conducted during the first week of the second semester classes. The survey established that all students had Facebook account and can access Facebook though their mobile phones via mobile data. Ninety percent of the students used smartphones which was pre-loaded with the Facebook application. The other 10% can access Facebook through internet shops and opened Facebook at least four times in a week.

Setting-up the Facebook group

After determining the prospective experimental group, the Facebook group (mother fb group) named The Research Class was set-up. The learning materials were then uploaded in that Facebook group. They were in a form of PowerPoint presentations, portable document format (pdf) files, video clips, document files, and website links. The instructions and guidelines of the membership of that Facebook group were also posted to sustain confidentiality of the group as well as the confidentiality of the learning materials.

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Implementation of Facebook Group in Mathematics Teaching-Learning Process

The table below presents the day-to-day activity in the course of the implementation of Facebook group in Mathematics teaching-learning process.

No.	Day	Activities
1	Monday class	▪ Class orientation on *Facebook group in Mathematics teaching-learning process* ▪ Assigning of student groups ▪ After class, creating Group Chats (by group representatives) ▪ Checking the complete members in each Group Chats ▪ Creating the Sub-FB Group from its original Group Chat
2	Wednesday Class	▪ Survey on students' attitude towards Mathematics ▪ Orientation on the mechanics of the utilization of Facebook group in the teaching-learning process ▪ Survey on students' perception on the utilization of Facebook group in the teaching-learning process ▪ Pre-Test ▪ After class, posting of the Learning Materials to the Mother-FB Group
3	Friday	▪ Posting of Online Exercise 1
4	Friday *(to Sunday)*	▪ Cooperative Learning via Sub-FB Group
5	Sunday	▪ Posting of Online Exercise 2
6	Sunday *(to Wednesday)*	▪ Cooperative Learning via Sub-FB Group
7	Monday class	▪ Actual Test 1. Covering Online Exercise 1 ▪ Checking and Discussion of Answers
9	Wednesday class	▪ Actual Test 2. Covering Online Exercise 2 ▪ Checking and Discussion of Answers
9	Friday	▪ Posting of Online Exercise 3
10	Friday *(to Sunday)*	▪ Cooperative Learning via Sub-FB Group
11	Monday class	▪ Actual Test 3. Covering Online Exercise 3 ▪ Checking and Discussion of Answers
12	Wednesday class	▪ Post-Test ▪ Survey on students' attitude on the utilization of Facebook group in the teaching-learning process and their assessment of the effectiveness of its utilization

Statistical Treatment of Data

The collected data were statistically analyzed utilizing a variety of statistical tools to provide accurate results and analysis. The intervening factors and their associated statistical treatment are shown follow: (1) Differences in mathematics performance - analysis of variance was used to determine the differences in mathematics performance between the experimental and control groups.(2) Students' attitudes toward mathematics – the weighted mean was used to conduct analysis on the 5-point scale survey of the experimental group and the two control groups' attitudes toward mathematics. (3) Distinction in students' attitudes toward mathematics — The chi-square test was used to determine the difference in students' attitudes toward mathematics between the experimental group and each of the two control groups. (4) Students' perceptions of the use of Facebook groups in the mathematics teaching-learning process – the weighted mean was used to analyze the experimental group's perceptions of the use of Facebook groups

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in the mathematics teaching-learning process prior to their actual experience with the processes and procedures of its use. (5) Students' attitudes toward the use of Facebook groups in the mathematics teaching-learning process – the weighted mean was used to analyze the experimental group's attitude toward the use of Facebook groups in the mathematics teaching-learning process after they had actually encountered the processes and procedures for its use. (6) Distinction between students' perceptions and attitudes toward the use of Facebook groups in the mathematics teaching-learning process – the chi-square test was used to determine the difference between the experimental groups' perceptions and attitudes toward the use of Facebook groups in the mathematics teaching-learning process. Additionally, this altered their perspective on the use of Facebook groups in the teaching-learning process. (7) Pre-test findings – analysis of variance was used to determine the difference between the experimental group and the two control groups' pre-test results. (8) Post-test results difference – analysis of variance was used to determine the difference in post-test results between the experimental group and the two control groups. (9) Difference between the pre- and post-tests – the t-test between paired-means was used to determine the change in the experimental group's score between the pre- and post-tests. (10) Effectiveness of the use of a Facebook group in the teaching-learning process – the weighted mean was used to conduct a study of the experimental group's perceptions on a 5-point scale. the efficacy of using a Facebook group to facilitate the teaching-learning process.

Scope and Limitation of the Study

The use of facebook group in this study mainly focused on the utilization of its various features, namely: (a) group chat - for exclusive group conversation; (2) Discussion - for group wall posts, announcements, queries, shared links etc; (3) Comment boxes - for replies to wall posts, announcement, queries, shared links etc; (4) File tab - document-sharing as pdf, word, excel, and powerpoint; (5) Video - for video sharing; (6) Albums - for photo sharing

The experimental group examined the Normal Distribution using these different characteristics. The teaching-learning process happens seldom on this Facebook group's platform. To measure student learning, students completed authentic exams in the classroom as formative assessments. The students then went on to the next section of the course, using the facebook platform for teaching-learning once again.

The controlled group taught and learned using the conventional lecture technique. This omits the usage of chalkboards for lectures, boardwork, and formative evaluation.

Results and Discussion

The data gathered were applied with statistical treatment and analysis. The results of the investigations are presented below.

Table 1. Difference among the Mathematics Performance of the Experimental and Two Controlled Groups

Groups	n	Mean	Std. Dev.	Comp. Value	Crit. Value	p-value	Remarks
Experimental	36	2.64	0.4707	0.31	3.08285	0.7327	Not Significant
Controlled 1	37	2.67	0.4454				
Controlled 2	35	2.73	0.5077				

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The difference in mathematics performance between the experimental group and the two control groups is seen in Table 1. As seen in the table, the p-value of 0.7327 is higher than the 0.5 threshold of significance, indicating that the null hypothesis is accepted. The calculated value of 0.31 is smaller than the crucial value of 3.08285 and therefore supports the null hypothesis's acceptance. This indicates that there is no statistically significant difference in Mathematics performance between the experimental and control groups. Additionally, this demonstrates that the three groups earned the same grade in General Mathematics the previous semester. As a result of these results, the three groups were placed on an equal footing prior to the start of the experimental research.

Table 2. Students' (Experimental Group) Attitude towards Mathematics

Statements	**5**	**4**	**3**	**2**	**1**	**Wx**	**Verbal Description**
1	2	9	18	5	2	3.1	Undecided
2	5	8	17	5	1	3.3	Undecided
3	8	17	8	2	1	3.8	Agree
4	9	16	7	4	0	3.8	Agree
5	4	3	19	7	3	2.9	Undecided
6	9	14	10	1	2	3.8	Agree
7	2	15	15	2	2	3.4	Undecided
8	9	10	12	3	2	3.6	Agree
9	5	8	12	9	2	3.1	Undecided
10	1	5	15	8	7	2.6	Disagree
11	3	8	9	12	4	2.8	Undecided
12	2	9	19	4	2	3.1	Undecided
13	1	7	20	6	2	3.0	Undecided
14	22	10	3	0	1	4.4	Agree
15	8	13	7	6	2	3.5	Agree
Total	90	152	191	74	33	3.4	Undecided

The experimental group's attitude toward mathematics is shown in Table 2. As shown in the table, 8 of 15 (53.33 percent) statements got an indecisive evaluation from the experimental group's pupils. Six out of fifteen (40%) statements got an agree rating. On the other side, one out of every fifteen (6.67%) comments got a disagree rating.

This further demonstrates that students concur when asked to respond to the following statements: a) Whenever I hear the word "Mathematics," I immediately think of unsolved problems; b) I always look forward to learning more in my Mathematics class; c) I am always nervous in a Mathematics class; d) Solving problems in Mathematics makes me feel like an adventurer willing to take a risk.

However, when asked to reply to the statement, "I do not mind getting discharged late from my Mathematics lesson; and d) the prospect of having a Mathematics issue makes me anxious," the students disagreed.

Attitude has a significant role in learning. It all relies on an individual's attitude toward learning, and mathematics has long been seen as a critical core topic in a school curriculum (Mohamed, L., & Waheed, H, 2011). Nobody can dispute the critical nature of it for kids to learn about.

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According to Goos et al. (2003), "technology has the potential to transform the nature of school mathematics by engaging students in more active mathematical practices such as experimenting, investigating, and problem solving that add depth to their learning and encourage them to ask questions rather than seeking answers." With today's technology, teaching math has become easier, faster, and more in-depth. The ability of technology to deliver correct answers and hundreds of learning resources to pupils is critical in teaching.

Table 3. Difference between Students' Attitude Towards Mathematics

Group	5	4	3	2	1	Wx	Description	Comp. Value	Crit. Value	p-value	Remarks
Experimental	90	152	191	74	33	3.4	Undecided	5.17	9.488	0.2703	Not Significant
Controlled 1	84	159	221	85	21	3.4	Undecided				
Experimental	90	152	191	74	33	3.4	Undecided	4.48	9.488	0.3449	Not Significant
Controlled 2	97	152	219	64	23	3.4	Undecided				

The difference in students' attitudes about Mathematics between the experimental and control groups is seen in Table 3. As shown in the table, the p-values of 0.2703 and 0.3449 are higher than the 0.5 threshold of significance, indicating that the null hypothesis is accepted. The calculated values of 5.17 and 4.48 are less than the critical value of 9.488, indicating that the null hypothesis is acceptable. This indicates that there is no discernible change in students' attitudes about mathematics between the experimental group and the two control groups.

Table 4. Students' Perception before the Utilization of Facebook Group in Mathematics Teaching-Learning Process

Statements	5	4	3	2	1	Wx	Verbal Description
1	18	13	4	1	0	4.3	Strongly Agree
2	11	13	12	0	0	4.0	Agree
3	3	20	13	0	0	3.7	Agree
4	7	10	17	2	0	3.6	Agree
5	7	17	12	0	0	3.9	Agree
6	9	17	9	1	0	3.9	Agree
7	4	15	16	1	0	3.6	Agree
8	6	19	11	0	0	3.9	Agree
9	16	14	5	1	0	4.3	Strongly Agree
10	10	11	12	2	1	3.8	Agree
11	10	16	10	0	0	4.0	Agree
Total	**106**	**169**	**124**	**10**	**2**	**4.0**	**Agree**

Table 4 summarizes students' perceptions on Facebook's use in the mathematics teaching-learning process. This reflects their emotions previous to their individual exposure to testing. As shown in the chart, the students agreed on the use of Facebook in the mathematics teaching-learning process. This indicates that students are open to experimenting with Facebook groups as a novel approach for teaching-learning experiences. To be more specific, the students strongly agreed with the following statements: a) I will include the usage of Facebook groups into our STAT01 teaching-learning process; and b) Senior high school students should understand how to use Facebook groups into their STAT01 teaching-learning process.

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This result is relevant to Murray et al(2015) .'s research, "Student Perceptions of Flipped Learning." They discovered that students' overall views of flipped learning were favorable. Students clearly preferred the flipped learning approach. Students appreciated the ease and accessibility of the video lectures, and many reported feeling more connected to their classmates and teachers as a result.

According to a research conducted by Abdulsalam Alhazmi and Azizah Abdul Rahman, those who use Facebook for academic reasons have an unfavorable view of the usage of Facebook for education. This is because the majority of students see Facebook as a personal space and a place for peer interaction. Academic reasons accounted for a tiny part of how students utilized Facebook; rather, it is mostly used for pleasure purposes (Shohrowardhy, H.S.,Hassan, H.M.K. 2014)

Table 5. Students' Attitude after the Utilization of Facebook Group in Mathematics Teaching-Learning Process

Statements	**5**	**4**	**3**	**2**	**1**	**Wx**	**Verbal Description**
1	24	12	0	0	0	4.7	Strongly Agree
2	22	11	3	0	0	4.5	Strongly Agree
3	21	14	1	0	0	4.6	Strongly Agree
4	14	17	5	0	0	4.3	Strongly Agree
5	24	7	5	0	0	4.5	Strongly Agree
6	20	13	3	0	0	4.5	Strongly Agree
7	23	12	1	0	0	4.6	Strongly Agree
8	18	15	3	0	0	4.4	Strongly Agree
9	27	8	1	0	0	4.7	Strongly Agree
10	21	10	5	0	0	4.4	Strongly Agree
11	25	10	1	0	0	4.7	Strongly Agree
Total	**244**	**133**	**31**	**2**	**1**	4.7	**Strongly Agree**

The following table summarizes students' attitudes about the use of Facebook groups in the mathematics teaching-learning process. This reflects their emotions after their own exposure to experimenting. As shown in the table, the overall weighted mean of 4.7 indicated that students agreed on the use of Facebook groups in the teaching-learning process of mathematics. This indicates that students are more receptive to using Facebook groups to facilitate teaching-learning experiences. This agreement indicates that students remain willing to engage in and collaborate with this kind of teaching-learning activity.

Indeed, Moore & Chung's (2015) research corroborates these results. They discovered that a flipped classroom model has a positive effect on students' attitudes toward mathematics, as they recognize the need for additional resources and time to comprehend the material presented in a mathematics class, appreciate having access to web-based videos for additional support, and are less concerned about falling behind in class as a result of their access to web-based videos.

Kayri & Cakr (2010) discovered that students' views were remarkably diverse, and a correlational analysis revealed that those who spent significant time on Facebook viewed it as an educational tool. In other words, individuals who previously saw Facebook as a social setting expressed favorable views toward instructional usage of the platform. The pupils comprehend how effective Facebook can be as a teaching tool.

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Table 6. Difference Between the Students' Perception and Attitude on the Utilization of Facebook Group in Mathematics Teaching-Learning Process

Variables	5	4	3	2	1	Wx	Description	Comp. Value	Crit. Value	p-value	Remarks
Perception	106	169	124	10	2	4.0	Agree	120.17	9.488	4.92E-25	Significant
Attitude	244	133	31	2	1	4.7	Strongly Agree				

The difference in students' perceptions and attitudes about the use of the Facebook group in the mathematics teaching-learning process is shown in Table 6. As seen in the table, the p-value of 4.92E-25 is significantly less than the 0.5 threshold of significance, indicating that the null hypothesis is rejected. The calculated result of 120.17, which is significantly higher than the critical value of 9.488, indicates that the null hypothesis is rejected. This also indicates that students' ratings of the use of Facebook groups in the mathematics teaching-learning process have increased significantly from 4.0 to 4.7. This result is related to a few student-respondents who said that they experienced a strengthening of camaraderie among classmates throughout their usage.

According to Perisic et al. (2014), "creating and sustaining contact with and among students throughout the semester increases students' engagement and therefore achievement, resulting in a more positive learning experience in general, and Facebook is an excellent tool for this." This highlights the critical role of Facebook in the teaching-learning process, since it is the ideal medium for engaging students.

Table 7. Difference Among the Pre-Test Results of the Experimental and Two Controlled Groups

Groups	n	Mean	Std. Dev.	Comp. Value	Crit. Value	p-value	Remarks
Experimental	36	7.86	2.40	0.17	3.0829	0.8443	Not Significant
Controlled 1	37	8.23	2.70				
Controlled 2	35	8.03	2.71				

The difference between the experimental group's Pre-Test scores and those of the two control groups is seen in Table 7. As seen in the table, the p-value of 0.8443 is higher than the 0.5 threshold of significance, indicating that the null hypothesis is accepted. The calculated value of 0.17, which is less than the critical value of 3.0829, indicates that the null hypothesis should be accepted. This indicates that there is no statistically significant difference between the experimental group's Pre-Test scores and those of the two control groups. This also demonstrates that the three groups are on an equal footing about the subject prior to the experiment's start. Additionally, the equality of the average scores of the three groups prior to the start of the experiment indicates that these groups lack previous knowledge of the topic. Thus, this serves as a foundation for evaluating the effect of the Facebook group on the mathematics teaching-learning process once it begins.

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Table 8. Difference Between the Post-Test Results of the Experimental and Two Controlled Groups

Groups	n	Mean	Std. Dev.	Comp. Value	Crit. Value	p-value	Remarks
Experimental	36	15.97	3.03	0.9	3.0829	0.4099	Not Significant
Controlled 1	37	14.95	3.63				
Controlled 2	35	15.57	3.19				

The difference between the experimental group's Post-Test scores and those of the two control groups is seen in Table 8. As seen in the table, the p-value of 0.4099 is higher than the 0.5 threshold of significance, indicating that the null hypothesis is accepted. The calculated value of 0.9, which is less than the critical value of 3.0829, indicates that the null hypothesis should be accepted. This indicates that there is no statistically significant difference between the experimental group's Post-Test scores and those of the two control groups. Additionally, this indicates that both groups did equally well in this test. This result implies that the use of Facebook groups in the teaching-learning process of mathematics is successful. This is shown by the fact that the experimental group's scores are comparable to those of the two control groups. Even though the experimental group did not participate in a formal classroom discussion, they fared as well as the two controls groups that did.

Additionally, these results demonstrate that all groups did equally well independent of the technique employed in the teaching-learning process. This also indicates that the experimental group maintained a constant level of performance despite having recently completed a group study of the learning materials. Consistency was shown in one research on constructivist learning. When students acquire information via direct personal experiences such as activities, projects, and conversations, constructivist learning occurs (Ultanir, 2012). The frequency of these personal experiences may be enhanced in a flipped classroom via the use of activities, which develop students into active rather than passive learners (those who learn through analysis, synthesis, and assessment) (Minhas et al.,2012; Sams, 2013).

Schulman & Sims (1999) discovered no significant changes in post-test results between online and conventional students enrolled in an undergraduate course. Jones (1999) compared an entirely online class to a conventional class and found no statistically significant variations in GPA between online and traditional learners. All of these data corroborate the results of our test, which revealed no significant difference in midterm grades between the controlled and experimental groups.

Table 9. Difference Between the Pre-Test and Post-Test Results of the Experimental Group

Variables	n	Mean	Mean Difference	Std. Dev.	Comp. Value	Crit. Value	p-value	Remarks
Pre-test	36	7.86	8.11	3.41	14.26	1.6896	3.78E-16	Significant
Post-Test	36	15.97						

The difference between the Pre- and Post-Test scores for the experimental group is shown in Table 9. As seen in the table, the p-value of 3.78E-16 is significantly less than the 0.5 threshold of significance, indicating that the null hypothesis is rejected. The calculated result of 14.26, which is much higher than the crucial value of 1.6896, confirms the null hypothesis's rejection. This indicates that the experimental group's post-test result is larger than their pre-test result. This indicates that the outcome improved from the pre- to the post-test.

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This corroborates a research that showed that active learning (learning via analysis, synthesis, and assessment of autonomous problem-solving) produces higher grades than passive learning (learning by information absorption through hearing, seeing, and reading) (Minhas et al., 2012). Additionally, the incorporation of group discussions results in a high degree of collaborative learning. Collaborative learning occurs when two or more individuals work together to accomplish a task, holding one another responsible for their progress (Roberts, 2004).

Table 10. Difference Between the Proportion of Students Who Passed

Group	n	# of Passers	%	p-value	Computed Value	Critical Value	Remarks
Experimental	36	24	66.67	0.7369	0.34	1.96	Not Significant
Controlled 1	35	22	62.86				
Experimental	36	24	66.67	0.2709	1.1	1.96	Not Significant
Controlled 2	37	20	58.82				

The difference in the percentage of students who passed between the experimental group and the two control groups is seen in Table 10. As seen in the table, the p-values of 0.7369 and 0.2709 are higher than the 0.5 threshold of significance, indicating that the null hypothesis is accepted. The calculated values of 0.34 and 1.11 are less than the critical value of 1.96, indicating that the null hypothesis is acceptable. This indicates that the experimental group's pass rate is identical to that of the two control groups. This showed that the experimental group's performance is almost identical to that of the two control groups. Additionally, this demonstrates the efficacy of using the Facebook group in the mathematics teaching-learning process. This is because the experimental group did not participate in classroom discussion, yet they fared as well as the two controlled groups that did.

Indeed, the flipped classroom may be a worthwhile instructional design or it may just be another fad. While it is admirable to experiment with different methods of teaching kids, they should not be mandated since the outcomes are same and the flipped classroom needs resources that not all students own (Fulton, 2012).

Table 11. Effectiveness of the Utilization of Facebook Group in Mathematics Teaching-Learning Process, as Perceived by the Students

Statements	**5**	**4**	**3**	**2**	**1**	**Wx**	**Verbal Description**
1	25	10	1	0	0	4.7	Strongly Agree
2	15	20	1	0	0	4.4	Strongly Agree
3	29	5	2	0	0	4.8	Strongly Agree
4	24	10	2	0	0	4.6	Strongly Agree
Total	**93**	**45**	**6**	**0**	**0**	**4.6**	**Strongly Agree**

Table 11 summarizes students' perceptions on the efficacy of using a Facebook group in the mathematics teaching-learning process. The overall weighted average, as shown in the table, is 4.6. This demonstrates that students have a high favorable attitude about the use of Facebook groups in the teaching-learning process of mathematics. Additionally, this indicates that students regarded the execution as very successful. To be more specific, the students strongly agreed with the following statements: a) The Facebook group was an effective tool for learning because it provided immediate feedback; b) The Facebook group was the best, easiest, and fastest method of receiving feedback in learning; c) The Facebook group opened up new opportunities for knowledge; and d) The Facebook group was a more flexible method of learning because it allowed for learning at one's own pace. The experimental group's

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performance on the Flipped Classroom task also indicates that the most relevant learning happens as a consequence of effective utilization of the additional class time in a flipped classroom (Tucker, 2012).

Daraei, (2015) discovered via her study that Facebook was an excellent educational tool. According to one of the students in the Facebook group, Facebook provides a helpful learning environment where they can exchange instructional resources and increase their involvement in the learning process. It promoted teamwork, which may benefit both instructors and students when used as a supplement to courses. Additionally, it aided instructors and students in becoming acquainted via the use of profile pages.

General Observations on the Students' Experiences in the Utilization of Facebook in Mathematics Teaching-Learning Process

At the end of the implementation of the utilization of Facebook group in Mathematics teaching-learning process, the students have expressed their feelings on their experiences. Presented below are few of their comments:

> *"Stressful when the students cram, but (the lesson) can be understood when one will exert effort".*
> *"It would be nicer if it will always be like this. However, I don't know with others' (opinion). I prefer this because I don't feel any pressure, because I am learning the lessons according to my own pace."*
> *"It is helpful, because if ever we will not understand some concepts (in the word file or pdf file), there are video clips which are helpful in understanding the concepts. Also, our groupmates are very ready to elaborate whenever we really find it difficult to understand."*
> *"It is the most productive thing on Facebook (with heart emoticon)."*
> *"Thank your Sir, for the opportunity to experience this style of learning."*

The implementation have developed the students' interpersonal relationship. Presented below are few of their conversations:

> *"Marie (name of a certain shy type student inside the class is withheld), don't be shy to ask questions."*
> *"Louise (name of a certain low performing student inside the class is withheld), what are the things that are confusing to you?"*
> *"Nice Steph (name of a certain high performing student inside the class is withheld), thanks for elaborating!"*

The students in the experimental group were excited and enthusiastic in taking the actual exercises inside the classroom compared to those students in the controlled group. They took exercises and examinations without bringing any list of formulas, while the controlled group students are dependent on their list of formula. They finish the exercises and examinations at least 15 minutes earlier than the allotted time, while the controlled group request 5 – 10 minutes extension.

After the online cooperative learning, the low performing students have performed well in the actual exercises inside the classroom. Evidently, few of them answered the exercises ***quickly*** and got ***perfect scores***, while other got relatively high scores compared to their usual scores in the previous exercises.

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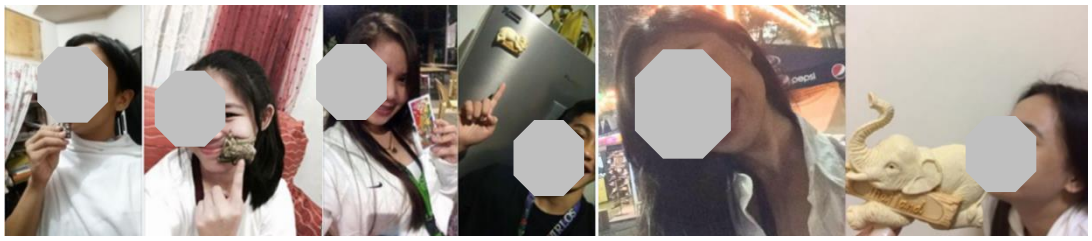

Figure 1. Student-respondents who got a perfect score in the test

The students-respondents in Figure 1 above got their token as a prize for earning a perfect score on the Actual Test. Actual Tests were administered in class to evaluate student-respondents' learning after their online cooperative learning through their individual Facebook group. Student Female 1 (SF1) (extreme right) aced both Actual Tests #1 and #2. Student Male 1 (SM1), Student Female 2 (SF2), Student Female 3 (SF3), Student Male 2 (SM2), and Student Female 4 (SF4) all received flawless scores on Actual Test #2. According to SF1, "the learning process is enjoyable since we also learn a lot by discussing what we've learned from the learning materials posted to our Facebook group." "The education we received aided us in developing deeper friendships inside our group," she said*."*

Figure 2. A perfect scorer in Actual Test who answered with enthusiasm and confidence

Figure 2 shows a student who is not used to get a high score in the test but got a perfect score in the Actual Test # 2 after actively participating in their online cooperative learning through their Facebook group. Inside the examination room, Student Female 5 (in Figure 2) was enthusiastic in receiving the test paper. She is not bringing any list of formula but confident in taking the test. She finished the test ten (10) minutes ahead of the allotted time, and submitted the test energetically with high level confidence. She then turned out to be a perfect scorer. SF 5 mentioned in her post,

> *"How I wish it will always be like this. Because I can learn the lesson in own pace. (Also) whenever I get confused (on some concepts), I have my groupmates who are willing to reach me out through our Facebook group discussion."* She added, *"The earning materials (video clips, PowerPoint presentations, pdf files, website links, etc.) which are uploaded by our instructor in our Facebook group are very much helpful in learning the lesson even without the actual discussion inside the classroom."*

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Figure 3. Student-respondents surprisingly took the final assessment without using the list of formula and finished thirty (30) minutes before the allotted time

Figure 3 depicts student responders who completed the final exam thirty (30) minutes ahead of schedule. Within the examination room, the student-respondents were awake and alive when they received the examination paper. They responded enthusiastically to the test, in contrast to the control group, which was reluctant and apprehensive upon entering the examination room. In contrast to the controlled group, which carried a list of formulas into the examination room, the student-respondents did not request a list of formulas. The final exam was scheduled to last one (1) hour and thirty (30) minutes; nevertheless, many student-respondents completed it in less than one (1) hour. Since shown in the picture, the student-respondents waited patiently for the time by resting their heads on the arm of their seats, as they were not permitted to leave the examination room prior to departure time. In the controlled group, students requested an additional fifteen (15) minutes to complete all of the questions on the exam, which included calculations and problem solving.

Conclusion

According to the results of this research study, including Facebook groups into the mathematics teaching-learning process benefits SHS-ABM students at the University of San Carlos in Cebu City. To be more precise, the following findings are reached; (1) The following methods and procedures were used to include Facebook groups into the mathematics teaching-learning process; (a) Preliminaries - a survey of students' Facebook use; (b) Establishing the class's Facebook group – adding instructional resources to the group, such as PowerPoint presentations, portable document format (pdf) files, video clips, document files, and internet connections; and publishing instructions and rules for the group's membership; (c) Incorporating Facebook Groups into the Mathematics Teaching-Learning Process – class orientation; formation of group chats and corresponding Facebook groups; posting of online exercises; students' online cooperative learning approach to responding to the online exercise; classroom-based actual assessment of students' learning; (2) Prior to deployment, students had a favorable attitude about the use of Facebook groups in the teaching-learning process of mathematics. This demonstrates that the students are willing to participate in a Facebook group while they are being taught and that they will acquire Mathematics subjects; (3) Following implementation, students had a very favorable attitude toward the use of Facebook groups in the teaching-learning process of mathematics. This demonstrates that after seeing its implementation firsthand, students are more receptive to experiencing the use of a Facebook group when they are taught and will learn Mathematics lessons; (4) Prior to deployment, students gave a weighted mean of 4.0 to the use of Facebook groups in the mathematics teaching-learning process. This indicates that the pupils consented to its use. It rose considerably to 4.7 by the conclusion of its deployment. This indicated an increasing degree of consensus about its use. (5) The experimental and control groups achieve statistical parity in their post-test outcomes. This demonstrates that the performance of students in the experimental and control groups is comparable. This indicates that the use of Facebook groups

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in the teaching-learning process of mathematics is successful. Even though the experimental group did not participate in a formal classroom discussion, they fared as well as the two controls groups that did. (6) There is a substantial rise in the experimental group's post-test score from the pre-test score. This indicates that the outcome improved from the pre- to the post-test. (7) The proportion of students passing the controlled group is statistically equal to the proportion passing the experimental group. This demonstrates the efficacy of using the Facebook group in the mathematics teaching-learning process. This is because the experimental groups did not participate in classroom discussions yet fared as well as the controls groups who did; (8) On average, students rated the efficiency of using the Facebook group in the mathematics teaching-learning process a rating of 4.6. This demonstrates that the pupils unanimously agreed on its efficacy. This demonstrates that the implementation is very successful in terms of enhancing the mathematics teaching-learning process. Additionally, the students were unanimous in their agreement with the following statements: a) The Facebook group was an effective tool for learning because it provided immediate feedback; b) The Facebook group was the best, easiest, and fastest method of receiving feedback in learning; c) The Facebook group opened up new opportunities for knowledge; and d) The Facebook group was a more flexible method of learning because it allowed for learning at one's own pace. (9)Through a Facebook group and online cooperative learning, students established interpersonal relationships. Additionally, the students developed the following abilities; (a) Collaborative learning skills among peers; (b) Acquired the ability to show gratitude to their groups for assisting them throughout the group online conversation; (c) Invited the more reserved group members to participate in the online group discussion; (d) Demonstrated the growth of higher-order thinking abilities via the substance of their cooperative online discussions exchanges; (10) The poor performers increased their performance after their online cooperative learning, as demonstrated by the outcomes of their real activities; (11) The students were enthused and enthusiastic about participating in the classroom exercises. They took the exam without utilizing any formulas, in contrast to the controlled group's restless and formula-dependent pupils; (12) The students completed the activities and exams ahead of schedule, in comparison to the controlled group, which required a 5- to 10-minute extension.

Recommendations

With reference to the statistical analyses, the vast literature on the use of mobile gadget in the teaching-earning process, findings and conclusions, this research study provides the following recommendations:

To the Mathematics Teachers; (1) Utilize the accessibility of Facebook group in the content delivery of the lesson; (2) Develop learning materials which can be accessed by the students through the use of Facebook group; (3) Conceptualize a system of real-time consultation for students during the discussion and outside the classroom setting using Facebook group; (4) Maximize the students' very high level of awareness on Facebook group by utilizing it as a medium of instruction.

To the School Administrators and/or Curriculum Planners; (1) Create a strategic plan for Mathematics instruction where mobile gadgets are utilized in the teaching-learning process. (2) Include the following goals in developing the strategic plan: (a) Program Development Plan; (b) Governance Strengthening Plan; (c) Subscription and Development Program; (d) Physical Development Plan; (e) Design a mobile e-learning system that is compatible to all mobile gadgets.

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To the Book Authors and/or Publishing Companies: (a) Take advantage of the accessibility of Facebook group in the development of learning materials and references (b) Deliver multimedia materials designed specifically for Facebook group; (c) Design activities that are accessible to all Facebook group.

To the Mobile Application Developers (1) Maximize the accessibility of Facebook group towards interactive and educational tasks; (2) Develop interactive learning materials in Mathematics utilizing the ubiquity of Facebook; (3) Create a consultation system that enables student and professor interaction.

To the Future Researchers; (1) Create a strategic plan for research purpose that will serve as a springboard for the school administrators in their implementation of Facebook in Mathematics classroom; (2) Venture into further research for wider implementation of Facebook group in the classroom setting

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