



Group Integration Method in Integral Calculus at the College of Engineering University of Eastern Philippines

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Authors' contributions

This work was carried out in collaboration between both authors. Author EBJJ designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author BDV managed the analyses of the study and the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

This study intended to determine the effect of Group Integration Method on academic performance in Integral Calculus at the College of Engineering University of Eastern Philippines.

It employed a quasi-experimental design that involved two sections of second year BSEE students enrolled in Integral Calculus in the College of Engineering. The students in these sections were comparable since their pre-test on a 1-1 scoring system were not significantly different using the t-test of independent sample at 0.05 level of significance in Integral Calculus ability of the students between the control and experimental group.

The average pre-test scores per class were determined to set the experimental and control group. The former bears the lower average scores, which needs more attention through cooperative learning among group members while the latter bears the higher ones since the students can handle individual learning. The individual pre-test scores were used in the categorization of the students in both control and experimental groups. The scores were ranked and categorized into

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three (3): the High Performer (HP), the Average Performer (AP) and the low Performer (LP). The result showed that most of the respondents for both groups are males, first timers and average students with respect to differential calculus academic performance. As to the age bracket, the data shows majority of the students were (18-20) years old. The outcomes of the study further showed that the respondents exposed to the Integration Method and Traditional Method had the overall interpretation of failed rating at the start of the study. As the study progressed 8 respondents from the Group Integration and 12 respondents were added in Traditional method above failing stage considering the post-test administered to both groups. The T-test at 0.05 level of significance stressed out that post-test and combined tests for pre-test/post-test significantly differs for both Group Integration and Traditional methods of instruction. Finally, as to the academic performance, Group Integration is better than Traditional Methods of Instruction. This implies that the intervention aided the students to boost their skills in Integral calculus under the experimental group.

Keywords: Group integration method; integral calculus; cooperative learning; mathematics innovation; teaching strategy; calculus teaching guide.

1. INTRODUCTION

Integral calculus is one of the mathematics subjects that have been always included in the licensure examinations of the engineering disciplines. This is a very important engineering subject because it is a prerequisite to three (3) or four (4) basic engineering subjects. It is one of the mathematics subjects that serve to screen out second year engineering students from entering the formal study of the major engineering subjects. Hence, engineering students should be able to cope with the demands of the subject in order to proceed to the third year level of a particular engineering discipline or else the student will be allowed to enrol only in non-engineering subjects.

While integral calculus is a quite difficult subject, the student has two to three chances to enrol and pass this subject because the retention policy of the College of Engineering states that "any student who fails twice or drop thrice a particular mathematics subject will be automatically dropped from the rolls of the college and will no longer be readmitted to enrol in any other engineering course [1]. With this scenario, the faculty members assigned to teach this subject should take some initiative to do some strategy that will somehow expose the students to more opportunities to study the lessons being discussed.

Understanding what integral calculus represents in the physical world is important to how well and how easily a student will remember a concept. These students often struggle because

of their inability to easily connect the abstract or conceptual aspects of integral calculus with reality, even if they might have a high level of potential for higher-level mathematical thinking.

Still failing Integral Calculus, in general sense, is a major problem of the student in the college of engineering. Based on the six consecutive semestral records filed at the College of Engineering of Varela [2] alone, the average failing percentage from 2010 to 2016 of the two hundred (200) enrolled students in integral calculus is as high as forty-eight percent (48%). In addition, out of forty-nine (49) enrolled last first semester SY 2016-2017 under the researcher, twenty-eight (28) students failed with a percentage of fifty-seven (57%). Luna [3] points out that having defective and under resourced educational system often leads into context training that gives lower substance and knowledge. With this unwanted realities plaguing mathematics education there is a need to review the proficiency test level on the learning processes.

One strategy maybe that will help students is to conduct a group integration method instruction. Tan [4] revealed that students exposed to homogenous grouping performed better than students that compete individually in a mathematics subject. However, this may be laborious on the part of the faculty member, this group assessment of knowledge and skills will give the students an initial experience on the kind of examination and problems he/she will meet in an individual examination for a particular lesson/topic. Salazar [5] confirmed that gain scores of the students from grouping method are

better than individual method in learning mathematics. Having this experience could improve the student's familiarity and analytical skill in answering the individual examination, which is given more weight than the group examination.

In recent years, psychological and educational research has witnessed the relevant use of grouping method in mathematics education. It introduces several theories and approaches to learning which make students more knowledgeable of and responsible for their own learning cognition, and thinking.

By adapting the Integration Group Method, coined as Salazar's Grouping Method, in relation with the effects on student's Achievement in Integral Calculus, it seems that it is as important that the students should be able to demonstrate a high level of proficiency in Integral Calculus using direct instruction that employs qualitative and quantitative analyses [5].

The qualitative assessment of Integration Group Method develops self-confidence, encourages effective communication and facilitates exchange of ideas towards a common goal among students. Its features help students to acquire mathematical proficiency with an implication on how the instructors can develop that proficiency in the students and how this can be tested by group examination using direct method of instruction employed in Integration Group Method.

Hence, this study assessed whether the conduct of Group Integration Method will improve the performance of students taking integral calculus in the individual examination. As of now, no similar study has been conducted yet in Northern Samar as far as Group Integration Method is concerned.

1.1 Study Objectives

This study determined students' academic performance in Integral Calculus using group integration method vis-à-vis the individual learning performance. Specifically, this study aimed to:

1. determine the profile of student in Integral Calculus in the Second Semester, SY 2016-2017, in terms of
 - age
 - sex

- status of students in taking Integral Calculus whether first time taker or repeater; and
 - average final grade in Differential Calculus;
2. determine the pre-test of the Group Integration Method and the Traditional Method of Instruction;
 3. determine whether there is a significant difference between the pre-test of Group Integration and the Traditional Methods of Instruction;
 4. determine the post test of the Group Integration Method and the Traditional Method of Instruction;
 5. determine whether there is a significant difference between the post test of Group Integration and the Traditional Methods of Instruction;
 6. determine whether there is a significant difference between the pre-test and post-test under the Group Integration and the Traditional Instruction Methods employed in Integral Calculus;

1.1.1 Hypothesis

The following null hypotheses were tested in this study:

1. There is no significant difference between the pre-test of respondent under the Group Integration and the Traditional Instruction Methods employed in Integral Calculus.
2. There is no significant difference between the post test of respondent under the Group Integration and the Traditional Instruction Methods employed in Integral Calculus.
3. There is no significant difference between the pre-test and post-test under the Group Integration and the Traditional Instruction Methods employed in Integral Calculus.

2. LITERATURE REVIEW

Gilles and Ashman [6] embedded the recognition to the importance of cooperative learning, in contrast to the traditional classroom, as an effective approach to learning. Its coverage of the subject ranges across the educational spectrum, from pre-school years to university, and offers a fresh perspective on a topic that has gained increasing interest worldwide. With contributions from an international panel of

leading experts in the field, this engaging text succeeds in providing key insights, linking the theories that underpin the study of group dynamics to their practical application in the classroom. It presents a comprehensive overview of this alternative educative approach, illustrating how cooperative learning experiences can promote socialization and friendships, and facilitates learning. The editors assemble a range of well-researched essays, covering such aspects as: The importance of teacher and student interaction, small group, virtual and non-virtual teaching environments, assessment practices for measuring the outcomes of individual and group progress, the effect of cooperative learning on relationships amongst students with diverse cultural, social and learning needs. Illustrated with practical examples throughout, this book will be a crucial read for teacher educators, educational psychologists, student teachers, academics and researchers who wish to attain a fuller understanding of the subject and unleash the significant potential of cooperative learning in any educational setting.

Jebson [7] on her research work investigated the impact of cooperative learning approach on the performance of secondary school students in mathematics using some selected secondary schools. It employed one hundred and twenty students selected from the entire population of students offering mathematics at the senior secondary two (SS 2) levels of the selected schools. Quasi- experimental research design was used and the samples were grouped into groups A and B named experimental and control groups respectively. The experimental period was four weeks with a total number of sixteen hours of lesson delivery for each group. The experimental group was taught using the cooperative learning approach while the control group was taught using the conventional method. A Mathematics Test of Assimilation (MTAS) was administered to the groups and the result was analyzed using t-test. The analysis revealed that the experimental group has a mean score that is significantly higher than that of the control group ($p < 0.05$). It was also observed that sex difference or gender has no significant influence on the performance of students in mathematics when taught using or not using cooperative learning approach ($p < 0.05$). The research generally revealed that the experimental group performed better than the control group. This implies that cooperative learning approach has significant effect on students' performance in secondary school mathematics. It is therefore

recommended that teachers of mathematics should work together toward the improvement of students' performance in mathematics.

Mathematics is usually singled out as being a particularly worrying problem when concern is expressed about the performance of pupils. It seems that the whole world regards it as important that children should be able to demonstrate a high level of proficiency in the subject.

Hiebert & Carpenter [8] stated in their handbook that a persistent dilemma for mathematics teachers is concern on how to help student understand abstract concepts. Teachers face a double challenge. Symbols may be difficult to teach to students who have not yet grasped the concept that they represent. At the same time, the concept may be difficult to reach to students who have not yet mastered the symbols. Not surprisingly, both teachers and mathematics researchers have called for better technique to help students learn mathematics concepts and symbols.

Grootenboer & Hemmings [9] reported on a study examining those factors which contribute to the mathematics performance of a sample of children aged between 8 and 13 years. The study was designed specifically to consider the potency of a number of mathematical affective factors, as well as background characteristics, on children's mathematics performance. Data were collected by surveying the children and drawing on performance ratings from their teachers. A correlation analysis revealed that the relationships between the respective dispositional and background variables with mathematics performance were significant and in the direction as predicted. Moreover, the findings from a logistic regression showed that a combination of these variables was able to appropriately classify students who either were below-average or above-average mathematics performers. We pay particular attention to the influence of certain dispositions with respect to mathematics performance and conclude by detailing the implications of the study for teachers and researchers.

Sammuelson [10] revealed that the mathematics curriculum during elementary school in Sweden has many components, but there is a strong emphasis on concepts and operations of numbers. From an international perspective, mathematics knowledge is defined as something

more complex than concept and operations of numbers. The five strands which together build students' mathematical proficiency provide a framework for discussing the knowledge, skills, abilities, and beliefs that constitute mathematical proficiency.

Nordin et al. [11] on their presentation showed evidence that older children fare better academically than their younger, age appropriate peers. On the other hand, with the used research evidence about the relationship between age and achievement as well as other evidence to argue that the older and/or more mature students in a class fare better than younger classmates. In contrast they found no significant relationship between age and achievement. It was found significantly higher achievement of the oldest as compared to the youngest students at age nine but this difference disappeared by age seventeen.

Grootenboer & Hemmings [9] agreed that the issues of sex have been a rich area, and probably initiated interest in research out affective factors and mathematics learning. Historically, the achievement of girls in mathematics, across a range of different contexts, was lower than that of the boys, and this was attributed to a variety of reasons including affective factors. In a meta-analysis of studies female students held more negative attitudes to mathematics than male students, and these differences increased with age.

This study is similar to Grootenboer & Hemmings study because both assessed the performance of students, only its difference is the former focused on the essence of the role played by affective and background factors while the latter focus on achievement level of student in Integral Calculus.

Sammuelson [10] stated that there are studies discussing mathematics as a boy's subject in terms of girls' lack of confidence in their ability and in terms of attitudes to mathematics as a school subject and girls' achievement. There are other studies arguing that teaching approaches where students practice rote learning and rote following are positive to girls. Boys are more interested in classroom settings where it is possible to take risks and where it is possible to find out different ways to solve problems - a more creative environment.

According to Vasquez (2012) as to attitude towards mathematics, it was found out that most

of the respondents were responsible in checking error in their solutions in Math. They were undecided as to the issue to think about to take so many units of mathematics in their future coursework. It is conceived that the use of student-generated stories builds up in the learners the positive attitude towards mathematics, the feeling of independence and building up self-confidence in the learning process at their own speed as a facilitator. It implied that that the students who were exposed to the use of student-generated stories perform better compared to those under the conventional/lecture method of teaching. A quasi-experimental research design was used which involved an experimental and control group. The research designed employed was used to examine the effect on the Intermediate Algebra students' performance exposed to traditional lecture method of teaching and the use of student-generated stories. There is a significant difference on both groups on the pre and post-test.

Varela [2] in his previous study was related to the present study in the sense that it also aimed to find out the mathematics performance of the engineering students in terms their learning outcomes. It only differ on the locale and level of respondents. This study assesses the process of mathematics achievement level of students while other study has different strategies used.

Salazar's study aimed to raise the achievement level of students in Integral Calculus using Direct Instruction with Salazar's Method of Grouping. This study is similar to Salazar's [5] which aimed to raise the achievement level of students in Integral Calculus using Direct Instruction with Integration Method. Both studies used the quasi-experimental method of research. The method of grouping of both studies develops self-confidence, encourages effective communication and facilitates exchange of ideas towards a common goal. The students from both groups were in favour to the presentation of the lesson.

3. METHODOLOGY

This research study was conducted in the College of Engineering, University of Eastern Philippines Main Campus (UEP Main Campus), Catarman, Northern Samar during the Second Semester, SY 2016 – 2017.

The College of Engineering – UEP Main Campus was established in 1966. It offers four

engineering programs, namely: Bachelor of Science in Agricultural Engineering, Bachelor of Science in Civil Engineering, Bachelor of Science in Electrical Engineering and Bachelor of Science in Mechanical Engineering.

This study employed a quasi-experimental research design, particularly, the non-equivalent control group design. A randomized experimental group design was used to investigate the difference of students' performance in Integral Calculus involving one experimental group (Integration Method of Instruction) and one control group (Traditional Method of Instruction). The pre-test results were utilized to randomly assign the students in the control and experimental groups. This was done to equate the two groups in the distribution of student's mathematical ability.

There were two group variables involved in this study. The independent variables were categorized into student's status (first time taker or repeater), grades of student's in Differential Calculus, the integration method used as teaching strategy and the level of usefulness of Group Long Examination was predetermined. The dependent variable was the achievement scores in integral calculus (difference of pre-test and post-test).

The two (2) classes in Math 227e (Integral Calculus) offered during the second semester, SY 2016-2017, handled by the researcher were taken as population of the study. Samples students from these two classes were categorized into experimental and control groups.

The respondents for this study were the BSEE second year students enrolled in Integral Calculus handled by the researcher during the second semester, school year 2016-2017. The said classes are the combination of first time takers and repeaters in Integral Calculus. The researcher considered both statuses in the data gathering in order to attain reliable results when it comes to the Integration Method Instruction.

A validated teacher-made pre-test and post-test questionnaire patterned after the Calculus Schaum's Outline by Ayres [12] was used. These questionnaires were all problem solving items requiring the respondents to solve four (4) problems on the topics area under a curve, area between curves and volume of solid of revolution – disk and ring method. The content of the

teacher-made pre-test/post-test was carefully chosen to ensure that all items were included in the topics covered by the study. The content validity of the test was checked and strengthened by senior mathematics teachers in the College of Engineering. It was pilot-tested with the agricultural engineering students enrolled in Correlation Course V in Mathematics.

The pre-test was administered to the students before they were distributed to the control and experimental groups. The average pre-test scores per class were determined to set-up the experimental and control group. The former bears the lower average score which needs more attention through group integration instruction the latter bears the higher ones since the students can handle individual (traditional) learning. The individual pre-test scores were also used in the categorization of the students in both control and experimental groups. The pre-test scores were ranked and categorized into three (3): the top 33.33% (HP), the middle 33.33 (AP) and the lower 33.34% (LP). Each member in the category was randomly assigned into eight (8) subgroups. Each subgroup was represented by one (1) member of each category from HP, AP and LP with three members to ensure equal randomized class distribution.

To ensure comparability of the control and experimental groups, T-test for independent sample at 0.05 level of significance was used to test if there is significant difference in the ability of the students between groups as far as Integral Calculus is concerned.

The distribution of students in the experimental group (Fig. 1) was proportioned on the basis of their scores in the pre-test using randomized sampling.

In Fig. 1, the top 33.33% of the total samples of the pre-test were marked as high performer (HP) group. The middle 33.33% served as the average performer (AP) group while the remaining samples (33.34%) were the low performer (LP) group. Each member of the group was drawn at random to their final groupings composed of HP, MP and LP as shown in color-coded subgroupings. Matching were done to ensure comparability in terms of the mathematical abilities equally distributed among subgroups.

After random distribution and categorization of students, the experimental and control groups

were finalized, an orientation of both groups was conducted. The students in the experimental group was informed on the process of Integration Method of Instruction since group cooperation is necessary despite their differences to avoid individual competition and personal dispute among group members A try-out was conducted for one (1) meeting to familiarize and to make the students feel at ease with the new classroom activity [4].

After the try-out session, the regular class sessions in Integral Calculus was undertaken. Four (4) topics were covered in the research study. Both groups were provided with course specifications and instructional materials. The teaching method adopted the steps based on the prepared subject plans by the researcher. To control other factors that may influence the

outcomes of the study, the time for conducting classes was limited to one and half hours.

During the experimental period, direct method of instruction was used in both groups. However, during the seatwork activities, Group Integration Method was used in the experimental group and Traditional Instruction Method for individual learning in the control group. The sequence of activities for both groups is outlined next page.

After the experimental period, the experimental and control groups were subjected to post-test to measure the student's achievement. Similar with the pre-test, students in both groups solved the post-test individually.

The pre-test and post-test papers were checked and graded using the university grading system and interpreted as follows.

Table 1. Sequence of activities on the two methods of instruction used

| Integration method (Group Learning) | Traditional method (Individual Learning) |
|---|--|
| 1.Introduction/Review Setting the stage for learning among students within the group. | 1.Introduction Setting the stage for learning by the teacher himself. |
| 2.Development The teacher discussed and derived the formula, and adopted a group discussion on the given illustrative examples based on the knowledge input developed. | 2.Development The teacher discussed and derived the formula and gave illustrative examples. |
| 3.Guided Practice Student-centered practice was given with emphasis on seatwork wherein cooperative learning is highlighted during problem solving. The teacher acted only as facilitator. | 3.Guided Practice Teacher-centered practice was given with emphasis on problem solving. The teacher himself solved the problem given on seatwork. |
| 4.Closure Summarizing the subject with emphasis on the important points derived from group discussions. | 4.Closure Summarizing the subject with the emphasis on the teachers knowledge on the topic only. |
| 5.Pre-Individual Long Examination Students underwent group long examination before the Individual Examination. | 5.Self-review Students were advised for self-review on the subject matter. |
| 6.Individual Long Examination Administered Individual Examination which served as student performance evaluation. | 6.Individual Long Examination Administered Individual Examination which served as student performance evaluation. |

Table 2. University grading system and interpreted

| University grading system | | | |
|----------------------------------|---------------------|--------------------|-----------------------|
| Score | Grade Rating | Grade Range | Interpretation |
| 16 | 96-100 | 1.00 | Excellent |
| 14-15 | 86-95 | 1.25-1.50 | Very good |
| 11-13 | 69-85 | 1.75-2.25 | Good |
| 8-10 | 50-68 | 2.50-3.00 | Fair |
| Below 8 | 0-49 | 5.0 | Failed |

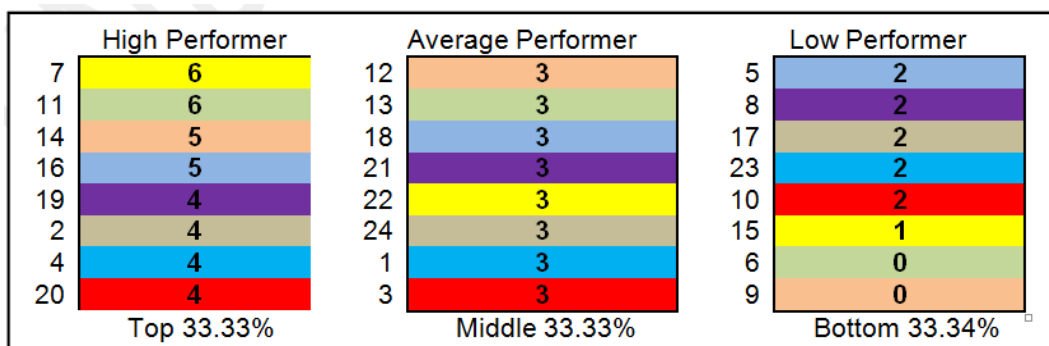


Fig. 1. Distribution of Students (experimental group)

With respect to the gain scores (difference in Post-test and Pre-test scores), the following interpretation were used.

Table 3. Gain scores

| Gain scores | Interpretation |
|-------------|--------------------|
| 14-16 | Very High Increase |
| 11-13 | High Increase |
| 8-10 | Average Increase |
| 5-7 | Low Increase |
| 1-4 | Very Low Increase |

Raw scores obtained from the pre-test and post-test were presented in tabular form for the purpose of analysis and interpretation. Means were computed for each group. The differences in the mean scores of the experimental group (Integration Method of Instruction) and control group (Traditional Method of Instruction) on the pre-test and post-test were tested at 0.05 level of significance using T-test.

The difference in the academic performance of students of both control and experimental groups was tested using T-test for two independent samples. Statistical computation was performed manually and verified using XLSTAT statistical software.

4. RESULTS AND DISCUSSION

4.1 Profile of Students in Integral Calculus

Table 4 shows the profile of BSEE students officially enrolled in integral calculus for the two class sections in the second semester, SY 2016 – 2017 with Section A under the Traditional Method of Instruction and Section B under the

Group Integration Method, both having twenty four (24) students per section.

- Age: The data shows that for both groups, there are three (3) age brackets, 15–17, 18-20 and 21-23 years old in the section under Group Integration Method whereas there are only two (2) age brackets, 15-17 and 18-20 years old for the section under the Traditional Method. Majority of the students in both sections are 18-20 years old with 79.17% and 62.50% for the Traditional and Group Integration, respectively. The table further shows that all the respondents for the Traditional Method were 20 years old and below, whereas, there are three (3) students above the 20 years in the Group Integration.
- Sex: Table 4 again reveals that among the respondents, 66.70% and 33.30% are males and females, respectively, for the Traditional Method; and 75% and 25% for the Group Integration Method, are males and females, respectively. This further indicates that most of the respondents for both methods are males.
- Status in Taking Integral Calculus: The status of respondents in taking Integral Calculus reveals that 95.8% and 91.70% are first timers for the Traditional and Group Integration Methods, respectively. Only one (1) respondent for Traditional Group and two (2) for the Group Integration were repeaters.
- Average Final Grade in Differential Calculus: As to the average grade in differential calculus, Table 4 reveals that 3 (12.50%), 10 (41.67%) and 11(45.83%) of

the respondents have average final grades ranging 1.25-1.50, 1.75-2.25 and 2.5-3.0 for the Traditional Method Group. On the other hand, for the Group Integration Method Group, the same table shows that the final grades are in the range of 1.75-2.25 and 2.50-3.0 having 4 (16.67%) and 20 (83.33%) respondents, respectively. This implies that most respondents in the Group Integration are students with

average performance in differential calculus.

4.2 Pre-Test Scores of the Students under Group Integration and Traditional Methods of Instruction

The scores of students under Group Integration Method of Instruction in the Pre-test on a 1-1 scoring are shown in Table 5. It reveals that

Table 4. Profile of students in Integral Calculus

| Age | Frequency | Percentage |
|---|------------------|-------------------|
| Traditional Group | | |
| 15 - 17 | 5 | 20.83 |
| 18 - 20 | 19 | 79.17 |
| 21 – 23 | 0 | 0.00 |
| Total | 24 | 100.00 |
| Group Integration | | |
| 15 - 17 | 6 | 25.00 |
| 18 - 20 | 15 | 62.50 |
| 21 – 23 | 3 | 12.50 |
| Total | 24 | 100.00 |
| Sex | Frequency | Percentage |
| Traditional Group | | |
| Male | 16 | 66.70 |
| Female | 8 | 33.30 |
| Total | 24 | 100.00 |
| Group Integration | | |
| Male | 18 | 75.00 |
| Female | 6 | 25.00 |
| Total | 24 | 100.00 |
| Status of Students Taking Integral Calculus | Frequency | Percentage |
| Traditional Group | | |
| First timer | 23 | 95.80 |
| Repeater | 1 | 4.20 |
| Total | 24 | 100.00 |
| Group Integration | | |
| First timer | 22 | 91.70 |
| Repeater | 2 | 8.30 |
| Total | 24 | 100.00 |
| Average Final Grade in Differential Calculus | Frequency | Percentage |
| Traditional Group | | |
| 1.25 – 1.50 | 3 | 12.50 |
| 1.75 – 2.25 | 10 | 41.67 |
| 2.50 – 3.0 | 11 | 45.83 |
| Total | 24 | 100.00 |
| Group Integration | | |
| 1.25 – 1.50 | 0 | 0.00 |
| 1.75 – 2.25 | 4 | 16.67 |
| 2.50 – 3.0 | 20 | 83.33 |
| Total | 24 | 100.00 |

Table 5. Pre-test scores of respondents in the group integration and traditional methods of instruction

| Group integration method | | | |
|--------------------------|-----------|------------|----------------|
| Scores | Frequency | Percentage | Interpretation |
| 3 | 2 | 8.33 | Failed |
| 2 | 2 | 8.33 | Failed |
| 1 | 6 | 25.00 | Failed |
| 0 | 14 | 58.34 | Failed |
| Total | 24 | 100.00 | |

| Traditional method | | | |
|--------------------|-----------|------------|----------------|
| Scores | Frequency | Percentage | Interpretation |
| 3 | 1 | 4.17 | Failed |
| 2 | 7 | 29.16 | Failed |
| 1 | 4 | 16.67 | Failed |
| 0 | 12 | 50.00 | Failed |
| Total | 24 | 100.00 | |

Table 6. Significance of difference between the pre-test under the group integration and traditional group methods in integral calculus

| Group | N | Mean | Df | Mean differences | t-values (0.05) | | Interpretation |
|-------------|----|-------|----|------------------|-----------------|------|-----------------|
| | | | | | Comp. | Tab. | |
| Integration | 24 | 0.667 | 23 | 0.208 | 0.894 | 2.07 | Not Significant |
| Traditional | 24 | 0.875 | | | | | |

Table 7. Post-test score of respondents under the group integration and traditional methods of Instruction

| Group integration method | | | |
|--------------------------|-----------|------------|----------------|
| Scores | Frequency | Percentage | Interpretation |
| 11 | 1 | 4.17 | Good |
| 10 | 3 | 12.50 | Fair |
| 9 | 1 | 4.17 | Fair |
| 8 | 3 | 12.50 | Fair |
| 7 | 3 | 12.50 | Failed |
| 6 | 4 | 16.67 | Failed |
| 5 | 4 | 16.67 | Failed |
| 4 | 4 | 16.67 | Failed |
| 3 | - | - | - |
| 2 | 1 | 4.17 | Failed |
| Total | 24 | 100.00 | |

| Traditional method | | | |
|--------------------|-----------|------------|----------------|
| Scores | Frequency | Percentage | Interpretation |
| 12 | 1 | 4.17 | Good |
| 11 | 2 | 8.33 | Good |
| 10 | 7 | 29.17 | Fair |
| 9 | 1 | 4.17 | Fair |
| 8 | 3 | 12.50 | Fair |
| 7 | 2 | 8.33 | Failed |
| 6 | 2 | 8.33 | Failed |
| 5 | 4 | 16.67 | Failed |
| 4 | 2 | 8.33 | Failed |
| Total | 24 | 100.00 | |

most respondents (14 or 58.34%) scored 0 out of 16 points while 6 or 25% respondents, 2 or 8.33% and 2 or 8.33%, respectively, have scores of 1, 2, and 3 points, respectively. Sadly, however, all respondents failed in the pre-test.

Furthermore, same table divulges that the lowest score of students in the Traditional Method of Instruction is 0 with a frequency of 12 (50%). There were 4 (16.67%), 7 (29.16%) and 1 (4.27%) respondents with scores of 1, 2, and 3 point. This means that all respondents failed.

This further implies that the two groups of respondents are not different from each other because all of them failed in the pre-test.

4.3 Test of Significant Difference in the Pre-Test Scores of Respondents under Group Integration and Traditional Methods of Instruction

As shown in Table 6 the difference in the Pre-test Scores of the respondents under Group Integration and Traditional Methods of Instruction was found to be insignificant at 0.05 level of significance, because the obtained absolute t-computed value of 0.894 is lesser than the tabular value of 2.07 on a 1-1 scoring. Hence, the null hypothesis “that there is no significant difference between the Pre-test Scores of respondents under the Group Integration and Traditional Methods employed in Integral Calculus” is accepted. This implies that the two groups have parallel knowledge skills in integral calculus prior to the intervention.

4.4 Post-Test Scores of Students under the Group Integration and Traditional Methods of Instruction

The scores in the Post-test of the experimental group under the Group Integration Method of Instruction are shown in Table 7. It reveals that 8 (33.33%) of the 24 respondents have scores of 8 points or more while 16 (66.67%) have scores below 8 points. In terms of frequency counts,

there were 3 respondents each who got 10 points, 8 points and 7 points. Likewise, 4 respondents got 6 points, 5 points and 4 points. Lastly, 1 respondent got 2 points, 9 points and 11 points as far as the Group Integration Method of Instruction is concerned. This implies that only 1, 7 and 16 respondents under the Group Integration Method have good, fair and poor performance in Integral Calculus.

The same table unveils the post-test scores of respondents in the Traditional Method of Instruction. It reveals that 14 (58.33%) of the 24 respondents have scores of 8 points or more while 10 (41.67%) have scores below 8 points. In terms of frequency counts, there were 2 respondents each who got 4 points, 6 points and 7 points and 11 points. Likewise, 1 respondent each got 9 points and 12 points. Lastly, 4 and 7 respondents got 5 points and 10 points, respectively, as far as the Traditional Method of Instruction is concerned. This implies that only 3, 11 and 10 respondents under the Traditional Method have good, fair and poor performance in Integral Calculus.

4.5 Test of Significant Difference in the Post-Test under Group Integration and Traditional Methods of Instruction

The mean difference in the scores of the post-test between groups, as shown was found to be 2.0, interpreted as “significant” at 0.05 level significance because the computed t-value of 2.106 is greater than the tabular value of 2.07. Hence, the null hypothesis that “that there is no significant difference between the post-test of respondents under the Group Integration and Traditional Methods employed in Integral Calculus” is rejected.

Table 8. Academic performance of respondents in the different methods of instruction

| Group integration method | | | |
|--------------------------|-----------|------------|-------------------|
| Performance | Frequency | Percentage | Interpretation |
| 11-13 | 2 | 8.33 | High Increase |
| 8-10 | 1 | 4.17 | Average Increase |
| 5-7 | 11 | 45.83 | Low Increase |
| 1-4 | 10 | 41.67 | Very Low Increase |
| Total | 24 | 100.00 | |
| Traditional method | | | |
| Performance | Frequency | Percentage | Interpretation |
| 8-10 | 8 | 33.33 | Average Increase |
| 5-7 | 7 | 29.17 | Low Increase |
| 1-4 | 9 | 37.50 | Very Low Increase |
| Total | 24 | 100.00 | |

4.6 Test of Significant Differences in the Pre-Test and Post-Test Scores of Students under Group Integration and Traditional Methods of Instruction

The mean difference in the scores of the pre-test and post-test in the Group Integration was found to be 5.289, which is interpreted as “significant” at 0.05 level significance because the computed t-value of 8.814 is greater than the tabular value of 2.07. It indicates the high ability of learning by respondents.

Likewise, the mean difference in pre-test and post-test of the Traditional Method was found to be 5.767, which is interpreted as “significant” at 0.05 level significance because the computed t-value of 12.171 is greater than the tabular value of 2.07.

Hence, the null hypothesis that “There is no significant difference between the pre-test and post-test under the Group Integration and the Traditional Methods of Instruction employed in Integral Calculus” is rejected.

4.7 Academic Performance under Group Integration and Traditional Methods of Instruction

Table 8 reveals that academic performance in the Group Integration Method is better than the Traditional Method since 2 or 8.33% of the respondents has high increase, 1 or 4.17% has average increase, 11 or 45.83% has low increase and 10 or 41.67% has very low increase in their academic performance in Integral Calculus while in the Traditional Method 8 or 33.33% has average increase, 7 or 29.17% low increase and 9 or 37.50% has very low increase in their academic performance in Integral Calculus. No one in the Traditional Method obtained a High Increase in performance.

This shows that the intervention administered in the Group Integration Method improved the performance of the students in Integral Calculus compared with the Traditional Method of Instruction used.

The t-Test, however, revealed that the academic performances of respondents under the Group Integration and Traditional Methods of Instruction are not significantly different since the computed t-value is 0.766 lesser than the tabular value of 2.07.

5. CONCLUSIONS AND IMPLICATIONS

In view of the findings of the study, the following conclusions were drawn:

The average grade in differential calculus implies that majority of the respondents are average students.

In terms of the scores in the pre-test, all the respondents in the two methods of instruction failed. It implies that the respondents under both methods of instruction are comparable.

The pre-test scores of both groups are not significantly different from each other. This implies that not all respondents yet familiar with the applications of Integral Calculus at the start of experimental period.

The post-test scores of both groups are significantly different from each other. It implies that the post-test scores of the respondents under the Group Integration Method are better than the post-test scores of those under the Traditional Method.

The test of difference between the pre-test and post-test scores of the two groups of respondents revealed significant differences. This implies that a significant number of the respondents have a good learning ability although most of the respondents did not perform well.

Finally, on the academic performance, the respondents under the Group Integration Method have better performance than those in the Traditional Method. This implies that the Group Integration Method helped the students in boosting their skills in Integral calculus.

6. RECOMMENDATIONS

Based on the findings of this study, the following recommendations and future research are proposed:

1. The College of Engineering should impose pre-admission requirements such as battery examination on prerequisite subjects before the students are allowed to enrol in Integral Calculus.
2. The foundation subjects of Integral Calculus such as analytic geometric should give more emphasizes on functions and boundaries which are essential in solving problems applied in Integral Calculus.

3. School administrators should embolden instructors to adopt group method of instructions in the different subject areas and let them explore prospects that will allow for more creativity so that the students remain attentive, motivated, and fervent throughout their mathematics subjects and the major subject.
4. Lessons on indefinite integrals should be added for future study since the basic integration is necessary in the application of Integral Calculus.
5. A similar study may be conducted covering all the different topics of integral calculus and not on the applications only. Intervention, evaluation and assessment within the period may be well monitored and assessed

CONSENT AND ETHICAL APPROVAL

As per international standard or university standard guideline participant consent and ethical approval has been collected and preserved by the authors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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