
Grouping Method and Self-Esteem of Engineering Students in Mathematics Subject

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ABSTRACT

This study sought to determine the effect of grouping students by mathematical ability and sex during classroom activity in students' achievement and self-esteem in an engineering mathematics classroom. The study adopted a pure experimental research design with randomized control and experimental group. Pre-test was used to randomly assign thirty (30) first year and first timer students in Advanced Algebra subject to control and experimental groups and to equate in terms of distribution by ability and sex. Results revealed that students allocated to the experimental group significantly outscored the students in the control group in terms of achievement scores. Students in the control and experimental group had higher self-esteem, however, the test of difference on the change in self esteem after the teaching intervention to students found to be insignificant. Furthermore, test of difference of both groups on students' achievement and self esteem between male and female as well as high and low ability was found to be insignificant. The study shows that students in homogeneously grouped math classroom activities tend to perform better. It can be concluded that by providing a learning environment favorable to the learners, students are clustered with same ability and sex, they are likely to improve academically.

Keywords- *Engineering Mathematics, Grouping Method, Self-esteem, Achievement*

INTRODUCTION

The recent challenge of ASEAN integration has caught the attention of Philippine Higher Education Institutions' (HEIs) in molding and producing globally competitive professionals. It is evident that the quality of graduates and professionals relies on the schools, as it is the one who controls the condition of success.

The introduction of Outcome Based Education (OBE) in the Philippine educational system and the subsequent issuance of CMO 37 series of 2012 implementing OBE in engineering education is part of the Commission on Higher Education's commitment to develop competency based learning that will comply with the existing international standards. OBE focuses on learning outcomes at the institutional, program, and course levels [1]. One of the highlights of the program is the shift from input based education (Teacher-centered Instruction) to outcome based education (learner-centered education). Engineering and mathematics educator should device a strategy that will not only raise the achievement level of the student in the course but develop their abilities to think logically, deeply and creatively in the solution of engineering problems. It is now the obligation of the schools and educators

to continuously search for the best modern teaching techniques and methods that could bring a significant mathematical learning among students.

Introducing group work in solving mathematical problems as instructional strategy in the classroom or assigning engineering students by group to work collaboratively in solving mathematical problem would help our students exposed in the real world of engineering. However, there is a need to understand on as to how our learners respond academically on the introduced intervention. The study of Thanh-Pham, Gillis and Renshaw found that Cooperative Learning was no better and worse than the traditional lectured-based teaching method in term of increasing students' academic achievement [2]. Other research conducted stressed that benefits of CL are not automatic, however if it is not properly implemented, it will create considerable difficulties to the lecturers, most notably dysfunctional teams and student resistance or hostility to group work [3] .

This study determines the effect of grouping students by ability and sex during seat work, board work and assignment stage only on students' achievement and self-esteem. Specifically, this study aimed to;

1. determine the pre-test and post-test scores of both the control and experimental groups;
2. determine the self-esteem of the students in experimental group before and after the intervention;
3. determine the self-esteem of the students in the control group before and after teaching;
4. find out the significant difference between the control and experimental group in terms of achievement scores and self-esteem.
5. determine the significant difference between the male and female students of both control and experimental groups in terms of achievement scores and self-esteem.
6. find out the significant difference between high and low ability students of both control and experimental groups in terms of achievement scores and self-esteem.

METHODOLOGY

Research Design

This study adopted a randomized pre-test post-test control group design. This is a pure experimental research with randomized control and experimental groups. Pre-test was used to randomly assign the students in the control and experimental group. This was done to equate the two groups in terms of distribution of students by mathematical ability and sex.

The Variables

The independent variable was the classroom teaching learning activities at two levels; students grouping method (experimental group) and conventional teaching (control group). Dependent variables included achievement scores in advance algebra subject (difference of post test and pre-test scores), and self-esteem while moderator variable include sex (male and female) and mathematical ability at two levels categorized as high and low.

Population and Sampling

Two classes during the second semester school year 2015-2016 in an Advanced College Algebra subject composed of BSAE and BSME students were taken as samples of the study. Sample students from the two classes were re-grouped into experimental and control group using pre-test. Sex of the student-respondents was also considered in the allocation. However, students from the two classes who previously enrolled in the same subject but failed to pass were excluded as respondents.

Research Instrument

Two instruments were used in this study. First, was a validated teacher-made pre-test/post-test questionnaire, which was administered to the students before its allocation to the control and experimental groups. The questions in the pre-test/post-test instrument were taken from the identified topics included in the study.

The second instrument used in this study was the Rosenberg Self Esteem Scale adopted from Center for Disease Control and Prevention, National Center for Injury Prevention and Control [4]. This instrument was also administered before and after the treatment.

Scoring and Interpretation of Data

The data derived from the research instruments were scored and interpreted as follows:

Pre-test/Post-test. *The scores obtained were used to classify the students into low and high ability levels. Students who got score that belonged to upper 50% were categorized as having high level of ability while students who got score that belonged to lower 50% were categorized as students of low level of ability. Achievement scores of the students in both groups were obtained by subtracting the pre-test to the post-test scores.*

Self-esteem

Data gathered on self-esteem were interpreted as follows:

4.20- 5.00 (Very high)	3.40 - 4.19 (High)
2.60 - 3.39 (Moderate)	1.80 - 2.59 (Low)
1.00 - 1.79 (Very low)	

Data Gathering Procedure

Pre-test scores of the students were used in the random categorization of the students in both control and experimental groups as follows: Male-High Mathematical Ability, Male-Low Mathematical Ability, Female-High Mathematical Ability and Female-Low Mathematical Ability.

The randomized class assigned as control group had a class schedule at 8:30 to 10:00 am every Tuesday and Thursday, while the randomized class assigned as experimental group had a class schedule at 10:00 to 11:30 am every Tuesday and Thursday.

In order to ascertain the comparability of the control and experimental groups, t-test on independent sample at 0.05 level of significance was used to test the insignificant difference on mathematical ability of the students between groups. Significant difference between the group of high and low ability for both control and experimental groups was also checked before coming up with the final grouping. After random allocation and categorization of the students into experimental and control groups had been finalized, students in the

experimental group were informed and oriented on the individual small grouping assignment. Considering the number of students, this study assigned four students every group, but three student members were also considered. Both groups were subjected by the researcher to an orientation on the processes involved in the study. Prior to the conduct of the experiment, a try-out was done for one meeting, to familiarize and to make the students feel at ease with the new classroom activity.

Quadratic equation, system of linear equations using Matrix and determinants and progressions were the topics included in the investigation. Both groups were provided with course specifications and instructional materials. Power Point presentations were prepared on selected topics. The time allotment for each topic was based on the prepared course specification/subject syllabus. Teaching method differed only on the seatwork, board work and assignment stage. The experimental group received direct instruction, the conventional chalk and talk method similar to control group, but were exposed to student grouping during seatwork, board work and assignment stage while the control group worked and compete individually during the above mentioned classroom activities. Direct Method of Instruction was used to both groups.

RESULTS AND DISCUSSION

Pre-test and Post-test Scores of both Control and Experimental Groups

Table 1 presents the scores of the students allocated in the control and experimental groups in a teacher made pre-test and post-test. Students in the experimental group got a weighted mean score of 9.26 and 21.73 for pre-test and post-test respectively, while the control group had a pre-test score of 9.5 and post-test score of 17.93.

T-test for correlated sample was performed and come up with t computed value of 3.49 and 3.7 for experimental group and control groups, respectively. Results were higher than the t tabular of 2.145 at 0.05 level of significance and degrees of freedom of 14.

Generally, difference in weighted mean scores in pre-test and post test of both experimental and control groups were significant. It implies that with and without the designed intervention, students involved in this study statistically achieved the outcomes expected from them in the topics taught and included in the investigation.

Table 1. Pre-test and post test scores of control and experimental group

GROUP	SAMPLE	CONTROL GROUP		EXP. GROUP	
		PRE-TEST SCORES	POST-TEST SCORE	PRE-TEST SCORE	POST-TEST SCORE
Male-High Ability	1	13	18	14	26
	2	13	19	13	23
	3	12	23	12	31
	4	11	23	11	25
Group Mean		12.25	20.75	12.3	26.25
Female-High Ability	5	11	16	12	28
	6	11	23	9	33
	7	10	18	9	20

Group Mean		10.67	19.00	10.00	27.00
Male-	8	8	16	8	14
Low	9	8	20	8	13
Ability	10	8	15	7	11
	11	6	14	7	22
Group Mean		7.50	16.25	7.50	15.00
Female-	12	9	19	8	14
Low	13	8	13	8	24
Ability	14	8	18	7	22
	15	7	14	6	20
Group Mean		8	16	7.25	20
WEIGHTED MEAN		9.5	17.93	9.26	21.73

Furthermore, as reflected in the table, student belonged to experimental group of female high ability got the highest mean score of 27 followed by male of high ability in the same group with mean score of 26.25. This means that high ability students can perform more if they were exposed to the `designed intervention. Interaction or collaboration of high ability group of students in the solution of mathematical problems tends to produce greater achievement. According to Mckeachi, students interaction associated with a basic face-to-face promotes interaction and drives one or more cognitive processes [5].

Self-esteem of Students in Experimental Group Before and After the Teaching Intervention

Table 2 shows that student respondent in the experimental group had a high level of self-esteem. The computed grand mean before the introduction of teaching intervention was found to 3.65 and there was a minimal decrease on the grand mean to 3.60 after the intervention. This means that the introduced intervention was found to be non-discriminating on the part of the student samples in this study.

Table 2. Self-esteem of the students in experimental group before and after the teaching intervention

STATEMENT	Before W. MEAN	INTERP.	After W. MEAN	INTERP.
1. I feel that I'm a person of worth, at least on an equal par with others.	4.00	H	3.47	H
2. I feel that I have a number of good qualities.	4.13	H	3.80	H
3. All in all, I am inclined to feel that I'm a failure.	3.27	M	3.27	M
4. I am able to do things as well as most other people.	3.73	H	4.07	H
5. I feel I do not have much to be proud of.	3.27	M	3.27	M
6. I take a positive attitude toward	3.93	H	4.33	VH

myself.				
7. On the whole, I am satisfied with myself.	3.73	H	3.67	H
8. I wish I could have more respect for myself	4.33	VH	3.73	H
9. I certainly feel useless at times	2.87	M	3.2	M
10. At times I think that I am no good at all	3.27	M	3.27	M
TOTAL	36.53		36.07	
GRAND MEAN	3.65	H	3.60	H
<i>VH- Very High H- High M- Moderate L - Low VL – Very Low</i>				

Possessing high self-esteem greatly affects the students' academic achievements. As mentioned by Sandra, self-esteem affects the thinking process, emotions, desires, values and goals in a person [6]. This was supported by the findings in the study of Yanti Rosli et al. that self-esteem had a positive correlation with the general point grade average of the students [7].

Self-esteem of Students in the Control Group Before and After Teaching

Table 3 presents the self-esteem of the students in the control group before and after the teaching. As shown in the table, students in this group had a high level of self-esteem as manifested by the computed grand mean of 3.55 before teaching and a grand mean of 3.4 after teaching. However, the recorded decrease in self esteem was further tested using t test for correlated samples, and the result revealed an insignificant difference on the means of self esteem score of the students in the control group before and after teaching.

Generally, the result of students' self-esteem scores in the control group was interpreted as high. This means that students who belong to this group possesses a positive outlook towards himself/ herself and believes on his/her own ability in general.

Table 3. Self-esteem of the students in the control group before and after teaching

STATEMENTS	Before		After	
	W. MEAN	INTERP	W. MEAN	INTERP
1. I feel that I'm a person of worth, at least on an equal par with others.	4.00	H	3.87	H
2. I feel that I have a number of good qualities.	3.73	H	3.93	H
3. All in all, I am inclined to feel that I'm a failure.	3.13	M	2.67	M
4. I am able to do things as well as most other people.	3.67	H	3.73	H
5. I feel I do not have much to be proud of.	2.93	M	2.73	M
6. I take a positive attitude toward myself.	3.93	H	4.00	H

7. On the whole, I am satisfied with myself.	3.67	H	3.60	H
8. I wish I could have more respect for myself	4.07	H	3.87	H
9. I certainly feel useless at times	3.00	M	2.87	M
10. At times I think that I am no good at all	3.4	H	2.87	M
TOTAL	35.53		34.13	
GRAND MEAN	3.55	H	3.4	H

VH- Very High H- High M- Moderate L - Low VL-Very Low

Significant Difference between Control and Experimental Group in Terms of Achievement Scores and Self-esteem

Achievement Score

Table 4 presents the significant difference between the means of the experimental and control groups in terms of achievement scores. As presented in the table, the control group got a mean score of 8.4 while the experimental group got a mean score of 12.53. T-test for two independent samples revealed that there was a significant difference between the mean achievement scores of experimental group and control group. It means that students exposed to grouping method during seat work and assignment stage, considering ability and sex performed well than students in the traditional classroom condition where students were doing seat work and assignments individually. The finding on achievements of this study is consistent with the findings of the study of Abudo and Agbayewa on homogeneous ability grouping [8], Salazar using Razalas grouping method [9], and in the study of Hossain that method of grouping is effective in raising the achievement level of the students [10].

Table 4. Significant difference between control and experimental group in achievement scores

GROUP	N	Mean	df	Mean Diff.	t- value(0.05) Comp.	Tab.	Interpretation
Exp.	15	12.53	28	4.13	2.6	2.05	Significant
Control	15	8.4					

Self-esteem

Table 5 presents the significant difference on the change in self-esteem scores after teaching of the students in the experimental and control groups. The table depicts the decrease in self-esteem scores of both groups where experimental group registered a -0.05 decrease while -0.14 decrease for the control group. The t-test performed revealed an insignificant difference on the change in self esteem. With this result, it can be concluded that homogenous grouping did not affect the students' self-esteem. Homogenously grouping students is the provision of a learning environment familiar to them or comparable to the learning environment they were used to be with. According to Abudo et al., students can work at a faster or slower pace without being discouraged within the group of same ability level they belong [8]. He added that homogeneous grouping is close to individualized instructional method.

Table 5. Significant difference in Self-esteem between control and experimental group

GROUP	N	Mean	df	Mean Diff.	t- Value (0.05)		Interpretation
					Comp.	Tab.	
Exp.	15	-0.05	28	-0.09	-0.66	2.05	Not Significant
Control	15	-0.14					

Significant Difference between Male and Female Students of both Control and Experimental group in Achievement Scores and Self-esteem

Difference in Achievement Scores of Male and Female Students in Experimental and Control Groups

To test the significant difference between the mean scores of the male and female students in the experimental group, t-test for two independents sample was used. Table 6 depicts the insignificant difference between the achievement scores of male and female students. The insignificant difference of the achievement scores between male and female students negates the findings in the study of Hossain et al., wherein the performance of female is significantly better than the performance of male but it has something in common with the finding in this study [10]. Female respondents got an achievement score of 14.57 while male got only 10.75. This means that homogenous group learning enhanced mathematics achievement for female students, while the male counterparts do not benefit as much as the female group. Thus it is important that female students be provided with opportunities to learn mathematics in the classroom in the group learning environment.

Table 6 also depicts the significant difference in achievement scores of male and female students in control group. Test for difference between the means was found to be insignificant at 0.05 level of significance. This result of insignificant difference in achievement score of male and female and a very low mean difference in the control group strengthens the finding that female students benefited by the introduced group learning intervention.

Table 6. Significant difference in Achievement scores of male and female students in experimental and control groups

GROUP	N	Mean	df	Mean Diff.	t- Value (0.05)		Interpretation	
					Comp.	Tab.		
EXP.	Female	7	14.57	13	3.82	1.36	2.16	Not significant
	Male	8	10.75					
CONTROL	Female	7	8.14	13	-0.48	-0.34	2.16	Not significant
	Male	8	8.62					

Difference in Self-esteem of Male and Female Students in both Experimental and Control Groups

Table 7 presents the significant difference between the change in self-esteem of male and female students in the experimental group and control group. As shown in the table, the female students had a -0.11 decrease while male students registered a 0.01 decrease in self-

esteem score after teaching and introduction of the intervention in the experimental group. The test for significant difference using t-test for two independent samples was found to be insignificant at significance level of 0.05.

The change in self-esteem of male and female students in the control group is also shown in table 7. T-test for independent sample revealed an insignificant difference on the change in self-esteem between male and female students. This simply means that male and female students in the control group possess almost equal level and equal change of self-esteem.

The minimal change or almost equal change in self-esteem of the students' respondents in the experimental group along with the decrease in self-esteem of the students in the control group is an indicator of respondents' positive view to the introduced homogeneous grouping method. In contrary to reports showing females students self esteem declines more rapidly than the males by Heaven and Ciarrochi as cited in the study of Yanti Rosli et al. [7]

Table 7. Significant difference in Self-esteem of male and female students in experimental and control groups

GROUP		N	Mean	df	Mean Diff.	t- Value (0.05)		Interp.
						Comp	Tab.	
EXP.	Female	7	-0.11	13	-0.13	-0.55	2.16	Not significant
	Male	8	0.01					
CONTROL	Female	7	-0.29	13	-0.27	-1.67	2.16	Not significant
	Male	8	-0.01					

Significant Difference Between High and Low Ability Students of Both Control and Experimental Group in Terms of Achievement and self-esteem.

Achievement scores

Table 8 presents the significant difference in achievement scores between high and low ability students in the experimental and control groups.

The data shows that students with high ability had higher mean achievement scores of 14.57 and the mean achievement scores of students with low ability is 10.12 with a mean difference of 4.45. Using t-test for two independent samples, results found to be insignificant at significance level of 0.05. It means that despite of higher mean difference on the means of the high and low ability groups, they are still statistically almost equal. This study has partial agreement with the findings of Cheung & Rudowicz as cited by Aydin [12], and in the study of Tully on their investigation on the effect of ability grouping on students' achievement [11].

Table 8 also presents the significant difference between mean achievement scores of high and low ability students in the control group. As depicted in the table, the high ability students got a mean achievement score of 8.43 slightly higher than the mean score of low ability group who got an achievement score of 8.38.

The t-test for two independent samples revealed that there is an insignificant difference between the achievement scores of the students that belong to high and low ability groups. The insignificant result and the almost equal mean scores achieved by both high and low ability students in the control group, strengthen the researcher claims that students in the

experimental group benefited by the introduced group learning activities as supported by the separate study conducted by Tully and Hossain [10][11].

Table 8. Significant difference in achievement scores of high and low ability students in experimental and control group

GROUP		N	Mean	df	Mean Diff.	t- Value(0.05)		Interpretation
						Comp.	Tab.	
EXP.	High	7	14.57	13	4.45	1.72	2.16	Not significant
	Low	8	10.12					
CONTROL	High	7	8.43	13	0.05	0.04	2.16	Not significant
	Low	8	8.38					

Difference in Self-esteem between High and Low ability Students in both Experimental and Control Group

Table 9 presents the significant difference in the change of self-esteem scores of high and low ability students of both experimental group and control group after teaching. As shown in the table, only the high ability students in the experimental group display an increase of self-esteem scores. The rest of the students demonstrated a decrease of self-esteem score. Test difference of the change in self-esteem of high and low ability students in the experimental group found to be insignificant. This means that the change in self-esteem of high and low ability students in the experimental group is almost equal.

This insignificant difference in self-esteem among high and low ability students in the experimental group means that their self-esteem was not affected by the intervention introduced to them. However, looking on the positive way, the result finds the ability grouping to be effective in the sense that it is non-discriminatory on the part of the students with low ability and to consider the numerically higher achievement scores of the ability group. Hence, this study contradicts with the stands of Slavin and Braddock as cited in the article prepared by Aydin on the negative effect of ability grouping on the low ability students' self-esteem [12].

Table 9. Significant difference in self-esteem between high and low ability students in experimental and control group

GROUP		N	Mean	df	Mean Dif.	t- Value(0.05)		Interpretation
						Comp	Tab	
EXP.	High	7	0.07	13	0.22	0.98	2.16	Not significant
	Low	8	-0.15					
CONTROL	High	7	-0.17	13	-0.06	-0.33	2.16	Not significant
	Low	8	-0.11					

The table also presents the test of difference on the change in self-esteem among high and low ability students in the control group. Result of the t-test revealed an insignificant difference in the change of self-esteem scores. The decrease of self-esteem scores of the students in the control group also strengthens the claim of the researcher that homogeneously grouping students by ability have no negative effect on the students' self-esteem.

CONCLUSION

The introduced intervention yielded a promising result as the students exposed to homogeneous grouping by ability and sex during seat work, board work and assignment stage significantly outperformed the students in the traditional engineering math class settings in terms of achievement. No effect on students' self-esteem was found. Grouping by ability and by sex found it non-discriminating based on the results of test of difference on both students achievement and self-esteem.

The success of this technique also relies on the teachers on as how he/she delivers this intervention to encourage more collaborative efforts, critical thinking and promote more positive attitude towards the engineering math subject. It is hoped that the results of this study would be significant to students, teachers, educators and policy makers in education. The research findings can offer an understanding of the strengths of the implementation of group learning approach from the view point of practicing teachers and students. Since the teachers and students are directly involved in the situation, they are the most appropriate persons to offer insights into the matter. For educators, they can evaluate mathematics teaching methods that are suitable with the kind of student they have.

Acknowledgment

This work was part of the thesis presented as requirement for the degree in MA Mathematics Education. The author acknowledged with gratitude the insights and suggestions provided and shared by the panellist headed by Dr. Benjamin D. Varela, dean of the University College of Engineering, University of Eastern Philippines.

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