
Students' Academic Achievement and Motivation: Comparative Analysis of Cooperative and Independent Learning Methods in Teaching Statistics

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ABSTRACT

The major decisions affecting the lives of everything on this planet have statistical justifications or basis and the methods we teach are significant to understand these decisions. This quasi-experimental pretest-posttest two-group design compared the effects of the two teaching methods in teaching Statistics to the level of achievement and motivation of Grade 11 students of Saint Columban College for the school year 2018-2019. With One-Way Analysis of Covariance (ANCOVA), there was a significant difference in students' achievement when taught using Cooperative Learning Method (experimental group) and using Independent Learning Method (control group) in teaching during the first trial run in favor of the independent learning. Similarly, the second trial run confirmed that there was a significant difference in students' achievement using Cooperative Learning Method (experimental group) and using the Independent Learning Method (control group) in teaching. In addition, the study found out that students in the control group with independent learning method had a higher level of achievement in Statistics class than those in the experimental group with cooperative learning method. In addition, the students in the control group with independent learning method had a higher motivation than the students with cooperative learning method. These research outcomes affirmed the claim that Independent Learning Method could enhance students' achievement in Statistics. Hence, teachers could practice appropriately and thoughtfully the individualistic classroom approach so that it will be an excellent instructional model which promotes students' higher forms of cognitive domains.

KEYWORDS: *Quasi-experimental, Cooperative Learning, Independent Learning, Collaborative Learning*

1. INTRODUCTION

Andrew Gelman and Deborah Nolan said that we use Statistics when we make decisions, both at an individual and a public level and to understand the world. The major decisions affecting the lives of everything on this planet have statistical justifications or bases and the methods we teach are significant to understand these decisions (Gelman, & Nolan, 2017).

Nowadays everyone bumps into an absurd amount of statistical information daily, while listening to weather forecast, or using customers' opinion surveys to choose certain goods and services. Therefore, learning Statistics becomes a priority for the growing number of people who aspire to be able to interpret and evaluate the accuracy of information. Statistics

is a theoretical domain that studies the process of transmission, dissemination, and acquisition of statistical data, particularly in schools or universities. The two disciplines Mathematics and Statistics do share common elements that concentrate in the domain commonly called Mathematical Statistics. However, both Mathematics and Mathematical Statistics are the tools needed in the teaching of Statistics. So, the teaching of Statistics in the most effective and comprehensive way is becoming an important educational goal (Régnier, Ekaterina & Kuznetsova, 2015).

Until recently, the way in which Statistics curriculum developed prior to the 1960s has leaned towards determining the content, effective teaching methods, and right assessment of this subject. In France, it is a common experience among statistical educationalists that teachers and examining boards have been slow to respond to the changing nature of Statistics and to recognize that it is an applied subject which is ought to lead by everybody. It is not a subject only for mathematicians, despite its strong mathematical foundations (Hawkins, Jolliffe & Glickman, 2014). One way to enhance students' achievement is to help students evaluate the validity and accuracy of their mathematical thinking through -explaining and self-explaining with peers (Chi & Wylie, 2014; Luzano & Ubalde, 2023). Statistics achievement increased from the 50th percentile to the 73rd percentile for the students who had instructed using cooperative and collaborative small group learning methods (Kalaian and Kasim, 2014).

Thomas Telford School in the UK, the first comprehensive school discovered that 100% of students gained A–C grades. The school claimed that one of the reasons for this success was the development of independent learning skills across the school. In addition, students in self-regulated learning environments are more motivated to learn than those who study in more restrictive environments (Meyer, Haywood, Sachdev and Faraday, 2008; Luzano, 2020). Developments in Statistics are still ongoing, and these should continue to have an impact on statistical education. The formation of statistical perceptive may be interpreted from various beliefs. It should be considered as one of the essential purposes of studying statistics (Régnier, Ekaterina & Kuznetsova, 2014).

In Saint Columban College, it is inevitable to observe that some of the grade 11 students had poor achievement in Mathematics specifically in their Statistics and Probability subject. It was noticed that their low motivation to learn was one of the problems and that their willingness to listen to the discussion of the teacher was moved out. As a result, they got a poor grade in the said subject. The students nowadays need various teaching methods to grasp their attention and to have purposive learning. Thus, their substantial motivation to every lesson is particularly important believing that purposive teaching strategy could be a significant help for them.

This present study looked forward to the effects of the two teaching methods on teaching Statistics to the level of achievement and motivation of Grade 11 students of Saint Columban College for the school year 2018-2019. Thus, with this concern, the researcher has used the cooperative learning method and independent learning method in teaching Statistics to find its effects on students' achievements and motivation in Statistics.

1.1. Research Objectives

Specifically, this study sought to answer the following questions:

1. What is the level of students' motivation in Statistics using the cooperative learning method (experimental group) and independent learning method (control group)?
2. What is the level of students' achievement in Statistics using the cooperative learning method (experimental group) and independent learning method (control group) as a revealed by the pre-test and post-test results in two runs?
3. What is the percentage increase of students' achievement in the experimental and control group from the pre-test to the post-test during the two trial runs?
4. Is there a significant difference in the students' achievement between the cooperative learning method (experimental group) and independent learning method (control group) as a revealed by the pre-test and post-test results in two runs?
5. Based on the results of the study, what lesson guide can be designed to develop students' motivation and achievement in Statistics subject?

2. LITERATURE REVIEW

Cooperative learning is a teaching method wherein learners must form small groups and help one another to learn educational objectives. It is best for increasing students' competency for they are in a team of achieving group goals who focus on sharing what they have learned rather than simply finishing a group's task (Slavin, 2015). The cooperative learning method is effective in enhancing students' interactive skill that would motivate them to communicate effectively in achieving their educational goals (Baghcheghi, Koohestani, and Rezaei, 2011). Cooperative learning environment leads learners to higher achievement in every educational goal. However, the learners are needed less effort compared to those who are independent learners (McWilliams, Malecha, Langford, & Clutter, 2017). Furthermore, there is greater responsiveness and confidence among students in a cooperative learning classroom (Mondéjar and Pastor, 2017).

In engineering education, cooperative learning is one of the teaching strategies that were adopted by teachers to produce excellent and experienced students. The third-year chemical engineering students have considered the teaching strategy as a medium that motivates their thoughts and resourcefulness and develop their teamwork skills (Azizan, Mellon, Ramli, Yusup, 2018). In Spain specifically at the University of Oviedo, there were 990 teachers from 60 schools had participated to establish their perceptions about cooperative learning method. Since then, teachers have shown positive feedback towards cooperative learning implementation nevertheless of their subject area or educational stage (Tapper, 2018)

In the mixed-method study entitled "Students' Perspectives of using Cooperative Learning in a Flipped Statistics Classroom" found out that, teachers should give students a sense of preparedness to manage the students' positive in-class learning behavior during the small group activity for they have diverse needs and backgrounds in traditional classroom settings (Romorosa, et al., 2023). It was concluded also that pre-recorded multimedia lectures appeared to be an effective instructional strategy in the flipped statistics classroom setting (Chen et al., 2015; Casanova, et al., 2023).

The efficacy of teaching method with the satisfaction of the students' learning is the very aim of the academic field (Pang-an, et al, 2022). This cooperative learning method had resulted in a higher level of satisfaction, motivation, and achievement in students' learning (Mohammadjani, & Tonkaboni, 2015). It has a great advantage in learning if it enhances

cooperation and development of interpersonal skills (Altun, 2015). Team-based learning aims to promote critical thinking and to provide students with procedural and conceptual knowledge (Luzano, 2023). Even though the team-based learning had no significant difference from the lecture method, it was still shown that it had a higher performance. It was also found out that it helps to improve students' achievement (Currey et al., 2015)

Independent Learning is associated with other approaches to learning such as 'personalization', 'student-centered learning' and 'ownership' of learning. It was emphasized that independent learning does not merely involve students working alone. It stressed the significant role teachers can play in enabling and supporting independent learning. Independent learning depends on external and internal factors. External factors involve the creation of a strong relationship between teachers and students' internal factors are the skills that individual students must get (Aranzo, et al., 2023). These include cognitive skills such as focusing on memory and attention and problem-solving, metacognitive skills associated with an understanding of how learning occurs, and affective skills related to feelings and emotions. Thomas Telford School in the UK, the first comprehensive school discovered that 100% of students gained A–C grades. The school claimed that one of the reasons for this success was the development of independent learning skills across the school. In addition, students in self-regulated learning environments are more motivated to learn than those who study in more restrictive environments (Meyer, Haywood, Sachdev and Faraday, 2008).

Student's achievement can be defined as "the quantity of academic content a student learns in a determined amount of time" It is the ability of the students to do something successfully or efficiently in every lesson. Each student has distinct ways of acquiring knowledge in learning. Students, whose performance is poor, do not necessarily mean that they do not have the skills, but maybe it is because they did not enhance their skills. Student achievement and student engagement are different from each other. Students may have the possibility not to achieve the goals that have been set for them even though they are engaged in class activities (Carter, 2017).

There are often two types of motivation: extrinsic motivation and intrinsic motivation. There are students who are extrinsically motivated when they are driven to engage in an activity to earn a reward while intrinsically motivated when motivated from within and process information more to increase understanding. Hence, upholding students' motivation in learning is one of the ways to efficient education (Lei, 2010)

The students, who are having a positive connection with peers can create higher levels of self-belief and value social interaction. They are more motivated and even excel in class. Up to this present, it has been a challenge for all educators to increase students' motivation in learning (Wentzel&Ramani, 2016).

Motivation in the educational field is particularly critical however, it is poorly understood. The application of high technology like smartphones, computers, and e-learning are very essential components when aiming for the increase of students' motivation (Fryer & Bovee, 2016). Due to the absence of the learning practice and application, Malaysian students have low motivation in learning. For educators, proper planning and implementation are important to achieve successful motivation for students (Hanafi, Said, Wahab, &Samsuddin, 2017).

Student's achievement is regularly measured in the form of giving test based on the intended learning outcomes. Statistical competence includes the understanding of basic statistical

terms and ideas, awareness, collection, description, and interpretation of data. Therefore, learners will have to strengthen their thinking and reasoning skills and go through the learning process (Mahmud et al.,2018)

Based on the studies and related literature above, it had been found that the application of cooperative learning method in teaching both local and international levels supply desirable results in terms of their motivation and achievement. However, there is a lack of related study about the effectiveness of teaching statistics using the cooperative learning method. Hence, this study used the review of related literature and studies as a starting point to analyze the result of this present study. Therefore, the researcher decided to find out in this study whether it can also provide a desirable effect in teaching Statistics to Grade 11 students in Saint Columban College.

3. METHODOLOGY

To achieve the objectives of this study and to ensure the accuracy in the analysis and interpretation of the data that was gathered, the researcher employed the quasi-experimental pre-test post-test two-group design. Quasi-experimental design includes choosing groups, upon which a variable is tested, without any random pre-selection processes. The design also needs two groups of equivalent standing in terms of students' achievement or mental ability. The researchers look at the effects of at least one independent variable on one or more dependent variables (Fraenkel and Wallen, 2006).

The first group that was taught using the independent learning method was designated as the control group while the second group under the cooperative learning method was the experimental group. Both groups had been given the same pretest. After the experimental period, both groups were given the same posttest to determine the significant differences in the students' achievement among and between the two groups. The study used four sets of lesson plans for the two trial runs (first and second topics). One lesson plan dealt with the application of the cooperative learning method while the other one used the independent learning method. The first and second sets of lesson plan constituted the same topic and essential understanding designed for cooperative learning method and independent learning method. These were administered in the pre-test for the first trial run (first topic), and they were evaluated by a post-test. The second trial run (second topic) adhered to the same procedure to the first trial run, but the second topic introduced captured the third and fourth sets of lesson plans for the two methods.

To measure the students' level of motivation in Statistics, the questionnaire adapted from Glynn, Brickman, Armstrong, & Taasobshirazi, (2011) comprises 25 items set at a 4-point Likert scale (1-Never, 2-Sometimes, 3-Often, and 4-Always) was used.

The following was the hypothetical mean range that was used to describe students' motivation in the learning process:

3.26 – 4.00	Very High
2.51 – 3.25	High
1.76 – 2.50	Low
1.00 – 1.75	Very Low

Two sets of a researcher-made questionnaire for the two topics on Statistics were prepared and developed then administered as pretest and posttest. These were presented and approved by the research panel during the proposal hearing. To determine the level of achievement in statistics of the students during the pretest and posttest, the Mean Percentage Score (MPS) and its descriptive equivalent below taken from DepEd Memorandum No. 160, s. 2012 were used.

MPS	Descriptive Equivalent
96 – 100%	Mastered
86 – 95%	Closely Approximating Mastery
66 – 85%	Moving Towards Mastery
35 – 65%	Average
15 – 34%	Low
5 – 14%	Very Low
0 – 4%	Absolutely No Mastery

The questionnaires were subjected to validity and reliability tests. The validity test such as the content, criterion, and face validity of the questionnaires was done by the panel of experts in the field of mathematics. The questionnaires were also undergone with the process of pilot testing which was administered to another group of students to check its reliability. With the use of the result of pilot testing, the internal consistency reliability of each factor was measured using Cronbach's alpha coefficients. The first set of questionnaires had a Cronbach's Alpha value of 0.785 which means highly reliable with 30 items only after excluding 10 items which had less internal consistency while the second set of questionnaires had a Cronbach's Alpha value of 0.789 which also means highly reliable with 30 items also after excluding five items which also had less internal consistency.

4. RESULTS AND DISCUSSION

Table 1. Level of Students' Motivation in Statistics.

Indicators	Control Group			Experimental Group		
	Mea n	SD	Remark s	Mea n	SD	Remark s
1. Learning statistics is interesting.	3.00	.94	High	2.74	.70	High
2. The statistics I learn is relevant to my life.	2.86	.77	High	2.40	.55	Low
3. Learning statistics makes my life more meaningful.	2.57	.85	High	2.11	.63	Low
4. I enjoy learning statistics.	2.71	.89	High	2.40	.74	Low
5. I want to learn as much as I could in statistics class.	3.29	.89	Very High	3.17	.66	High
6. When I'm in statistics class, I listen very carefully.	3.00	.80	High	2.63	.65	High
7. Learning statistics will help me get a good job.	3.23	.81	High	2.91	.78	High

8. Understanding statistics will benefit me in my career.	3.34	.76	Very High	2.94	.97	High
9. I am hopeful I can relate my statistics learning in the future.	3.51	.70	Very High	3.29	.83	Very High
10. I will use statistics problem solving skills in my career.	2.97	.86	High	2.49	.82	Low
11. I come to statistics class prepared.	2.60	.78	High	2.23	.84	Low
12. I study hard to learn statistics.	3.03	.89	High	2.51	.70	High
13. I work several examples of the same type of problem when studying so that I can learn better.	3.11	.93	High	2.34	.73	Low
14. When we work on something in statistics class, I feel encourage to share my learning with my classmates.	2.68	.90	High	2.23	.81	Low
15. I prepare well for statistics test.	2.94	.91	High	1.71	.46	Very Low
16. I put enough effort into learning statistics.	3.11	.87	High	2.43	.61	Low
17. I contribute to statistics class discussion.	2.54	.85	High	2.23	.73	Low
18. I spend a lot of time learning statistics.	2.42	.74	High	2.17	.79	Low
19. I believe I can earn a high grade in statistics.	2.57	.73	High	2.11	.76	Low
20. I believe I can master statistics knowledge and skills.	2.77	.88	High	2.29	.83	Low
21. I am sure I can understand statistics.	2.91	.74	High	2.69	.91	High
22. I am confident that I can do well on statistics project.	2.71	.93	High	2.34	.73	Low
23. Scoring high on statistics test matters to me.	3.17	.92	High	2.49	.89	Low
24. It is important that I can get a high grade in statistics.	3.37	.64	Very High	2.51	0.81	High
25. I like to do better than other students on statistics test.	2.86	.94	High	2.17	.89	Low
Overall	2.93	0.83	High	2.47	0.75	Low

Scale: 1.00 – 1.75 = Very Low; 1.76 – 2.50 = Low; 2.51 – 3.25 = High; 3.26 – 4.00 = Very High

These figures suggested that students in the control group who were taught using the Independent Learning Method were greatly interested in the Statistics classes. On the other hand, students in the experimental group who were taught using the Cooperative Learning Method were having a low level of motivation.

In cooperative learning, despite its great possibility that it can enhance students' achievement, it won't change the fact that learners are required less effort, which would lead to low motivation compared to those who are independent learners (McWilliams, Malecha, Langford, & Clutter, 2017).

Table 2. Level of students' statistics achievement.

Test	Cooperative Learning Method (Experimental Group)		Independent Learning Method (Control Group)		
	MPS	Descriptive Equivalent	MPS	Descriptive Equivalent	
1 st Trial Run	Pretest	43%	Average	38%	Average
	Posttest	73%	Moving Towards Mastery	79%	Moving Towards Mastery
	MPS Increase	30%		41%	
2 nd Trial Run	Pretest	37%	Average	37%	Average
	Posttest	68%	Moving Towards Mastery	76%	Moving Towards Mastery
	MPS Increase	31%		39%	

Scale: 96 – 100% = Mastered; 86 – 95% = Closely Approximating Mastery; 66 – 85% = Moving Towards Mastery; 35 – 65% = Average; 15 – 34% = Low; 5 – 14% = Very Low; 0 – 14% = Absolutely No Mastery

Moreover, the control group who were taught using Independent Learning Method in teaching Statistics generated a posttest result with an MPS of 79%, descriptively interpreted as *moving towards mastery* of which a computed increase of 41% in the level of students' achievement from the pretest with an MPS of 41% which is descriptively interpreted as *average* for the first trial run was exhibited. The posttest result for the second trial run showed an MPS of 76%, descriptively interpreted as *moving towards mastery*, which had 39% increase in the level of students' achievement from the pretest with an MPS of 37% which is descriptively interpreted as *average*.

The findings indicated that there was an increase in the level of students' achievement from the pretest to posttest using the two methods in teaching Statistics. The control group, which was taught using the Independent Learning Method, appeared to have a better performance with an average increase in their level of achievement of 40% compared to students in the experimental group with an average increase of only 30.5%. The posttest results of the control group during the two trial runs were higher than that of the experimental group. These results indicated that in teaching Statistics, Independent Learning Method generated a higher achievement level than using the Cooperative Learning Method.

4. 1. Testing the Difference in Students' Achievement

Table 3. One-way ANCOVA to test the difference in students' achievement in statistics using the cooperative learning method (experimental group) and independent learning method (control group):

1st trial run.

Source of Variation	Type III Sum of Squares	Df	Mean Square	F-ratio	p-value
Corrected Model	218.137a	2	109.068	6.427	.003
Intercept	1712.321	1	1712.321	100.896	.000
Covariates	144.080	1	144.080	8.490	.005
Main Effects	112.941	1	112.941	6.655	.012
Error	1137.063	67	16.971		
Total	37744.000	70			
Corrected Total	1355.200	69			

a. *R Squared* = .161 (*Adjusted R Squared* = .136)

*Significant at the 0.05 level

The null hypothesis stating that there is no significant difference in the students' achievement using the cooperative learning method (experimental) and independent learning method (control) in teaching Statistics as revealed in the post-test during the first and second trial runs was tested using ANCOVA at 0.05 level of significance.

First Trial Run. Using One-Way Analysis of Covariance (ANCOVA) to test, analyze, and interpret the difference on the posttest while controlling pre-test as covariate in the experimental and control groups, the main effects of Table 3 (*f-ratio* = 6.65 and *p-value* < 0.05) reveals that there was a significant difference between students' achievement in the posttest results of the control and experimental groups during the first trial run in favor of the control group using Independent Learning Method. The adjusted R squared showed that 13.6% of the variation of students' achievement accounted for by the variations in the use of the Cooperative Learning Method and Independent Learning Method.

This favorable outcome to Independent Learning stressed the important role teachers can play in enabling and supporting independent learning. Meyer, Haywood, Sachdev, & Faraday (2008) claimed that one of the reasons for this success was the development of independent learning skills across the school. In addition, students in self-regulated learning environments are more motivated to learn than those who study in more restrictive environments. The independent learning in the web environment also encouraged students to have self-paced learning which allowed them to focus better because they could plan their own learning process (Li, 2016). These findings support the claim that Independent Learning Method could increase students' achievement in Statistics.

Table 4. One-way ANCOVA to test the difference in students' achievement in statistics using the cooperative learning method (experimental group) and independent learning method (control group): 2nd trial run.

Source of Variation	Type III Sum of Squares	Df	Mean Square	F-ratio	p-value
Corrected Model	439.850a	2	219.925	18.934	.000

Intercept	652.454	1	652.454	56.172	.000
Covariates	326.693	1	326.693	28.126	.000
Main Effects	56.866	1	56.866	4.896	.030
Error	778.221	67	11.615		
Total	34007.000	70			
Corrected Total	1218.071	69			

a. R Squared = .361 (Adjusted R Squared = .342)

**Significant at the 0.05 level*

Second Trial Run. By employing the One-Way Analysis of Covariance, Table 4 indicated the test of significant difference in students' achievement in the posttest results of the control group and experimental group during the second trial run. Consistently, the main effects (f -ratio=4.896 and p -value < 0.05) reveal that there was a significant difference in students' achievement when they were taught using Cooperative Learning Method and using Independent Learning Method in teaching Statistics in the second trial run. Thus, the control group using the Independent Learning Method proved to be better than the Cooperative Learning Method.

Based on the effect size, the adjusted R squared showed that 34.2% of the variation of students' achievement was accounted for by the variations in the use of a Cooperative Learning Method and Independent Learning Method.

Thomas Telford School in UK claimed that one of the reasons for the success of the utilization of Independent Learning Method is the development of independent learning skills across the school. Aligned to the findings in the first trial run and second trial run that there was a significant difference in students' achievement when they were taught using Cooperative Learning Method (experimental) and Independent Learning Method (control) in favor of the treatment variable, these outcomes warrant the claim that Independent Learning Method could significantly increase students' achievement in Statistics (Meyer, Haywood, Sachdev and Faraday, 2008).

5. CONCLUSION

This study has arrived at the conclusion that the utilization of an Independent Learning Method for teaching significantly improved students' achievements in Statistics compared to the use of the Cooperative Learning Method. These research outcomes signifying that there was a significant difference in students' achievement when they were taught using Cooperative Learning Method (experimental group) and using the Independent Learning Method (control group). Independent Learning Method could greatly improve students' achievements in Statistics. These empirical findings further suggest that the utilization of an Independent Learning Method should be reinforced in teaching and learning Statistics. This study suggested that educators must adopt an instructional approach that allows the students to learn at their own pace and allows the teachers to use class time in an effective manner with their proper guidance. The findings of this study support that individualistic approach in the statistics classroom is better than the collaborative approach of teaching. Thus, with the development and implementation of the individualistic classroom approach, both teaching

and learning Statistics can be made more effective and enhance learning performance and academic gains among learners.

However, the results of this study may not be generalizable due to lack of diversity in the group of respondents. The students of Accounting, Business, and Management (ABM) in the Senior High School department was the only group included in this study. In addition, due to time constraints, only the first and second trial runs of the experiment were applied to collect data on students' achievement in Statistics. Yet, the researcher believes that the findings of this study may have a big impact on future research. As a result, it is also encouraged to compare the independent learning and cooperative learning approaches to other groups of students specifically to the other strands in Senior High School curriculum. Future researchers can investigate the relevant study over an extended period to demonstrate more the relevance and consistency of the findings.

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