TASK SPECIALIZATION AND GROUP STUDY ON STUDENTS' ACHIEVEMENT AND ATTITUDE IN PHYSICS

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ABSTRACT

This study investigates the impact of cooperative learning strategies, particularly task specialization and group study, on student achievement and attitude in Physics among Grade 12 Science, Technology, Engineering, and Mathematics (STEM) students. Motivated by diffusion of responsibility, the research employed a One-Shot Pre-test Post-Test Research Design over three weeks. Students were divided into groups and assigned roles as managers, investigators, or recorder-reporters. The effectiveness of these roles was evaluated using the Student Physics Test and the Physics Attitude Inventory. Results indicated a significant improvement in student achievement (t-test = 14.65) but no substantial change in attitudes towards Physics (t-test = -0.47), suggesting pre-existing favorable attitudes in STEM students. The study concludes that while task specialization and group study effectively enhance achievement by reducing the diffusion of responsibility and promoting active participation, they do not significantly alter students' attitudes towards Physics. The findings recommend implementing these strategies across various subjects and educational strands to increase student achievement. Further research is suggested to explore the broader implications of these strategies on student attitudes, validate results over extended periods, and examine the effects of varying roles and group cooperation.

Keywords: action research, cooperative learning, task specialization and group study, achievement, attitude, Sto. Nino National High School, Iriga City, Philippines

INTRODUCTION

Science plays a vital role in national development. However, results of national and international assessments like the National Achievement Test (NAT) and PISA show alarming results in English, science, and mathematics. Among the 79 participating nations in PISA 2018, the Philippines achieved one of the lowest performance results, ranking last in reading with a score of 340 and second to last in math and science with scores of 353 and 357, respectively (Department of Education [DepEd], 2019).

Consequently, the objective at hand is to furnish a response to the fundamental inquiry,

"What should count as science (physics) education for the next millennium?" (Pabellon, 1999). To address these needs, transformative education is vital to adapt to the advent of the Fourth Industrial Revolution (4IR), maintain its relevance, and develop innovators, inventors, and problem-solvers. So, the K–12 Basic Education reform is a response to the fact that some Filipino students do well in national and international competitions and tests, while others do not. According to SEI-DOST and UP NISMED (2011), most Filipino students have "poor performance in international and national assessment studies due to low retention of concepts, limited reasoning and analytical skills, and poor communication skills."

The K–12 Curriculum (RA 10533) focused on science reform, expecting learners to develop scientific and technological literacy and to acquire scientific attitudes for innovation in response to their community's needs and the country based on their interests and expertise (K–12 Curriculum Guide, Science). Hence, teachers are expected to employ methods that promote scientific understanding and thinking focused on mastering scientific processes while de-emphasizing scientific facts' rote learning. For learning to be meaningful, students must comprehend the facts themselves and the structure and relationships of those facts. Diverse learning experiences should be made available to students, as greater student engagement leads to greater learning and thus ensures high-quality education (Carnoy, 2007). Schools, then, must offer learner-centered and value-driven teaching and learning environments. Objectives in the affective domain should be considered because student attitudes likely influence the achievement of cognitive goals (Osborne, 1976).

An individualistic classroom offers a compelling teaching paradigm that promotes self-discovery, accepts a variety of learning preferences, encourages creativity, and improves emotional intelligence. Teachers may enable students to take care of their learning and unleash their full academic and personal potential by identifying the unique potential in each student and designing lessons appropriately. This strategy aligns with modern educational philosophies that strongly emphasize student-centered and personalized learning, positioning pupils for success in the twenty-first century (Csikszentmihalyi and Sawyer, 2014; Deci and Ryan, 1985; Gardner, 1983). However, this structure makes an individual committed to his or her self-interest, meaning that success depends on one’s effort and not on others. People believed to be different are disliked, while people perceived to be similar are liked.

On the other hand, a competitive learning environment in the classroom can be a fascinating and successful strategy for developing students' motivation, success, resilience, and critical thinking. It stimulates their innate need for competitiveness, encouraging them to perform well and realize their full potential. Teachers can prepare learners for the realities of the real world and provide them with vital skills beyond academic brilliance by giving them opportunities for healthy competition. To ensure that learners also acquire strong interpersonal skills and the capacity to work in teams, it is essential to find a balance between healthy competition and collaboration (Bandura, 1985; Dweck, 2009; Ryan and Deci, 2000).

Collaboration being one of the skills of the twenty-first century, classrooms should be organized to encourage collaboration and cooperation so that students can maximize their own and one another's learning. Students must recognize that the attainment of their learning objectives is contingent upon the success of their peers in the learning groups. That triumph is the result of the collective endeavor of all group members. Students should see the science laboratory room as a workplace where they will understand and learn scientific concepts applicable to day-to-day situations. Their repertory of experiences should be expanded to include more quantitative observations, measurement, ordering, and predicting through inferences while teaching them how to work as part of a team because the future structure of organizations looks less like pyramids and more like a spider web network of teams.

Furthermore, Bossert (1988) and Nye and Williams (2022) posited that cooperative learning increases student achievement and promotes positive interpersonal relations, learning motivation, and self-esteem than the traditional classroom. Moreover, it helps students think more critically, encourages participation and engagement, and supports the growth of their communication abilities and scientific thought processes. Hence, teachers must create more equitable cooperative groupings to encourage participation and provide opportunities for students to acquire social skills through cooperative learning (Aviles and Garcia, 2013).

Peshkam (2020) of Harvard Business Publishing Education presented eight formal cooperative group practices that can be utilized in the classrooms:

1. **Poll-Group-Repoll.** Launch a poll and ask students a question with divergent responses. Have students discuss their positions in a small group. Relaunch the same poll to see if their responses have changed. Anchor a class discussion around any changes to students' answers.
2. **Value Line.** Ask each student to rank how they feel about an idea, then break them into groups of up to four students from a mix of ranks to discuss the issue. This will work best online (and in person if students can move about in a limited capacity).
3. **Student Teams-Achievement Divisions.** This teaching practice is particularly useful for challenging technical courses such as finance and accounting. Break students into groups of up to seven. Assign work for students to learn together—all group members are accountable for one another's learning. After a decided period, quiz each person individually and calculate the average group score (this can also count as a portion of the final grade). The group with the highest average score receives a reward.
4. **Learning Roles.** Break students into groups of up to seven to complete a task. Directly assign—or ask each group to choose—one or more of the following roles to each member: the leader (in charge of making sure everyone is on task), the speaker (the presenter who reports out), the recorder (writes the group's ideas and responses), the reflector (manages the group's process).
5. **Role Play.** Prepare elaborate characters for students to play in a pair or a group to highlight the challenge or tension of a specific interaction. For example, assign a student to play the part of a manager giving difficult feedback to a defensive subordinate regarding poor performance.
6. **Expertise/Specialization Project.** Divide students into groups of up to seven. Have them develop online whiteboards presenting support for an idea, a deep dive into a company's policy or practices, or a proposed solution to a problem (a portion of the in-person teaching time can be dedicated to this before groups continue asynchronously). Make sure those boards are visible to all. Ask groups to report back and "teach" the class during the in-person or synchronous online session. Then, discuss larger problems (that require understanding the sub-topics) as a large group. Ask group members to assess the quality of their peers' contributions to increase accountability.
7. **Peer Grading.** As a rule, extended group work that asks students to reach a common goal will increase accountability and cooperation if students grade each group member's contribution—on both the process and on the product of the work.
8. **Group Processing.** At the end of extended group assignments or tasks, ask students to give each other feedback on how they worked together, one by one. Specifically, ask them to share what the group member did well, what they need to work on, what they could have done differently.

Students in the field of science rank physics as one of the most prevalent and challenging disciplines which intimidates the less able and those who feel less able (Guido, 2018). However, peer influence (Zhu et al., 2020) seems to be the most powerful factor in determining students' achievement, so it is not advisable for teachers to discourage peer interaction instead, capitalize on this gregarious nature of man. Peer group interaction increases knowledge due to sharing of resources when equipment is very limited, prevalent in most science classrooms like Sto. Nino National High School. Peer interaction also decreases anxiety and increases trust. However, there is a diffusion of responsibility (Slavin, 1983) especially when students are grouped into five to eight members. Only two to three members do the work while the rest become passive observers or listeners. Others also do other things not needed in the activity because the leader does the rest especially if there is a group reward. As a result, a learner can be rewarded even if he did not work for the group, or a learner will not be rewarded even if he did his/her best.

This study hypothesized that a cooperative task structure (Candler, 2016) divided into task specialization *(Learning Roles) and group study (Student Teams-Achievement Divisions)* (Peshkam, 2020) will enhance performance by providing assistance to fellow group members and exerting influence on them to motivate each other to complete the group task, even in the absence of rewards.

In task specialization, every group member is tasked with a distinct aspect of the group activity, and all participants are expected to collaborate. When roles are assigned towards goal accomplishment, students make him or her feel an important part of the group. Diffusion of responsibility is reduced since group members' support for performance is activated. Likewise, it eliminates the problem of the dominant or passive student since every member is expected to contribute something to the group's success (Burke, 2011). In a group study, all group members study together without separate tasks. Motivationally speaking, cooperative goal structures establish circumstances in which group members can only achieve their objectives through the group's collective success. Therefore, to achieve their objectives, group members must assist their peers in doing whatever contributes to the group's success. Each member must exert their maximum effort (Purnawan, 2018). Along these lines, the researcher attempted to test the effect of task specialization and group study in the Philippine setting, especially in Sto. Nino National High School where the researcher teaches and handles the subject, General Physics 1 and 2 in Senior High School.

OBJECTIVES OF THE STUDY

This study aimed to determine the effect of task specialization and group study as cooperative learning strategies on the students' achievement and attitude toward Physics during laboratory activities. Specifically, to answer the following specific objectives:

1. Determine if task specialization in cooperative learning considerably enhances students' Physics achievement.
2. Determine if group study strategies in cooperative learning considerably enhance students' Physics achievement.
3. Determine if task specialization and group study strategies in cooperative learning considerably enhance students' Attitudes toward Physics.

METHODOLOGY

The study used a One-Shot Pre-test and Post-Test Research Design. It is one of the most popular quasi-experimental research designs. It involves pretesting, treatment, or modification of an independent variable, followed by post-testing on a group of research subjects or participants. Nevertheless, the absence of a control group and the non-experimental nature of the research design create uncertainty regarding whether the observed discrepancy stems from the independent variable itself or extraneous influences such as order effects or regression towards the mean.

Since there are only 17 Grade 12 students enrolled in STEM in Sto. Nino National High School, the students were purposively selected as the participants and main source of data and information for this action research. The students were ranked based on their grades in Physics from 1st to 3rd quarter, SY 2022-2023. Fifteen students ranked from third to bottom were included in the study. They were grouped heterogeneously. The top two students were asked to assist the teacher-researcher in materials preparation and monitoring of the groups. They were given special points for such work. They also took the SPT and PAI.

Data were gathered using an adapted 40-item Student Physics Test (SPT), 30-item Physics Attitude Inventory (PAI), Laboratory Worksheets, materials, and equipment. SPT questions were given one point per correct response. Pre-tests and post-tests using the SPT and PAI were done to answer the research questions.

Sixty items Student Physics Test (SPT) was formulated based on the Most Essential Learning Competencies (MELC) following the Knowledge, Comprehension, and Application level with a Table of Specifications. For content validity, the test was submitted to content experts. Likewise, items with difficulty index of .20 and .80 and discrimination index of .30 to .80 were included in the final 40 items SPT. For the reliability test, Kuder Richardson Formula 20 was used. The test has high reliability at .73.

A 40 statements Physics Attitude Inventory (PAI) was also prepared for content validity and pilot testing. The final draft consists of 30 Likert-type statements focused on the enjoyment of or interest in physics (items 1, 3, 5, 7, 16, 19, and 20), motivation in physics class (items 9, 13, 22, and 24), the importance of physics (items 11, 12, 15, 26, and 28), fear of physics and difficulty with the subject (items 2, 4, 6, 8, 10, 14, 21, 23, 25, 27, and 29), and the appeal of laboratory activities or equipment (items 17, 18, and 30).

One week before the treatment, the students were regrouped heterogeneously into three teams to ensure that each member had enough to do during the activities. Each team thought of a team name. Each member of the team was assigned roles (as manager, investigator, and recorder-reporter) while studying together to achieve a common goal for familiarization with the approach. The topic for this practice was Electromagnetic Induction.

The manager leads the group in gathering and returning materials, gives directions, keeps the group aware of time, and encourages everyone's participation. The investigator manipulates the equipment, performs, and collects data on the activity, and asks questions if everyone understands the activity and agrees on the solution. The recorder-reporter is the one who records the group's notes agreed by all group members, summarizes group discussion, and presents the conclusion to the other groups.

During the activities, team rules (Slavin, 1985) were emphasized:

a. It is the responsibility of everyone to ensure that their colleagues have mastered the materials.
b. None is considered done with the lessons unless all teammates mastered the subject.
c. Seek assistance from all colleagues before approaching the mentor.
d. Team members may engage in gentle conversation.

Two days before the treatment, a pretest using the SPT and PAI was given as basis of comparison. The treatment period took three weeks during the fourth quarter of SY 2022-2023. Lessons about light waves were covered because of their interesting applications. Although additional items were collected, other materials and equipment were available for eight structured laboratory activities namely: Reflection in Plane Mirror, Reflection in Curved Mirrors, Refraction of Light, Convex Lenses, The World in Color, The Eye and Camera, Diffraction and Interference, and Polarization of Light obtained from various sources. No groups were neglected during the activities.

Sessions were done following the regular class schedule for General Physics 2. Quizzes were given at the end of every lesson to determine individual learning and summative tests per week. Summative results were included in their grade for the Fourth quarter but were not included in the analysis of data. Teammates were separated during the tests to prevent copying or helping one another. Group achievement was determined by taking the average score of all group members for an additional point.

Post-tests using the SPT and PAI were given a week after the eight activities just like an ordinary test to avoid the attitude effect.

To answer the questions posed in the study, quantitative analysis was done. The researcher used the following statistical tools: mean, standard deviation, and t-test for the dependent sample mean to establish the effect of the treatment variable. The Likert-type scale registered the learner's feeling toward the subject with scores ranging from 5-strongly agree; 4-agree; 3-neutral; 2-disagree; and 1-strongly disagree. Reversed scoring was used for positive items from 5 to 1 with 5 as the highest, while negative items were scored from 1 to 5 with 1 as the highest.

Ethical Consideration

To address ethical issues, approval and permits to conduct the study were secured from the Principal and Schools Division Superintendent. Moreover, students were informed about the purpose and mechanisms of the study. To ensure the safety of the students-respondents, the researcher considered the provisions as stipulated in DepEd Order 40, s. 2012 or DepEd Child Protection Policy.

RESULTS AND DISCUSSION

1. Task specialization on students' Physics achievement

Table 1
Pre-test and Post-test results on the Student Physics Test

N	Pretest X	Posttest X	Difference between Means	t-ratio
17	12.47	29.18	16.71	14.65

* df=16, p<.05 (significant), p = 2.120

The pretest and posttest results using the 40 items SPT were tabulated and analyzed by computing the means and t-test. The computed t-ratio of 14.65 (Table 1), which is higher than the accepted critical p-value indicates that role assignment (manager, recorder, reporter) affected better achievement of learned concepts. This could be because the students were at ease in the roles they were assigned, maximizing the strengths of each group member (Andrist, 2015). Each group member is made to feel he or she is an important part of the group, and it helps eliminate the problem of the dominant or passive student because each one is expected to contribute to the group's performance. During the activities, it was seen that each member actively participated and carried out their assigned roles. No one was observed silently sitting while observing other group members doing the activity.

Furthermore, positive interdependence was observed in the groups. The students, though of mixed abilities recognized everyone's effort since every group member had specific roles to perform. Every member must have exerted their best effort to carry out the assigned role because the team's success was contingent on each member's performance.

2. Group study on students' Physics achievement

To assess individual learning, post-lesson quizzes and weekly summative exams were administered. The summative outcomes were incorporated into the students' fourth-quarter grade; however, they were excluded from the data analysis. To mitigate the risk of copying, team members were segregated throughout the assessments. Group accomplishment was calculated by adding one point to the mean score of every group member.

The effect of group study was seen through the computed t-ratio of 14.65 (Table 1), which is higher than the accepted critical p value indicating that the group study treatment effected better achievement of learned concepts. While there was group interdependence and cooperation, individual accountability was developed since each member's role was an integral part of the group output. This individual accountability must have accounted for the sustained interest and enjoyment in the role assigned group. Moreover, the low-performing students tried doing their best while the high-performing students extended unselfish help to those who needed help. The latter in turn learned more by teaching their peers. According to Hult (2018), "the best way to learn something is to teach it to someone else." It is worth citing that one student who scored the lowest (7 points) in the pretest improved in the posttest by obtaining a score of 30 points.

3. Task specialization and group study on students' Attitudes towards Physics

Cooperative learning, according to Slavin (1980), gives students the sense that they have a chance to achieve, that their efforts will result in success, and that success is a worthwhile objective. However, The results presented in Table 2 indicate that the attitude of the students does not differ significantly before and after the treatment. This could be because the students already have a favorable attitude in Physics even before the treatment. This implies that using the combined task specialization and group study will only reinforce the students' attitude toward the subject.

Table 2
Attitude Mean Gain Scores Before and After the Treatment

N	Pretest X	Posttest X	Difference between Means	t-ratio
17	6.07	4.52	1.55	-0.47

* df=16, p<.05 (significant), 2.120

Analysis of the students' attitude by category (Table 3) showed enjoyment of or interest in physics (items 1, 3, 5, 7, 16, 19, and 20) even before the treatment. The students were also interested on the materials used during the activities and discussion after the activities. There was interest in studying the subject, which is perceived as dry and boring. Furthermore, they believed they were valuable and important individuals who could withstand disappointments and become confident decision-makers who could be a happy and productive individual. Stronger friendship was formed, and increased contact between and among students. They engaged in pleasant activities together and worked towards a common goal.

Table 3
Mean Gain Scores in Attitude by Category

Attitude category	Pretest	Posttest	Mean Gain Score	t-ratio
Enjoyment of or interest in physics	25.82	26.47	-0.65	-0.72
Motivation in physics	14.12	13.82	0.30	0.62
Importance of physics	20.59	19.88	0.71	0.60
Fear of physics and difficulty with the subject	31.71	29.71	2.00	1.32
Appeal of laboratory activities or equipment	10.41	11.24	-0.83	-1.55

* df=16, p<.05 (significant), 2.120

In terms of motivation in physics (items 9, 13, 22, and 24), the computed t showed that the students were confident about themselves in physics class. The students already possess self-esteem and motivation. They already have self-motivation or an urge to learn new things. They are positive about getting high grades because of their curiosity to learn new things.

Having students work in groups with assigned roles made every student take greater responsibility for their own and other's learning. Nevertheless, the calculated t-value of 0.60 indicates no statistically significant difference between the pre-treatment and post-treatment periods. Students already see physics as an important component of society, which explains physical phenomena other subjects cannot explain. They were measured in items 11, 12, 15, 26, and 28. The students already possess favorable views about the importance of physics for technological change in society.

There was a considerable change of students' fear of physics and difficulty with the subject (items 2, 4, 6, 8, 10, 14, 21, 23, 25, 27, and 29) based on the pretest and posttest results although not statistically significant as shown by the observed t=1.32. It shows that there was a student support system where both the high-performing and low-performing students benefited especially the low-performing students, their feelings of inferiority towards their classmates and fear towards the subject, such as failing grades were lessened since working in a cooperative heterogenous group placed them on equal footing with the high-performing students.

The observed t=-1.55 on the appeal of laboratory activities or equipment (items 17, 18, and 30) also shows no significant difference before and after the treatment. Activities performed inside the laboratory were perceived as an important part of the learning situation to simulate the experiments done by the scientists and it is not as difficult as they thought. Cooperative goals with task specialization and group study facilitated greater learning because everyone shared his best effort to carry out the tasks assigned. Not only one or two did the activity but everybody contributed to the group work. Individual accountability transpired during the laboratory activities.

Furthermore, the heterogenous grouping could have also facilitated cooperative learning to enhance achievement and attitude toward physics. Both high-performing and low-performing pupils have unique chances. It challenges high performers to expand their comprehension and hone essential leadership and communication skills, while simultaneously giving struggling learners the support, direction, and academic advancement they require to prosper. Cooperative learning cultivates a supportive and empowering learning environment that supports academic and social progress for all students, regardless of their starting performance levels, by encouraging collaboration, inclusiveness, and mutual support (Slavin, 2014).

CONCLUSION

The diffusion of responsibility and performance of the students by grading period motivated the researcher to determine the effectiveness of cooperative learning with assigned roles and group study on increasing student achievement and attitude in Physics.

1. Anchored on the social process theory, the study proved the effectiveness of cooperative learning with assigned roles, and group study on increasing student achievement. Furthermore, the heterogeneous grouping could have also facilitated cooperative learning to enhance achievement toward physics. Both high-performing and low-performing pupils have unique chances. It challenges high performers to expand their comprehension and hone essential leadership and communication skills while giving struggling learners the support, direction, and academic advancement they require to prosper. Cooperative learning cultivates a supportive and empowering learning environment that supports academic and social progress for all students, regardless of their starting performance levels, by encouraging collaboration, inclusiveness, and mutual support (Slavin, 2014).
2. The findings of the PAI indicate that there is no statistically significant variation in the students' attitudes prior to and after the intervention. This could be because the students already have favorable attitude in Physics even before the treatment. This implies that using the combined task specialization and group study will only reinforce the attitude of the students toward the subject.

RECOMMENDATION

In light of the findings and conclusions of the study, the following recommendations are being proposed.

1. The study recommends the use of task specialization and groups in the classroom regardless of subject area because it increases student achievement. Roles are distributed to all group members.

2. Future research can be done to further establish the effect of role assignment and group study on students' attitudes not only in Physics but also in other science subjects or learning areas.
3. Future studies can be done with a longer time element. Roles can also be varied or rotated among group members to establish a significant effect on the variables studied. Furthermore, the level of cooperation among group members can also be investigated.

Way Forward

The result of this study will be shared among colleagues during conferences, LAC sessions or research forums because this pedagogy can be used by teachers for all student groups from different grades, tracks/strands, in different learning situations, and different learning areas to create opportunity for self-development and social interaction. It develops concern, respect, and understanding of individual differences and a sense of responsibility.

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