Effectiveness of Jig Saw Strategy on Academic Performance and Attitude towards Mathematics in Remote Learning

Abstract

This study aimed to find out the effectiveness of Jigsaw strategy on Students' Attitude towards Mathematics. The Quasi Pretest- posttest design was used. The main research instruments used in the study were the Attitude Scale Inventory and a 75- item multiple choice having a reliability coefficient of 0.82. Data were statistically analyzed using mean, standard deviation and the t-test for independent means.

Results revealed that a). there is an improvement in the attitude scores of the participants as manifested in the mean difference of 0.116 (posttest and pretest scores). Students became more homogeneous in their posttest as revealed in the standard deviation value; b). there is a significant difference between the attitude mean scores of the participants' posttest and pretest; c). there is an improvement in the academic performance of the participants as revealed in the mean difference of 4.08. Also students became more homogeneous in their posttest as shown in the computed standard deviation; d). there is a significant difference between the academic performance of the participants' posttest and pretest.

From the findings of the study, the following conclusions were drawn: Jigsaw strategy improves students attitude towards mathematics during remote learning; and Jigsaw strategy enhanced students' academic achievement during remote learning classes in Mathematics.

Introduction

The world was alarmed with the occurrence of a pneumonia related disease which originated in Wuhan , China [1-14]. The Outbreak was declared a Public Health Emergency of international concern on January 30, 2020 [5, 15, 16, 17, 8, 19, 20].

Effect of the worldwide pandemic caused major businesses to close, international and national flights were suspended, and major economic, social activities to shut down,

banning of public events, closure of commercial and retail businesses, closure of schools and universities [21, 22]. With education worldwide being thrown into disarray by coronavirus, more and more educators are being forced to teach their students from home. Most schools deliver instruction through modular distance learning (MDL) or on-line / distance learning. There are issues/ problems on distance Learning: Isolation, poor connectivity, veracity of student's answers for modular learning, and others.
Remote learning is where the student and the educator, or information source, are not physically present in a traditional classroom environment. Information is relayed through technology, such as discussion boards, video conferencing, and online assessments.

In Remote Learning, cooperative learning is possible. In cooperative classroom, students achieve success as a consequence of paying attention to their peers, asking good questions, helping each other, teaching each other, and helping each other teach.". One type of cooperative learning strategy in Mathematics and Science classes is the use of JigSaw strategy. The jigsaw strategy is a student-centered strategy that increases students' participation, which creates a supportive and motivating environment [23].

Jigsaw is a cooperative learning strategy that enables each student of a "home" group to specialize in one aspect of a topic. Students meet with members from other groups who are assigned the same aspect, and after mastering the material, return to the "home" group and teach the material to their group members. With this strategy, each student in the "home" group serves as a piece of the topic's puzzle and when they work together as a whole, they create the complete jigsaw puzzle.

During remote learning, Vergroesn [24] emphasized that the jigsaw technique builds on one of the most effective ways to process and retain information — teaching others. To utilize the jigsaw technique, ask each student to learn just a piece of the material, then teach it to the group. The group then works together to synthesize the information and create a presentation about what they've learned.

The jigsaw technique works best with small groups (five or six students) and complex topics. Divide the lesson or required reading into five or six separate sections. Each student is responsible for researching one part. For example, if you're studying different countries' approaches to healthcare policy, one student could research societal views of healthcare, one the countries' overall health and demographics, one the healthcare systems, and one the economic impacts of those policies.

Comment [L1]: Consider reverse: *[one student could research on the societal view of the healthcare,while others will research on .....,.....,.....,respectively].*

Once the students have completed their task, bring them back together to meet in small discussion boards or private video meetings to share what they've learned and to develop a greater understanding of the concept. Assess the group on their knowledge of all the materials with a group presentation, project, or essay.

Suspension of face-to-face instruction in schools during the COVID-19 pandemic has led to concerns about consequences for students' learning.

Comment [L2]: There should be consistency with the spacing.

Data on learning loss during lockdown have been slow to emerge. Unlike societal sectors like the economy or the healthcare system, school systems usually do not post data at high-frequency intervals. Schools and teachers have been struggling to adopt online-based solutions for instruction, let alone for assessment and accountability. During on line classes, students have to learn by themselves according to what their teachers ask them to do. Similarly, students are burdened with files of modules to be submitted on specified dates.

Meeting deadlines for requirements set by teachers, students are pressured and oftentimes resulted to stressful life and eventually to a more serious problem on mental health. Cases of increasing school dropouts in all levels are noticeable as seen in news and social media. Hence, this alternative learning mode is being explored.

Objectives

This study was intended to test the effectiveness of Jig Saw Strategy in teaching selected topics in Math Investigation for remote learning.

Comment [L3]: Reverse the sentence.

Specifically, it has the following problem questions:

1. What is the academic performance of the Math Investigation students before and after they are exposed to Jig Saw strategy
2. What is the attitude towards math of the math investigation students before and after they are exposed to jig saw strategy?
3. Is there a significant mean gain in the academic performance and attitude towards mathematics of student from pretest to posttest?

Comment [L4]: The idea is not clearly stated

Conceptual Framework

To have a common frame of reference of the study, the research paradigm is presented below to show the relationship of the variables being studied.

Cooperative learning is based on group work, but it's also so much more than that. The core element of cooperative learning is to showcase the positive effects of interdependence while underlining the importance of personal responsibility. This happens naturally in cooperative learning since students work with one another, but they all have a different task to accomplish or concept to explain.

Students' learning goals may be structured to promote cooperative, competitive, or individualistic efforts. In every classroom, instructional activities are aimed at accomplishing goals and are conducted under a goal structure. A learning goal is a desired future state of demonstrating competence or mastery in the subject area being studied. The goal structure specifies the ways in which students will interact with each other and the teacher during the instructional session.

Cooperation is working together to accomplish shared goals. Within cooperative situations, individuals seek outcomes that are beneficial to themselves and beneficial to all other group members. Research on classroom cooperative learning techniques, in which students work in small groups and receive rewards or recognition based on their

group performance, has been increasing in the past few years. This review summarizes the results of 28 primary field projects lasting at least 2 weeks, in which cooperative learning methods were used in elementary or secondary classrooms. The pattern of research findings supports the utility of cooperative learning methods in general for increasing student achievement, positive race relations in desegregated schools, mutual concern among students, student self-esteem, and other positive outcomes. The various cooperative learning methods are contrasted in terms of characteristics and outcomes, and the next steps for research in this area are outlined [25] .

Many students who have worked in a team in a laboratory-or project-based course do not have fond memories of the experience. Some recall one or two team members doing all the work and the others simply going along for the ride but getting the same grade [26].

When students are given the opportunity to contribute to a group, they also learn life skills such as communication and working within a timeline. This method also promotes collaboration and discussion, as well as self-motivated learning strategies. Students who work together learn to ask questions to clarify their understanding and provide critical feedback in appropriate manners. In addition, the jigsaw method in education effectively produces academic gains in problem solving and analyzing, two important cognitive skills [27]

Researches showed that the used of jigsaw strategy improved academic performance, self esteem, social life and other aspects of student learning. Perkins [28], pointed out that undergraduate statistics students vary widely in performance, and many are passive learners. Worksheets (problem sets) help students to be more active and to learn by doing. Working individually, however, students may require too much time to complete worksheets in class, when the instructor is available to help. In the "jigsaw classroom" technique described, a worksheet is divided into 2 to 4 complementary steps that are distributed to different groups of students. Students with the same step complete it together and then collaborate with other classmates to finish the entire worksheet in class. Students reported that this jigsaw technique helped them

understand a statistical procedure, used class time efficiently, and increased the variety of learning experiences available in this challenging course.

Walker and Crogan [29] investigated the effects of a cooperative learning environment and a Jigsaw classroom environment on academic performance, self-esteem, liking of school, liking of peers, and racial prejudice. The subjects were 103 children in Grades 4–6, in two separate schools. The cooperative learning condition was used as a baseline measure of the effects of cooperation, against which the effects of a Jigsaw method, involving both cooperation and interdependence, were compared. The results reveal that Jigsaw produced significant improvements on measures of academic performance, liking of peers, and racial prejudice. In contrast, the effect of the cooperative condition was to exacerbate pre-existing intergroup tensions.

Comment [L5]: There should be consistency in the citation method

Aside from improving academic performance, the use of jigsaw classroom also builds empathy, compassion, and achievement of students. The point is that the learning students derive from the process of their educational experience is powerful. It is important to be carefully designed and rigorously structured for the intended effect. Jigsaw is a specific type of group learning experience wherein each student must cooperate with his or her peers to achieve his or her individual goals. Just as in a jigsaw puzzle, each piece—each student's part—is essential for the production and full understanding of the final product. The benefit of jigsaw classroom is that it is a remarkably efficient way to learn the material. In jigsaw classroom, students work individually and compete against each other for grades. In the jigsaw classroom, the problem can be evaded by the simple device of shuffling groups every 8 weeks. Once a group of students start functioning well together, the barriers break down, and the students show a great deal of liking and empathy for one another, the group can be reform [30]. Eiks [31] taught atomic structure in lower secondary chemistry using modified jig-saw classroom method. The lesson was taught in grades 9 and 10 (age range 15–17 years) chemistry in 13 learning groups with a total of 313 students in various grammar, middle, and comprehensive schools in Germany. The written evaluation of the lesson focused on determining the students' opinions on the teaching methods that were used. Emphasis was on gathering information from the students'

viewpoint. Did the students think that these methods could make science lessons more attractive? Could these methods help to promote more active student learning, cooperative learning, or communicative and social abilities? Additional data that were derived from a cognitive test and teacher feedback are also presented. The results of the study show that teaching methods like the jigsaw classroom have potential to improve students' attitude towards science. The results may also indicate that it is appropriate to demand that student-oriented and cooperative-learning methods be used more often in secondary level science education. Susanti [32] research found out that Jigsaw II technique applied is useful and effective not only for students' achievement, but also for their involvement toward learning, especially teaching and learning reading skill to second semester students at the Sudy Program of Informatic Technique STMIK Pontianak, West Kalimantan, Indonesia.

On racial relationship, Crone and Portillo [33] explored Jigsaw classroom at the primary and secondary educational levels. The study explored whether the jigsaw classroom would have an effect on students' attitudes about their own academic abilities and practices at the university level. The present study also sought to illuminate the necessary time course for the technique. Three sections of students in a cognitive psychology course participated. One section received a full jigsaw exposure, one received a reduced jigsaw exposure, and one received no jigsaw exposure. Posttests reveal that students given the full jigsaw exposure report an increased ability to teach psychological concepts to other students compared to the control condition. Moreover, there is evidence that the jigsaw technique increases the students' ability to communicate orally and their belief in themselves as scholars.

In cooperative learning approach, the active and direct involvement of the learner in the learning process leads to a comprehensive development. Self-regulated learning and academic motivation focus on the role of the individual in the teaching-learning process.

Sanaie,et.al. [34] compared lecture and Jigsaw teaching strategies on the nursing students' self-regulated learning and academic motivation. They used quasi-experimental design from January to November 2018 on 94 nursing students in the fourth education semester in two classrooms. A classroom was randomly assigned to

the lecture group and the other as a Jigsaw group. The data collection tools were demographic data questionnaire, self-regulated learning questionnaire, and academic motivation scale. The interventions were lecture and Jigsaw teaching strategy for seven sessions lasting for 2 h in the lecture and Jigsaw groups respectively.

Paradigm

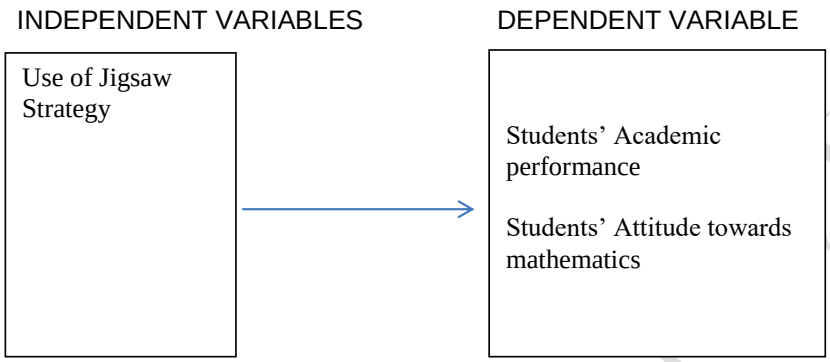

Figure 1. A paradigm showing the process of the study.

The research paradigm shows the dependent and independent variables. The independent variables are the use of the Jigsaw strategy. The dependent variables are students' academic performance and student's attitude towards Math.

Methodology

Research Design

The researcher employed the single group pretest-posttest pre- experimental design. The academic performance and attitude of students towards mathematics were measured on a pretest and posttest from achievement test and attitude scale inventory.

The design of the study is presented below:

O1 x O2

Where:

O1 - *Pre-test score of the experimental group*

O2 - *Post Test score of the experimental group*

x - *Experimental treatment (use of Jig Saw strategy)*

Locale of the Study

The study was conducted in Apayao State College-Luna. Classes were conducted on- line in asynchronous manner. Classes were monitored using facebook. Group chat was created to facilitate communication among students. In the conduct of on –line asynchronous classes, rooms were created for the purpose of establishing rapport among group members.

Respondents of the Study

The total enumeration was employed in this study. The Participating respondents of the study were 24 third year BSE –mathematics students.

Research Instrument

The researcher used the following research instruments to gather the needed data:

a. The achievement test was administered to the experimental on a pretest and posttest basis. It consist of a 75- item test of a multiple choice type covering the topics on problem solving, number and number patterns. Originally, there were 85 test items but were trimmed down to 75 items after items were subjected to validation and item analysis. These topics are covered in the midterm of Problem Solving, Math Investigation and Modelling. In order to achieve high degree of content validity, the suggestions of experts was sought. A table of specification was prepared which include the subject

content, percentage or proportion of items in each area, and the cognitive processes involved .

To check on content validity, the initial draft of the instrument was given to a group of Math teachers. All suggestions for improvement of the instrument were incorporated. After finalization of the second draft, this was pretested to two math classes. Item analysis follows to determine the item of discrimination and item difficulty. For the item analysis, there were two criterion groups, the top 27% and the bottom 27% based on scores. The accepted level of index of difficulty is 0. 25- 0.75. on the other hand, 0.20 – 0.40 is the acceptable level of discrimination for each item. 0. 40 and above is highly acceptable. Below 0.20 is not acceptable.

The reliability of the test was taken using the split half method. For every students, the number of correct answers in all even and odd items was counted and tallied in two separate columns. Another column was prepared for the students' total scores in the exams. To correlate the odd –numbered scores and the even –numbered scores, the Pearson's r was used. The result was the reliability of the half test. The reliability of the whole test was taken from the formula

$$rwt = 2\,rht / (1 + rht)$$

Where *rwt- reliability of the whole test*

rht- reliability of the half test

Teacher made test commonly have reliabilities somewhere between 0.60-0. 85. Using split half method, the reliability coefficient of the whole test is 0.82

b. Attitude Scale Inventory. The attitude scale inventory was a 5- point attitude scale inventory patterned after models (Ocampo & Ocampo: 2015) questionnaire. Revisions was done to suit content and predisposition of students on Mathematics learning.

Research Procedure

All the necessary document and letters were prepared following flow of communication were observed. . During the conduct of the study, students are cautioned with the health protocols and standards set by the IATF for covid -19.

During the conduct of the study, the following was undertaken

Pre Implementation Phase

Create a Group chat in fb for posting of activities, guidelines and other announcements

Implementation Phase

Step 1: Group Students into 4 -5 members each.

Step2. Let each group assign their own leader and rapporteur (to document group activities).

Step 3. Orientation on the lesson, what to do, deadlines, activities and others.

Step 4. Divide the day's lesson into 4 parts, and assign one student in each group to be responsible for a different segment.

Step 5: Give students time to learn and process their assigned segment independently. If he can not follow the lesson, he may ask their teacher for clarification/ assistance.

Step 6. Form temporary " expert groups" by having one student from each jigsaw group join other students assigned to the same segment. The leader whose lesson segment will invite other members from other group to join with him/her in his/ her fb room.

Step 7: Put students who completed the same segment together into an "expert group" to talk about and process the details of their segment.

Step 5: Have students return to their original "jigsaw" groups and take turns sharing the segments they've become experts on.

Step 6: Have students complete a task or a quiz that's reliant on them having understood the material from the contributions of all their group members.

Examinations such as achievement test and attitude scale inventory were conducted via google classroom.

Post- Implementation Phase

Have students (in group) make a video applying the lessons learned from the activities.

Statistical Treatment of Data

Mean and standard deviation were used to describe students response to each statement on the attitude scale inventory. The adjectival scale is presented below:

List 1 : Description limit and interpretation

Scale	Limits of Description	verbal Interpretation	Transcribed value
5	4.20-5.00	Strongly agree	Strongly positive
4	3.40-4.19	Agree	Positive
3	2.60- 3.39	Uncertain	Neutral
2	1.80- 2.59	Disagree	Negative
1	1.00 – 1.79	Strongly disagree	Strongly negative

.

The t-test for independent samples was used to compare the pre-test and posttest mean of the participants attitude towards Math and their academic achievement.

Results and Discussion

The attitude of students towards mathematics was measured using the Attitude Scale Inventory (ASI). The highest rating of the attitude scale inventory is 5 and 1 being the lowest. The ASI is intended to measure the predisposition of students towards

mathematics whether it is positive or negative. The mean and standard deviation of the pretest and posttest scores is presented in table 1.

Table 1. The mean and standard deviation of the attitude scores of the participants in their pretest and posttest

Test	Mean	Standard deviation
Pretest	3.424	0.25
Posttest	3.54	0.16

Both the pretest and posttest mean of the attitude scores of the participants yielded a positive attitude towards mathematics with mean values of 3.424 and 3.54. Students become more homogeneous in their attitude in their posttest score as manifested in the computed standard deviation of 0.16 as compared to 0.25 in the pretest.

Table 2. t-test of the pretest and posttest scores of the participants

Test	Mean	computed t	tabular t @5%	p-value	Decision
Pretest	3.424	1.95	1.68	0.0054	Reject Ho
Posttest	3.54				

In table 2, when the pretest scores and the posttest scores were subjected to t –test, the computed value of t was 1.97. This value is greater than the tabular value of t, 1.68 at 5 percent level of significance. This means that the null hypothesis is rejected, thus the difference in the pretest and posttest is significant. This findings is supported by the study of Ocampo and Ocampo[35] on the effectiveness of students team achievement division on students attitude towards Physics and Ocampo and Abayo-Rillo [36]on the effectiveness of audio-visual teaching on the writing performance of Grade 8. Moreover,

Abed, Sammer , Kasim ad Othman [37] stressed that jigsaw strategy improves students attitude towards mathematics.

Table 3. Mean and standard deviation of the achievement scores of the participants

Test	Mean	Standard deviation
Pretest	57.84	8.42
Posttest	61.92	6.71

The mean of the pretest is 57.84 while the posttest is 61.92 as manifested in table 3. This implies that the use of the jigsaw strategy enhances the academic achievement of students. The improvement of students' academic achievement can be attributed to the collaborative work done by student participants during remote learning. Working together brings them for a unified goal in learning [38] . The notable increase in the academic achievement is attributed to the intervention being implemented. During pandemic, the most common learning delivery mode used by teachers is the modular distance learning approach where students are given instructional materials to work on their own. The use of Jigsaw strategy improves the academic achievement as students engaged working not only for themselves but as a community of learners- engaging and involving themselves in the tasks given to them [39, 40] .

Table 4. T-test of the pretest and posttest scores of the achievement test

Test	Mean	Computed t-value	tabular t @5%	P value	Decision
Pretest	57.84	1.89	1.68	0.005	Reject Ho
Posttest	61.92				

When the pretest scores and the posttest scores were subjected to t –test, the computed value of t was 1.89. This value is greater than the tabular value of t, 1.68 at 5 percent level of significance. This means that the null hypothesis is rejected, thus the difference in the pretest and posttest is significant. This means that the use jigsaw strategy improves the academic achievement of students [41, 42, 43]

Summary, Conclusion and Recommendation

The researcher conducted this study to test the effectiveness of jigsaw strategy in teaching specific topics in Problem Solving and Mathematics Investigation. The pretest-posttest one shot pre experimental design was used. Participants of the study were 24 BSEd-Mathematics students of the Apayao State College-Luna Campus.

The study yielded the following results:

1. There is an improvement in the attitude scores of the participants as manifested in the mean difference of 0.116 (posttest and pretest scores). Students became more homogeneous in their posttest as revealed in the standard deviation value.
2. There is a significant difference between the attitude mean scores of the participants' posttest and pretest.
3. There is an improvement in the academic performance of the participants as revealed in the mean difference of 4.08. Also students became more homogeneous in their posttest as shown in the computed standard deviation.
4. There is a significant difference between the academic performance of the participants' posttest and pretest.

Conclusion

From the findings of the study, the following conclusions were drawn:

1. Jigsaw strategy improves students attitude towards mathematics during remote learning; and
2. Jigsaw strategy enhanced students' academic achievement during remote learning classes in Mathematics.

Recommendations

In the light of the findings and conclusions, the following are recommended:

1. Teachers are encouraged to use Jigsaw strategy for some selected topics in teaching Mathematics during remote learning.
2. In –service trainings should be conducted for the utilization of Jigsaw strategy and other strategies that enhance students' achievement and attitude.

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