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Enhancing Students' Science Achievement through Jigsaw II Strategy

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ABSTRACT The Science education curriculum in the Philippines has shifted from inputs-based to outcomes-based education, putting the learners at the core of the instruction. Hence, educators continue to innovate ways on how to engage the learners into relevant and responsive science instruction. Further, the implementation of the K to 12 curricula brings a paradigm shift in education in terms of pedagogy, assessment, and outcomes. Within-group quasi-experimental research attempts to test the effects of the Jigsaw II strategy on the students' science achievement. A total of 51 Grade 9 students in a government-run secondary school in Zambales, Philippines, participated in the study. Results revealed that the class improved from "developing" to "proficient" level in their science achievement after the implementation of the strategy. It found out that the Jigsaw II strategy had a significant effect on the science achievement of the learners. The study recommends the use of the instructional strategy in enhancing students' performance. The strategy may be applied in other science topics to see its effectiveness further. This paper likewise contributes to the literature on the effectiveness of the Jigsaw II learning strategy in science teaching in the Philippine context.

Keywords Jigsaw II teaching strategy, K to 12 Science curriculum, Quasi-experimental research, Science teaching

1. INTRODUCTION

Globally, science education has been facing a multitude of challenges in today's digital era in terms of pedagogy, assessment, and outcomes. The challenge for educators of science is to continually think of innovative ways to make science more responsive and relevant. In the Philippines, Rogayan (2019) reiterated that the science education confronts a myriad of changes in terms of curricular approach brought about by globalization, the Industry 4.0, Association of Southeast Asian Nations (ASEAN) integration, and the full implementation of the K to 12 curricula. The K to 12 science curriculum stresses that science and innovation should put in common human issues (Rogayan & Bautista, 2019). The curriculum requires active student participation and dynamic engagement in the learning process.

The country lags behind other countries in terms of quality of education, particularly in science education (Rogayan & Dollete, 2019). The World Economic Forum in 2018 reports that the Philippines ranked 55th out of 137 participating countries in terms of higher education and ranked 76th out of 137 countries in the quality of math and science education. Science teachers are challenged to be more innovative and creative for higher student achievement and favourable attitudes at the same time (Gernale, Duad, & Arañes, 2015). It observed that some teachers in Science still stagnated in the traditional way of teaching the subject, making them less effective teachers (Candrasekaran, 2014). Teachers see that the conventional method to be the only best pedagogy in science. The teachers in the traditional method tend to be the sole purveyor of knowledge and ask students to work individually. Results in boredom because there are no engaging tasks, challenging activities, and creative works to be accomplished by the learners. Teachers need to re-examine how they teach science and move from a traditional method to a more productive method (Candrasekaran, 2014). Gernale, Arañes, & Duad. (2015) stressed that a science teacher must be responsible for the device and provide the necessary materials for use in science classes and use practical teaching approaches to bridge the difficulties of students.

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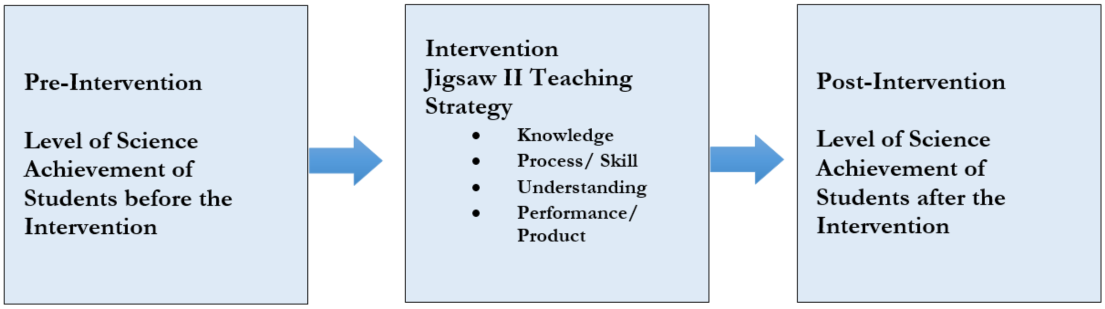

Figure 1 The conceptual paradigm of the study

One of the instructional approaches implemented in the classroom is cooperative learning, which considered a useful technique in enhancing student achievement in the learning process and has been used more often in a typical classroom environment (Siegel, 2005). One type of cooperative learning pedagogical technique is the Jigsaw strategy. Jigsaw is a cooperative learning model that involves small groups of 5–6 students teaching each other subject matter with success dependent upon student cooperation (Gömleksiz, 2007). It is a technique that is very flexible, can be applied in the classroom, and can be customized according to the needs of the learners (Hedeen, 2003; Doymus, 2007). In this study, a variation of Jigsaw called Jigsaw II was used.

According to Aronson (2000), jigsaw learning strategy allows the students to partake in the challenging and engaging tasks in their respective expert groups fuelled with dynamism since they know they are the only ones with that piece of information when they go back to their respective groups. Each group member becomes an expert on the various concepts or methodologies and is tasked to instruct these back to the group (Panitz, 1996). Just like a jigsaw puzzle, each piece is essential for the completion, and full understanding of the whole concept taught. As time passes by, Robert Slavin adapted Elliot Aronson's work on the Jigsaw technique and developed the Jigsaw II technique that allows competition among groups (Aronson & Patnoe, 2011). This healthy competition brings out the eagerness to participate more in the groups for its improvement.

Because of the gaps presented, the researchers were prompted to conduct the study. This study looked into the effects of the Jigsaw II teaching strategy in enhancing students' achievement. Innovative, student-centred, and engaging teaching strategies will increase students' performance in science. These instructional strategies should be utilized in science teaching to make the students more engaged, active, and curious, leading to increased science achievement.

1.1 The Framework of the Study

The present study is quasi-experimental research that determined the effects of the jigsaw II strategy on the students' science achievement. The study anchored on the cooperative learning approach. Cooperative learning is the instructional practice in which students help each other to learn in small groups towards a common goal (Johnson & Johnson, 1987). In Jigsaw II cooperative instructional strategy, students are assigned to three-member teams to work on academic materials. Initially, all students are assigned to study and understand the basic concepts of the materials. Later, each student gives a section/topic on which to become an expert. Students with the same section/topic meet in expert groups to discuss their topic, after which they return to their original teams to teach what they have learned to their teammates. Then students take group and individual quizzes that result in a team score based on the improvement score system (Slavin, 1986). As Slavin (2006) points out, teachers cannot only impart knowledge to the learners. The learners must be able to construct their knowledge with the guidance of the teachers, being the facilitators of learning. The use of the Jigsaw II teaching strategy exemplifies a student-dominated learning process (Figure 1).

Figure 1 shows the level of students' science achievement before the study as the pre-intervention. The intervention used is the Jigsaw II strategy, which measured the students' achievement in science in terms of knowledge, process/skill, understanding, and performance/ product. The level of students' achievement in science after the implementation of the strategy served as the post-intervention.

1.2 Purpose of the Study

This quasi-experimental study aimed to test the effects of the Jigsaw II teaching strategy in improving the Science achievement of Grade 9 students in a secondary school in Zambales, Philippines.

Specifically, it sought answers to the following research questions:

RQ1. What is the level of scientific achievement of the Grade 9 students before the intervention?

RQ2. How does the Jigsaw II strategy improve the science achievement of Grade 9 students?

RQ3. What is the level of scientific achievement of the Grade 9 students after the application of strategy?

RQ4. Is there a significant difference in the science achievement of the students before and after the application of the Jigsaw II teaching strategy?

Table 1 Modified steps of the Jigsaw II strategy

Step	Title	Description
1	Reading	Each participant of the expert group gives an identical set of materials relevant to the topic, as well as an expert sheet. Each student had a designated sub-topic to study. The researcher let them study first the different issues before discussing it properly.
2	Expert Group Discussion	Participants working on the same topic share what they had to learn based on the reading
3	HomeGroup Reporting	Participants in the working group go back to their original homegroup to teach others the things they have discussed.
4	Testing	After the mastering of the testing materials, a quiz bee-like evaluation happened. It was composed of eight groups with six to seven members. It was like a quiz bowl type of assessment.
5	Group Recognition	Each member of the winning group had a reward because their efforts exerted to perform successfully. In every assessment, there was a group champion whereby the challenge was to maintain their throne as a champion and for the other groups to replace the winning group.

2. METHOD

2.1 Research Design

This within-group quasi-experimental research attempted to determine the effects of the Jigsaw II teachings strategy on the students' science achievement.

2.2 Research Setting and Participants

This study was conducted in a government-run secondary school in Zambales, Philippines. It involved one different class composed of 51 Grade 9 students. The class was divided into 17 boys and 34 girls with ages ranging from 14 to 17.

2.3 Research Instruments

To gather reliable and valid data, the researcher used a teacher-made pretest/posttest as the primary gathering tool. The pretest/post-test used is composed of 30 items based on the topics covered for the Third Grading Quarter in Grade 9 Science-based from the Science Learners' module prescribed by the Department of Education (DepEd). The conceptual test is composed of 30 items that cover topics of Earth and Space, such as volcanoes and the interior of the earth, climate, and constellations. The test is divided into knowledge (6 items), process (8 items), understanding (4 items), and performance/product (12 items).

Table 2 Score interpretation

Verbal Description (VD)	Score Range			
	Pretest/ Posttest	Quiz	Lab Activity	Team Quiz
Advanced	25-30	9-10	21-25	5
Proficient	19-24	7-8	16-20	4
Approaching Proficiency	13-18	5-6	11-15	3
Developing	7-12	3-4	6-10	2
Beginning	1-6	1-2	1-5	1

Table 3 Distribution of students' scores in pretest

Score	Frequency	Percent
19-24	4	7.84
13-18	36	70.59
7-12	11	21.57
Total	**51**	**100.0**
Weighted Mean	**14.96 (Approaching Proficiency)**	

To see the improvement of the students' science achievement during the application of the strategy, they were also evaluated based on their quizzes, laboratory activities, and team quizzes.

2.4 Data Collection

The pretest was conducted at the start of the lesson to measure the science achievement of the class before the application of the technique. On the other hand, the post-test was administered toward the end of the study to determine how much the said technique helped in improving the science achievement of the students.

The researcher utilized the Jigsaw II as an intervention for a total of 4 weeks. This teaching strategy is a cognitive and collaborative strategy that recognizes the efforts made by each student in every activity and skill in studying different science concepts and ideas. The steps in infusing the strategy are modified based on Slavin (1986), as shown in Table 1.

2.5 Data Analysis

Data were analyzed using item analysis, frequency count and percent, weighted mean, standard deviation, and t-test for paired samples. The item analysis was used to measure the proficiency level of the students in the four domains of achievement, namely, knowledge, process, understanding, and performance/product. The frequency counts and percentages used for the tabular presentation of the raw scores of the students during the pre-test and post-test. The mean was used to determine the average scores of the students in the pretest/posttest, quizzes, laboratory activities, and team quizzes. Using the way, the researchers can identify the level of students' science achievement before and after the application of the intervention. The score interpretations, based on the DepEd Order No. 31, s. 2012 are as follows (Table 2).

Table 4 Distribution of proficient students in pretest per domain

Domain	Frequency	Percent
Knowledge	26	50.98
Process	29	56.86
Understanding	25	49.02
Performance/Product	24	47.06
Average	**26**	**50.98**

Note: N=56

Table 5 Students' mean scores in the formative assessments

Formative Assessment	Mean Score	SD	Verbal Description
Quiz	8.84	0.91	Advanced
Lab Activity	22.09	2.19	Advanced
Team Quiz	4.09	0.70	Proficient

3. RESULT AND DISCUSSION

3.1 Level of Science Achievement of the Students Before the Intervention

A 30-item diagnostic test was administered to assess the science achievement of the students and to determine their proficiency in the different domains of learning. The pretest results were tabulated to determine the science achievement level of the student before the application of the technique (Table 3). The results of the pretest showed that only 7.84% of the class belonged to the proficient level, most of the students belonged to the approaching proficiency level (70.59%) and developing level (21.57%). None of the students belonged to the advanced and beginning levels. With a calculated mean of 14.96 in the pretest, the performance of the class considered as approaching proficiency. It means that most of the students in the class have the fundamental knowledge and skills and core understandings and with little guidance from the teacher.

Table 4 shows the level of students' proficiency in the pretest, which is computed based on the total number of students who performed it correctly. The percentage of the students classified according to the level of performance of the class was 50.98% in Knowledge, 56.86% in Process/Skills, 49.02% in Understanding, and 47.06% in Performance/Product.

The result of the pretest showed that 26 (50.98%) students performed well in all of the four domains of students of academic performance. The table displays that the least performed domain is the Performance/Product (47.06%), which implies that only 24 out of 56 students can answer the questions that need an application to the real situations demonstrated through products and performances. The process skill was the most performed domain (56.86%). It only means that 29 students had no difficulties in questions based on the student's ability to process and make sense of information. It shows the understanding of the content of students and develops their critical thinking.

Table 6 Distribution of students' scores in post-test

Score	Frequency	Percent
25-30	9	17.65
19-24	27	52.94
13-18	15	29.41
Total	51	100.0
Weighted Mean	**21.02 (Proficient)**	

Table 7 Distribution of proficient students in post-test per domain

Domain	Frequency	Percent
Knowledge	37	72.55
Process	33	64.71
Understanding	40	78.43
Performance/Product	35	68.63
Average	36	70.59

Note: N=56

It can be observed from the results that the students can hardly answer the items on the Performance/Product and Understanding domains. It shows that students were good at performing different skills or doing activities, but their understanding of their activities and applying to the real situation were impoverished. It led the researcher to improve these domains through the use of the teaching strategy. Generally, the mean scores of the four domains were on the average level. It can be seen that the class was performing well before the application of the teaching strategy.

3.2 Level of Science Achievement of the Students during the Intervention

Formative assessment tools such as quizzes, laboratory activities, and team quizzes were gathered to determine the development of the science achievement of the students. Table 5 shows that the students are at the Advanced level based on the quiz overall mean score of 8.84 (SD=0.91), implying the effectiveness of the strategy during its application. Results of the respondents' quiz mean scores had a favourable increase during the implementation of the strategy. The strategy also helped much in improving the class science achievement seeing the results of the students' laboratory activities. The mean score of the students' four laboratory activities was 22.09 (SD=2.19), which is interpreted as advanced. That increased from 21.76 to 22.53 which implies that the strategy is effective in improving student achievement in terms of laboratory activities.

The strategy requires the participation of each student to make a successful outcome of their group. Each effort of the students is precious in this kind of strategy. For this reason, the researcher conducted a series of team quizzes that will also determine the development of the students. The results of their team quizzes showed that there increased their academic performance with regards to their participation in the evaluation process.

The overall mean score (4.09) in the team quizzes interpreted as proficient implies that the students have a favorable performance with the use of the intervention. The increase in the mean scores from 3.45 to 4.69 indicated that the strategy improved the science achievement of students in terms of the team quiz. Jigsaw cooperative learning strategy is one that mostly emphasizes facilitating learners with the opportunity to help each other in building and understanding the tasks assigned in the classroom (Abed, Sameer, Kasim, & Othman, 2019).

3.3 Level of Science Achievement of the Students after the Intervention

To assess the effectiveness of the Jigsaw II teaching strategy in improving the science achievement of the students, a post-test that has the same questions as the pretest was administered (Table 6). The results have shown that none of the class belonged to the beginning and developing level, 29.41% of the class belonged to the Approaching Proficiency, 52.94% for Proficient, and 17.65% of the class are in the Advanced level. With the calculated mean of 21.02 in the post-test, the class belonged to the Proficient level.

The frequency of correct answers in the post-test revealed that the science achievement of the class has improved (Table 7). The results showed that more than half of the class got correct answers in each of the domains used. That shows significant improvement in the science achievement of the students after the application of the Jigsaw II teaching strategy. Based on the table, it can be observed that the students' level of scientific achievement marked significant improvement after the application of the technique. More than half of the class, 36 students (70.59%), performed well in the four domains.

In the domain of Knowledge, students got an average of 37 (72.55%). That means that students conquered their difficulties in answering questions that test the information they acquired and information to firm up and deepen understanding. Process skill had an average of 33 (64.71%). That only means that students had lessened their difficulties in questions based on the student's ability to process and make sense of information. It shows the understanding of the content of students and develops their critical thinking.

Table 8 T-test of pretest and post-test scores

Test	Mean	SD	Mean Gain	t-value	df	p-value
Pre-Test	14.96	2.99	6.06	19.881	50	0.000
Post-test	21.02	3.11				

Note: Significant at $p<0.05$

The domain of Understanding had a total of 40 (78.43%). That shows that 39.86 students can answer the questions that were expressed using explanation, application, empathy, perspective, and self-knowledge, or any other discipline-based manifestation or indicator of understanding. In Performance/Product, an average of 35 (68.63%) students. It shows that the students can only answer the questions that need an application to the real situations demonstrated through products and performances.

The results of the study is parallel with previous studies on the effectiveness of Jigsaw learning strategy in improving students' achievement (Abed et al., 2019; Azmin, 2016; Gömleksiz, 2007; Kam-Wing, 2004), developing students' conceptual knowledge and understanding (Yimer & Feza, 2019), enhancing students' attitude (Kam-Wing, 2004; Yimer & Feza, 2019).

3.4 Difference in the science achievement of the Students before and after Application of the Jigsaw II

Results of the respondents' pretest and post-test scores were compared (Figure 2). It can be observed that there was an improvement in the students' science achievement. There was a positive change of 17.65% in the percentage

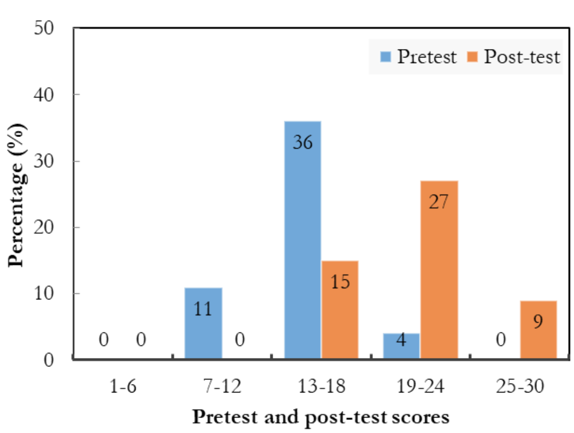

Figure 2 Comparison of students' pretest and post-test scores

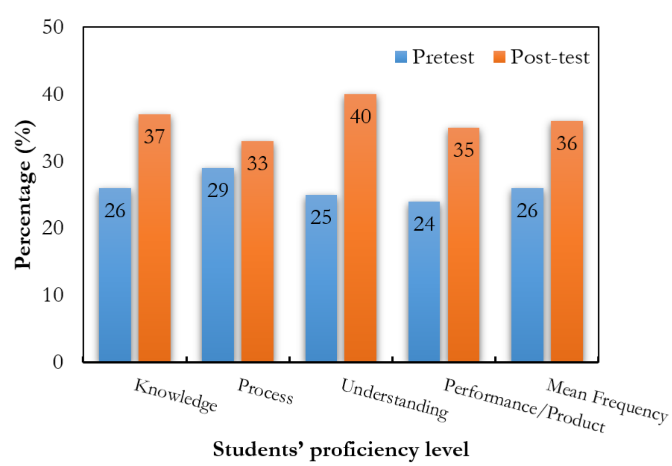

Figure 3 Comparison of students' proficiency level pretest and post-test

of students that belong to the Advanced level and 45.10% in the level of proficient. Also, there was a negative difference of 41.18% in the student percentage who belong to approaching proficiency level and -21.57% on the developing level. Although this marked a positive change, no one belongs to the beginning and developing standards after the application of the strategy.

On the other hand, Figure 3 presents the comparison of the students' proficiency level in the pretest and post-test. It shows that after the application of the strategy, there was an increase of 21.57% in the students' knowledge domain, a 7.85% increase in their process/skills domain, 29.41% difference in their understanding and 21.57% increase in their performance/product domain. An increase of 19.61% on the calculated mean that determines the effectiveness of the strategy.

The data show that there was a significant improvement in the overall science achievement of the Grade 9 students after the application of the Jigsaw II teaching strategy. Jigsaw would be a significant strategy to cooperate with the students in the classroom with an intimate atmosphere (Fry, Ketteridge & Marshall, 2008).

To further determine the change in the science achievement of the class before and after the application, the t-test of the pretest and post-test scores are presented (Table 8). The table shows that the pretest means score of the class is 14.96 (SD=2.99), and the post-test mean score is 21.02 (SD=3.11). A gain score of 6.06 was obtained after the application of the strategy, which indicates that there was an improvement in the science achievement of the students with the use of the strategy.

To determine if there was a significant difference before and after the application of the strategy, the t-test for paired samples computed. The t-value obtained was 19.881, and the p-value (p=0.000) is less than the 0.05 level of significance. Hence, the null hypothesis is rejected. It means that there was a significant difference in the science achievement of Grade 9 students after the application of the Jigsaw II teaching strategy.

The results corroborated several studies (Baron, 2019; Barrett, 2005; Chukwu & Dike, 2019; Evcim & Ipek, 2012; Maden, 2011; Mbacho & Changeiywo, 2013; Mohammed & Hamied, 2019; Oliveira, Vailati, Luiz, Boll, & Mendes, 2019; Sudrajat, Iasha, & Femayati, 2019; Suroto, 2017; Ward & Lee, 2005; Yoshida, 2018) which provide empirical evidences in the effectiveness of Jigsaw in enhancing student achievement in general.

4. CONCLUSION

The study determined the effects of the Jigsaw II strategy in enhancing students' science achievement in the Philippine setting. The use of the Jigsaw II teaching strategy marked a significant impact on the science achievement of the Grade 9 students based on the results of the study. The purpose of the intervention has improved the science achievement of the students. It was evident in the results of their pretest/post-test, quizzes, laboratory activities, and team quizzes. That further validated with the teacher's observation of the students' active participation in the class discussion and the different learning tasks. Furthermore, the pedagogical strategy employed by the teacher likewise enhanced the students' sub-skills in the four learning dimensions, the knowledge, process, understanding, and performance/product.

In the application of the instructional strategy, the teacher may prepare a set of sub-topics for students of each group before the lesson proper. The teacher may sternly reinforce their teaching authority to implement the technique in the learning process effectively. Classroom management may take into consideration to maximize the learning space. Teachers may employ the Jigsaw II teaching strategy in improving the achievement of the students in science. They may further localize and contextualize the learning tasks to suit the needs of their students. A follow-up study may be done to validate the effects of the intervention in improving the achievement of the students in science. Since the present study only involved one group, further studies may involve two groups, which will serve as experimental and control groups for better comparison.

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REFERENCES

Abed, A. Z., Sameer, S. A., Kasim, M. A., & Othman, A. T. (2019). Predicting Effect Implementing the Jigsaw Strategy on the Academic Achievement of Students in Mathematics Classes. *International Electronic Journal of Mathematics Education,* 15(1), em0558.

Aronson, E. (2000). Nobody left to hate — t*he Humanist*, *60*(3), 17.

Aronson, E., & Patnoe, S. (2011). Cooperation in the Classroom: The Jigsaw Method. London. UK: Pinter & Martin.

Azmin, N. H. (2016). Effect of the Jigsaw-Based Cooperative Learning Method on Student Performance in the General Certificate of Education Advanced-Level Psychology: An Exploratory Brunei Case Study. *International Education Studies*, *9*(1), 91-106.

Baron, R. (2019). Employing Jigsaw in English Academic Writing: An Action Research in An EFL Class in Indonesia. *Research and Innovation in Language Learning*, *2*(3), 228-236.

Barrett, T. (2005). Effects of cooperative learning on performance of sixth-grade physical education students. *Journal of Teaching in Physical Education*, *24*(1), 88-102.

Candrasekaran, S. (2014). Productive Methods of Teaching Middle School Science. *International Journal of Humanities and Social Science Invention*, *3*(7), 15-25.

Chukwu, J. C., & Dike, J. W. (2019). Effects of Jigsaw-puzzle and Graphic Organizer Instructional Strategies on Biology Students' Performance in Abia State. *Archives of Current Research International*, 1-6.

Doymus, K. (2007). Effects of a cooperative learning strategy on teaching and learning phases of matter and one-component phase diagrams. *Journal of Chemical Education*, *84*(11), 1857.

Evcim, H., & İpek, Ö. F. (2013). Effects of jigsaw II on academic achievement in English prep classes. *Procedia-Social and Behavioral Sciences*, *70*, 1651-1659.

Fry, Heather, Ketteridge, Steve, & Marshall, Stephanie. *A handbook for teaching and learning in higher education: Enhancing academic practice.* Routledge, 2008.

Gernale, J. P., Arañes, F. Q., & Duad, V. (2015). The Effects of Predict-Observe-Explain (POE) Approach on Students' Achievement and Attitudes Towards Science. *The Normal Lights*, *9*(2).

Gömleksiz, M. N. (2007). Effectiveness of cooperative learning (jigsaw II) method in teaching English as a foreign language to engineering students (Case of Firat University, Turkey). *European journal of engineering education*, *32*(5), 613-625.

Hedeen, T. (2003). The reverse jigsaw: A process of cooperative learning and discussion. *Teaching Sociology*, *31*(3), 325-332.

Johnson, D. W., & Johnson, R. T. (1987). *Learning together and alone: Cooperative, competitive, and individualistic learning.* Prentice-Hall, Inc.

Kam-Wing, C. (2004). Using Jigsaw II in Teacher Education Programmes. *Hong Kong Teachers' Centre Journal*, *3*, 91-97.

Maden, S. (2011). Effect of Jigsaw I Technique on Achievement in Written Expression Skill. *Educational Sciences: Theory and Practice*, *11*(2), 911-917.

Mbacho, N. W., & Changweiywo, J. M. (2013). Effects of jigsaw cooperative learning strategy on students' achievement by gender differences in secondary school mathematics in Laikipia East District, Kenya. *Journal of Education and Practice*, *4*(16), 55-63.

Mohammed, I. J., & Hamied, D. T. (2019). Using Jigsaw Cooperative Learning Strategy to Improve The EFL Iraqi Students in Writing Skill. *Journal Of Al-Frahedis Arts*, *11*(38), 504-524.

Oliveira, B. R., Vailati, A. L., Luiz, E., Böll, F. G., & Mendes, S. R. (2019). Jigsaw: Using Cooperative Learning in Teaching Organic Functions. *Journal of Chemical Education.*

Panitz, T. (1996). Getting students ready for learning. *Cooperative Learning and College Teaching*, *6*(2), 10-30.

Rogayan Jr, D. V., & Bautista, J. R. (2019). Filipino Students' Preferred Motivational Strategies in Science: A Cross-Sectional Survey. *IRJE (Indonesian Research Journal in Education)*, 358-372.

Rogayan, D.V., Jr. & Dollete, L.F. (2019). Development and Validation of Physical Science Workbook for Senior High School. *Science Education International, 30*(4).

Rogayan Jr, D. V. (2019). Biology learning station strategy (BLISS): Its effects on science achievement and attitude towards biology. *International Journal on Social and Education Sciences*, *1*(2), 78-89.

Siegel, C. (2005). Implementing a research-based model of cooperative learning. *The Journal of Educational Research*, *98*(6), 339-349.

Slavin, R. E. (1986). *Using student team learning (3rd ed.).* Baltimore, MD: The Johns Hopkins University.

Slavin, R. E., & Davis, N. (2006). *Educational psychology: Theory and practice.*

Sudrajat, A., Iasha, V., & Femayati, F. (2019). The Influence of the Use of Cooperative Learning Model Jigsaw & Two Stay Two Stray and the Learning Interest Result on 5th Grade Social Science. *ICEAP 2019*, *2*(2), 28-33.

Suroto, M. (2017). The Effectiveness of Jigsaw II Model in Improving Students' Understanding of Citizenship Education. In *5th SEA-DR (South East Asia Development Research) International Conference 2017 (SEADRIC 2017).* Atlantis Press.

Ward, P., & Lee, M. A. (2005). Peer-assisted learning in physical education: A review of theory and research. *Journal of teaching in physical education*, *24*(3), 205-225.

Yimer, S. T., & Feza, N. N. (2019). Learners' Conceptual Knowledge Development and Attitudinal Change towards Calculus Using Jigsaw Co-operative Learning Strategy Integrated with GeoGebra. *International Electronic Journal of Mathematics Education*, *15*(1), em0554.

Yoshida, M. (2018). Communication Jigsaw: A Teaching Method that Promotes Scholarly Communication. *International Journal of Emerging Technologies in Learning (iJET)*, *13*(10), 208-224.