International Journal of Scientific Research and Management (IJSRM)
||Volume||12||Issue||03||Pages||3264-3274||2024||
Website: https://ijsrm.net ISSN (e): 2321-3418
DOI: 10.18535/ijsrm/v12i03.el03

Effect of Stad Model of Cooperative Learning on Students' Learning Outcome on Nomenclature of Hydrocarbon

Emmanuel Nanor[1], Ruby Hanson[2], Alhassan Mahama[3]

[1]University of Education, Winneba Ghana
[2]University of Education, Winneba Ghana,
[3]University of Education, Winneba Ghana.

Corresponding Author
Name: Nanor Emmanuel

Abstract:
Students Team Achievement Division model of cooperative learning was employed to examine its effect on the learning outcome of students in the concept of nomenclature of hydrocarbons. Forty-one (41) students were purposively sampled for the study. The study employed an action research design. Pre and post-intervention tests were conducted before and after the intervention respectively to determine the effect of the intervention on students' learning outcome. The findings from the study showed that the STAD model of cooperative learning significantly improved learning outcome of the students in nomenclature of hydrocarbons. The study concluded that STAD model of cooperative learning was an effective learning model for improving students' learning outcome. The STAD model of cooperative learning provided conducive environment for active participation of learners resulting in meaning construction of knowledge. The intervention provided opportunities for developing analytical and critical thinking skills. The study therefore recommended the use of STAD model of cooperative learning for students owing to its effectiveness in improving learning outcome.

Keywords: STAD, cooperative learning, IUPAC nomenclature, learning outcome**.**

1. Introduction

Chemistry a branch of natural science that involves the study of properties, composition and structure of matter and energy changes that matter undergoes during chemical reactions (Respati & Atun, 2023). Chemistry plays a very significant role in the development of a nation (Yaayin, Oppong, & Hanson, 2021). Organic nomenclature is a major aspect of chemistry that is of great value. Inability of students to understand the concept results in students having difficulty in understanding other future concept in advanced topics. (Da Silva Júnior, Nobre, Do Nascimento, Torres, Leite, 2018). Despite the usefulness of the concept of organic nomenclature, students have difficulty answering questions correctly on IUPAC nomenclature of organic compounds (Fendos, 2021). In affirmation of the difficulties faced by students in naming of organic compound using the rules of IUPAC, Oppong, Quansah and Boachhie (2022), specifically stated that students have difficulty in answering questions correctly on the concept of nomenclature of hydrocarbons which is a major component of organic chemistry. As a result, students perform very poorly in the concept of nomenclature of hydrocarbons in the West African Senior School Certificate Examination. Abysmal performance of students in the concept of nomenclature of hydrocarbons is also affirmed by WAEC (2019; 2020) Chief Examiners' report.

Poor performance in nomenclature of hydrocarbons hinders students' understanding of certain concepts in pharmacy and medicine. There is therefore the need for a solution to this crucial problem. In attempting to remedy the learning difficulty of students in organic nomenclature, past researches employed incorporation of active learning strategies, implementation of peer-led team learning the use of in-class technology, curriculum and course content development and electronic and online homework systems. Others also investigated the use of ball and stick model. Some studies also implemented the jigsaw model of cooperative

learning (Austin, Ben-Daat, Zhu, Atkinson, Barrows, 2015; Obumnenye & Ahiakwo, 2013). In the literature however, there was no study found on the use of active learning technique like STAD model of cooperative learning in helping students to overcome their difficulty in the concept of nomenclature of hydrocarbons. Silva, Lopes, Dominguez and Morais (2022) stated that cooperative learning is an active learning technique that is learner centered, and involves learners working in heterogeneous group of relatively small members with the aim of sharing ideas, helping one another towards attainment of common goal of the group. Cooperative learning is very effective in improving students' understanding and achievement. As a result, it is one of the preferred learning strategies (Mahamod & Somasundram, 2017). Students learn far more effectively when they actively participate in and reflect on their own learning process. Facilitators must therefore ensure that active learning atmosphere is created for leaners to be active participants in the process of learning rather than just mere note takers (Bradforth, Miller, Dichtel, Leibovich, Feig, 2015). Foldnes (2016) opined that cooperative learning approach enables learners to achieve better understanding of concepts. Student Team Achievement Division (STAD) is an active learning model of cooperative learning (Zubaidah & Corebima, 2021) that involves placing students or learners in a heterogeneous group (group of learners with different levels of ability, ethnicity and gender) of three to five members (Kim, 2018) with the aim of helping one another in mastering a given learning material (Jahanbakhsh, AliAsgariZamani, & Garman, 2019). Yildiz and Arici (2021) affirmed that the STAD model of cooperative learning is effective in improving students' performance. In assertion. Suastika, Suartama, Sanjaya and Arta (2021) stated that STAD model of cooperative learning is effective in enhancing student learning outcome. The study therefore examined the effect of STAD model of cooperative learning on students' performance in the concept of nomenclature of hydrocarbons

2. Review of related literature

2.1 Theoretical Framework

Social constructivist theory of learning formed the framework of the study. Vygotsky in 1978 developed this theory of learning (Boutin Jr, 2021; Li & Lam, 2013; Mwanda & Midigo, 2019). Social constructivism proposes that, students learn best through active construction of their own knowledge (Finnegan & Ginty, 2019). Succinctly, social constructivism presupposes that, the way and manner knowledge is constructed is unique to each individual. Social group of people have much knowledge in common. Knowledge therefore is constructed by means of social interactions within the framework of specific social and societal context (Knapp, 2019). As applied to the study. the theory holds that social interaction among learners will result in meaningful construction of knowledge This theory is applicable to this study for the reason being that, it substantiates the fundamental importance of acknowledging various opinions in the classroom without restricting social interaction among students, teachers and facilitators creating a conducive atmosphere for active participation of learners in construction of their own knowledge leading to successful learning outcome (Adebola, Tsotetsi, & Omodan, 2020).

2.2 Social Constructivist view of Learning and Learners

Social constructivist learning is a type of learning that places emphasis on construction of knowledge and not transmission, not retention of knowledge but comprehension and application of knowledge. Critical thinking and careful analysis are also key elements that characterize social constructivist learning. Learning in the setting of social constructivism is a dynamic process (Tran, 2013). Social constructivists hold the view that, learning (recognition, meaning, understanding and knowledge) are constructed and internalized first of all by the individual within the framework of social setting. To them knowledge construction by learners originates from collaborative elaboration. Social constructivists see learning as that which comes about as a result of active participation in discovering principles, rules and understanding of concept. Social constructivists hold the view that learners construct knowledge in different ways. In order for learning to take place by the learner, the teacher need to be aware of the fact that, each learner has a unique way of constructing knowledge. The way and manner in which this is done depend on how the individual gets information, organize and interpret the information received from his or her environment. To social constructivists, social interaction is the pivot of learning. Understanding, interpretation and social interaction are the basic ingredients of the product learning.

2.3 Social Constructivists' Learning Environment

Akpan and Beard (2016) stated that not only is social constructivist classroom geared towards engaging the hands and mind of learners but also focuses on authentic tasks similar to those we see in our daily lives. Social constructivist learning environments furnish leaners with the opportunity to have a feel of real-world experiences and meaningful practices. Within a social constructivist classroom, an atmosphere that allows interaction among learners and between learners and facilitators is created in such a way that learners feel free to express themselves and bring to light their idea relative to the subject under discussion. Social constructivist learning environment create room for inspiration, ideas, knowledge meaning making to glow within each learner without hindrance (Kalina & Powell, 2009).

2.4 Cooperative Learning

Gillies (2016) affirmed that, cooperative learning is a pedagogical instructional approach that enhances social interaction and learning among learners across different subject areas. It creates that conducive atmosphere for learner to work together in group to achieve desirable tasks According to Slavin (2011), cooperative learning is a technique characterized by organization of learners by instructors into relatively smaller groups of four or five members with the aim of group members assisting one another in learning. Cooperative learning for that matter is the foundational block on which active learning approaches are built.

2.5 Elements of Cooperative Learning

There are certain elements or principles that set out conducive atmosphere for productive cooperative learning (Wichadee, 2005). According to Agarwal (2010), Song (2012) Johnson and Johnson (2018), Opdecam and Everaert (2018), Hussien (2020), Yusuf, Jusoh and Yusuf (2019) and De la Barra and Carbone (2020), these principles of cooperative learning, are individual and group accountability, positive interdependence, group processing, face-to-face promotive interaction, and interpersonal and small group skills.

Individual and group accountability: This means that each and every member of the group needs to be responsible and participate towards helping the group to achieve its goal or task. As a result, the whole group is accountable for its own achievement (Jahanbakhsh *et al.*, 2019).

Positive interdependence: Positive interdependence occurs when the actions of every single individual enhance the achievement of the goal of the group (Johnson & Johnson, 2009).

Jolliffe (2007) argue that positive interdependent demand that every single member of the small group contributes his or her quota towards the achievement of the task assigned to the whole group. This means that each individual in the group requires the contribution of others for their success and the success of the whole group.

Group processing. This element stresses discussion and decision making, the need for all the members of the group to express themselves freely towards the achievement of the task given to the group. There is therefore the need for good moral relationship, social interaction and respect for every single member of the group regardless of their state or short fall. This element emphasises the actual working together of the members of the group (Webb, 2008) .

Face to face promotive interaction: This is where team members directly communicate and interact with one another (Lv, 2014). This element is characterized by rendering of support to each and every member of a group. Here learners encourage, support and motivate one another to learn. The success of the group is the success of everyone (Arra, D'Antonio, & D'Antonio Jr, 2011).

Interpersonal and small group skills: For the success of the whole group, there is the need for every single individual to possess and exhibit leadership decision making, communication, and collaborative, organizational skill, and respect for each other (Lv, 2014).

2.6 Factors affecting students' learning outcome

Learning outcomes are skills, knowledge, attitude, abilities and observable change in behavior of a learner after going through teaching and learning experience (Widana & Umam, 2023). Learning outcome can be determined by scores, grades or grade point average of learners (Menekse, Zheng, & Anwar, 2020). Learning outcomes of students can be affected by factors such as learning environment, time of study, motivation,

socioeconomic background of students, teachers' mastery of the subject, use of teaching and learning materials, cognitive ability of learners etc (Ekpenyong, Owan, Mbon, & Undie, 2023)

2.7 Nomenclature of Hydrocarbons

During the early stages of the nineteenth century, organic compounds were name at the whim of those who discovered them (Klein, 2021). Most of the names given to those organic compounds at that time were based on the place of discovery, physical properties of the compound and their appearance (Chang & Overby, 2022). The way and manner compounds were named was not scientifically inclined. For instance, the name barbituric acid, which is found in barbiturate drugs was coined from a woman's name Barbara. During the middle of the nineteenth century, a lot of trivial names were used for compound that were either synthesized or discovered at that time. As a result, other chemists other than the discoverers were not able to visualise the exact structures of the compounds (Headley, 2020). As large number of compounds were discovered, scientists saw the need for a systematic naming of compounds. As a result, chemists in 1892 met and developed a system "organic nomenclature" for naming organic compounds. This system they referred to as the Geneva rules. Later referred to as IUPAC nomenclature. The steps involve in naming alkanes, alkenes, and alkynes are: Identification and naming of the parent, Identification and naming of the substituents, assigning a locant to each substituent and assembling the substituents alphabetically (Klein, 2021).

2.8 Student Teams Achievement Divisions (STAD) model of cooperative learning

This is a cooperative learning model developed by Robert Slavin in 1978 (Berzener, 2021; Nair & Sanai, 2018). Slavin (1980, as cited in Kim, 2018) at that time defined the model as operational instructional approach in which learners are rewarded for score they obtained as a team.

STAD is a highly structured (Ishtiaq, Ali, & Salem, 2017) cooperative instructional model (Kim, 2018) that involves formation of heterogeneous teams (Awada, Burston, & Ghannage, 2020) of four to five members (Suastika *et al.*, 2021) with the ultimate aim of maximizing academic achievement, (Syafril, Rahayu, Wati, & Yuberti, 2018). Zubaidah and Corebima (2021) argued that, STAD is practical model of cooperative instructional approach that accentuates classroom interactions that furnish students with the opportunity to work as a group, motivate, and assist every group member in apprehending a given learning materials for the ultimate purpose of achieving academic excellence hence requires the need of the teacher to monitor group proceedings to ensure active participation of everybody (Nair & Sanai, 2018). With reference to the above definitions of student team achievement division (STAD) we conclude that STAD is a cooperative learning model that is capable of creating conducive atmosphere for learners to improve their academic, social, problem solving and critical thinking skills by learning to fathom a given learning material in heterogeneous team without unhealthy contention among learners. STAD model of cooperative learning aim at inspiring learners in a group to encourage each other, work together and help each other to apprehend a specific concept contain in a given learning material. STAD model of cooperative learning presupposes that learners construct knowledge through social interactions with others (Mukuka, Mutarutinya, & Balimuttajjo, 2021).

2.8.1 Benefits of Student Teams Achievement Division model of cooperative learning

Anam, A'yun, Asitah, Purnomo and Laili (2021) argued that, STAD model of cooperative learning enhances interpersonal and communication skills of students. Anam *et al.* (2021) claimed that STAD is an excellent instructional strategy that aid in enhancing learners' attitude and understanding of subject matter. According to Takdir (2021), STAD offers learners the privilege of learning more effectively from their peers. Islami, Budiasih, Sukarianingsih and Sulistina (2021) affirmed that STAD is effective in improving learners' achievement. The heterogeneous group to which learners belong in STAD make it possible for learners to motivate one another. STAD also encourages students to think positively (Adawiyah, Zubaidah, Listyorini, & Astriani, 2021). Irawan, Zubaidah, Sulisetijono and Astriani (2021) asserts that student team achievement division empowers learners. Student team achievement division aids students in overcoming, mistakes, learning difficulties and misconceptions. STAD helps create interactive learning, fun, and motivates students to participate actively in learning (Bahari, Luthan, Azmi, & Anshar, 2021). According to Mulbar and Minggi (2021). Students Team Achievement Division enables learners to assist and encourage one another towards mastering of skills presented by the instructor.

2.8.2 Stages of implementation of STAD

The first stage of implementation of STAD is teacher presentation. It is at this stage that the teacher outline lesson objectives, introduces and teach the material to the whole class. The teacher encourages students to help their teammates to learn the material if they want their team to earn team rewards, during this stage, students are informed by the teacher to encourage their teammates to do their best (Berzener, 2021; Nasution & Hafizah, 2020).

The second stage of STAD referred to as group discussion is characterized by team learning activities. This is the stage where learners work in their various heterogeneous teams on the given task towards achievement of the set goal. This second stage of STAD creates conducive environment for learners to encourage and assist every member to learn and grasp the concept presented in the material. During this stage, students are encouraged to help and teach one another to master the material. This stage is also characterized by answering of questions presented to students on worksheet. The heterogeneous group or teams in which students learn is usually made of four to five members in a group (Nasution & Hafizah, 2020; Shobirin & Hildiana, 2021). The third stage is the stage where quiz is being conducted. It is at this stage that students take individual quizzes or test. During the conduction of the test, students are not allowed to help one another. Independent work by students is stressed (Nair & Sanai, 2018; Zahara & Maryam, 2021). The fourth stage of STAD is the stage where Quiz discussion and evaluation are carried out. This stage is characterized by the scoring of the test after which a discussion is carried out for further clarification (Berzener, 2021; Suastika *et al.*, 2021; Wichadee, 2005).

The final stage of STAD is Team recognition or Group reward. This is done by finding the average score of all groups after which outstanding teams are giving prizes (Berzener, 2021; Suastika *et al.*, 2021; Wichadee, 2005)

3 Materials and Methodology

3.1 Description of study area

The research was carried out in Ho Mawuli School. The school is located in Ho Township of Ghana in the Volta region. The school has a population of 4200 comprising of 3005 girls and 1195 boys. The school offers programs such as General Science, Home Economics, Business, Agricultural Science, Visual Art and General Art.

3.2 Research Design

The study design was action research design. Action research is a cyclical, unending dynamic process that aim at improving practices within a particular setting (Rojas-Bustos & Panniello, 2022)**.** Action research is an educational research design used by educational professionals and practitioners in enhancing their practices and pedagogies. It involves planning, acting, observing and reflection. Action research was chosen for the reason being that, it is effective in improving personal and professional development of teachers. It is also believed to be effective in improving students' academic performance.

3.3 The population of the study

The target population was all third-year science students in Ho Mawuli School. The accessible population consisted of General Art Form three students. The sample however consisted of 41 form three students (an intact class of General Art students). Out of the 41 students, 27 were boys and 14 were girls

3.4 Sample and Sampling Techniques

The sample consisted of forty-one senior high school from three students. Purposive sampling technique was employed in the selection of sample of the research.

3.5 Instruments for Data Collection

In this study, pretest and posttest were used. Each of the pretest and the posttest consisted of 37 test items. The tests items were placed into section A, B, C and D. The tests were scored over forty.

3.6 Validity and Reliability of Instruments

Validity of an instrument can be defined as the degree to which an instrument accurately measures what it has been purported to measure (Sarkodie., 2013). Validity of the instruments was determined by comparing the test items in the instruments with the integrated science syllabus in ensuring that the test items represent

the contents of the topic in the syllabus. Again, the validity of the instruments were ensured by reviewing of the test items by two experts in the field for critique and suggestions after which final modification was made for final version of the instruments.

In ensuring instruments reliability, the test items were stated without any ambiguity. The test items were also piloted. In ensuring the reliability of the instruments, the researcher also employed the test-retest technique. The Cronbach's alpha reliability coefficient of the tests were 0.8 and 0.9 for pretest and posttest respectively. These values indicated that the test items were reliable for Ajaja (2013), affirmed that reliability value of 0.70 or higher shows reliable instrument. This implies that the test items were appropriate for accurately measuring the characteristic they were designed to measure.

3.7 Procedure

3.7.1 Pre-intervention

The researcher tested students' knowledge in the concept of nomenclature of hydrocarbons on his first visit to the class. The researcher did this by administering the pre-test (Nomenclature of Hydrocarbons Achievement Test (NOHAT) to determine the strength and weakness of the students in the concept. The test items were scored. Almost all the students performed very poorly on the test. Discussion was held with the students with respect to their poor performance on the test. It came to light that they have very little knowledge on the concept as such, it was difficult for them to pick up high score. Marks were recorded for data analysis. The researchers decided to implement the STAD model of cooperative learning to address to see if it can help solve the problem.

3.7.2 Intervention phase (Implementation of STAD model of cooperative learning)

The intervention employed was Students Team Achievement (STAD) model of cooperative Learning. Implementation of STAD model proceeded in five stages Classroom presentation, teamwork, quiz, quiz discussion and evaluation and team recognition.

First Stage (Classroom Presentation)

This is the stage where the researchers presented the material to the whole class. They did this by outlining the objectives followed by teaching the students. The researchers encouraged students to help their teammates to learn the material if they want their team to earn team rewards. During this stage, students were informed by the teacher to encourage their teammates to do their best.

Second Stage (team work)

During the second stage the researchers helped Students to form heterogeneous teams of five members. The researchers encouraged learners to work in their various heterogeneous teams on the given task towards achievement of the set goal. The aim of this stage of STAD was to make learners study together in groups.

Third Stage (quiz conduction)

This is the stage where students took individual quizzes. During the conduct of the quiz, the researchers did not allow students to help one another. Independent work by students was emphasized.

The Fourth Stage

This stage of the intervention is the stage where the quizzes were scored by the researchers after which a discussion was carried out for further clarification.

The Fifth Stage

This stage is the final stage of STAD model. This is the stage where the researchers rewarded the teams with high average score

3.7.3 Post Intervention

After the intervention, a post-test (Nomenclature of Hydrocarbons Achievement Test (NOHAT) was conducted. The posttest aimed at determining the effectiveness of the intervention on learning outcome of the participants in the concept of nomenclature of hydrocarbons. Responses of participants to the test items were scored. The scores were recorded for analysis.

3.8 Method of data collection

A Pre-test was administered on the concept of nomenclature of hydrocarbons. The concept of nomenclature of hydrocarbons was then taught using STAD cooperative learning model within four weeks. A Post-Test was then administered in the fifth week.

3.9 Method of data analysis

Students' pre and post-test scores were analysed using SPSS version 25. Students test scores were analysed using dependent sample t-test.

4. Result And Discussion

4.1 Research question

Does STAD model of cooperative learning have any effect on students' performances in the concept of nomenclature of hydrocarbons?

Table 1: Paired sample t-test comparing the mean of students' pre and post-test scores

Table 1 *Comparison of students' mean score of pretest and posttest*						
Test	N	Mean	SD	df	t-value	Sig(2-tailed)
Pretest	41	9.02	2.72	40	19.30	0.00
Posttest	41	27.83	5.27			
Statistically significant at Alpha (α) = 0.05 level. P<0.05						

The mean score of the pre intervention test was 9.02 with standard deviation of 2.72. (Table 1). Mean score of students' pre-test indicates their performance prior to the implementation of STAD. Also, mean score of 27.83 with standard deviation of 5.27 was obtained after the implementation of the intervention. (Table 1). Mean score of 27.83 indicated students' performance after the implementation of STAD model of cooperative learning. Greater means score of the post-test indicated improvement in student's performance in the concept. The mean difference of 18.81 (Table 1) indicated that students performed better after the implementation of the intervention. (Table 1) showed that there was statistically significant difference between the learning outcome of students before and after the implementation of STAD model of cooperative learning. This proved that implementation of STAD model of cooperative learning in studying the concept of nomenclature of hydrocarbons significantly improved the performance of the students. This implies that STAD model of cooperative learning as an intervention positively affected the performance of students in the concept of nomenclature of hydrocarbons.

This finding is consistent with the finding of Haritsah (2022) who employed an action research in investigating the impact of Student Team Achievement Division model of cooperative learning on learning outcome of students in science and concluded that, STAD model of cooperative learning resulted in better performances. Again, better performance of students after the implementation of the intervention as observed in this study is also supported by Prananda and Hadiyanto (2019) who carried out an experimental research that implemented. STAD model of cooperative learning and found out that students who employed STAD model of cooperative learning performed better than those who did not. Again this finding is consistent with that of Tabatabaei and Heidari Shahreza (2022) who investigated the effect of STAD model of cooperative learning on creativity and learning outcome of learners and concluded that STAD model of cooperative learning brought about significant difference in achievement of students who utilised STAD and those who did not.

Better performance of the students after the implementation of STAD is attributed to active participation of students, and the fact that they compete with their classmates to win the prize or award (Khidr & Sabri, 2022). Jainal and Shahrill (2021) ascribed the high performance of students owing to STAD to active participation, cooperation and peer instruction and sharing of ideas among students (as cited in Abd Mokmin, Bungsu, & Shahrill, 2022).

4.2 Findings

Based on the analysis of data obtained from the study, it is evident that participants of the study performed poorly in the pre- intervention test in the concept of nomenclature of hydrocarbons. The analysis of the two test scores of the participants indicated that, their learning outcome in the concept of nomenclature of hydrocarbons has significantly improved due to the implementation of STAD model of cooperative learning.

5. Conclusion

The problem that necessitated the study was consistent report of abysmal performance of students by the chief Examiner (WAEC) in the nomenclature of organic compound. The study employed action research

design in examining effect of STAD on achievement of students in nomenclature of hydrocarbons**.** Findings from the study showed that the STAD model of cooperative learning significantly improved learning outcome of students.

The STAD model of cooperative learning owing to its effectiveness in enhancing students' attitude towards learning, active participation in learning as well as motivating students to learn. STAD model of cooperative learning is an effective learning model for improving students' learning outcome.

5.1 Recommendations

1. Practicing and students' teachers should be educated on STAD model of cooperative learning
2. Science teachers should employ STAD model of cooperative learning in schools owing to its effectiveness in improving students' learning outcome

References

1. Abd Mokmin, A. U. P., Bungsu, J., & Shahrill, M. (2022). Improving the Performance and Knowledge Retention of Aircraft Maintenance Engineering Students in the Theory of Light through STAD Cooperative Learning. *ASEAN Journal of Science and Engineering Education*, *3*(2), 149-162. https://doi.org/10.17509/xxxx.xxxx
2. Adawiyah, R., Zubaidah, S., Listyorini, D., & Astriani, M. (2021). The potential of Remap STAD in improving motivation and academic achievement. AIP Conference Proceedings,
3. Adebola, O. O., Tsotetsi, C. T., & Omodan, B. I. (2020). Enhancing students' academic performance in university system: The perspective of supplemental instruction. *International Journal of Learning, Teaching and Educational Research*, *19*(5), 217-230. https://doi.org/10.26803/ijlter.19.5.13
4. Agarwal, R. (2010). *Cooperative learning*. Gyan Publishing House.
5. Ajaja, O. P. (2013). Which way do we go in biology teaching? Lecturing, Concept mapping, Cooperative learning or Learning cycle? *The Electronic Journal for Research in Science & Mathematics Education*, *17*(1).
6. Akpan, J. P., & Beard, L. A. (2016). Using constructivist teaching strategies to enhance academic outcomes of students with special needs. *Universal journal of educational Research*, *4*(2), 392-398.
7. Anam, F., A'yun, D. Q., Asitah, N., Purnomo, A., & Laili, M. (2021). Do STAD Learning Method Can Improve Students' Learning Outcomes on Social Science? *Indonesian Journal of Islamic Education Studies (IJIES)*, *4*(1), 37-51. https://doi.org/10.33367/ijies.v4i1.1490
8. Arra, C. T., D'Antonio, M. D., & D'Antonio Jr, M. (2011). Students' Preferences for Cooperative Learning Instructional Approaches: Considerations for College Teachers. *Journal of Research in Education*, *21*(1), 114-126.
9. Austin, A. C., Ben-Daat, H., Zhu, M., Atkinson, R., Barrows, N., & Gould, I. R. (2015). Measuring student performance in general organic chemistry. *Chemistry Education Research and Practice*, *16*(1), 168-178.
10. Awada, G., Burston, J., & Ghannage, R. (2020). Effect of student team achievement division through WebQuest on EFL students' argumentative writing skills and their instructors' perceptions. *Computer Assisted Language Learning*, *33*(3), 275-300. https://doi.org/10.1080/09588221.2018.1558254
11. Bahari, A., Luthan, E., Azmi, W., & Anshar, A. L. (2021). Cooperative Model Type STAD and Its Effect on Student Learning Outcomes at Sustainability Accounting Courses. The 3rd International Conference on Educational Development and Quality Assurance (ICED-QA 2020),
12. Berzener, A. (2021). The Effect of Cooperative Learning on EFL Learners' Success of Reading Comprehension: An Experimental Study Implementing Slavin's STAD Method. *Turkish Online Journal of Educational Technology-TOJET*, *20*(4), 90-100.
13. Boutin Jr, P. J. (2021). Teaching Personal Selling Strategies and Tactics with Popular Culture Examples: An Active Learning In-Class Group Activity.
14. Bradforth, S. E., Miller, E. R., Dichtel, W. R., Leibovich, A. K., Feig, A. L., Martin, J. D., . . . Smith, T. L. (2015). University learning: Improve undergraduate science education. *Nature News*, *523*(7560), 282.
15. Chang, R., & Overby, J. (2022). *chemistry* (fourteenth ed.). McGraw Hill LLC.

16. Da Silva Júnior, J. N., Nobre, D. J., Do Nascimento, R. S., Torres, G. S., Jr., Leite, A. J. M., Jr., Monteiro, A. J., . . . Rojo, M. J. (2018). Interactive Computer Game That Engages Students in Reviewing Organic Compound Nomenclature. *Journal of Chemical Education*, *95*(5), 899-902. https://doi.org/10.1021/acs.jchemed.7b00793
17. De la Barra, E., & Carbone, S. (2020). Bridging Inequality: Cooperative Learning Through Literature in Two Vulnerable Schools in Santiago. *Profile Issues in TeachersProfessional Development*, *22*(2), 49-63.
18. Ekpenyong, J. A., Owan, V. J., Mbon, U. F., & Undie, S. B. (2023). Family and community inputs as predictors of students' overall, cognitive, affective and psychomotor learning outcomes in secondary schools.
19. Fendos, J. (2021). Combining Jigsaws, Rule-Based Learning, and Retrieval Practice Improves IUPAC Nomenclature Competence. *Journal of Chemical Education*, *98*(5), 1503-1517. https://doi.org/10.1021/acs.jchemed.0c01235
20. Finnegan, M., & Ginty, C. (2019). Moodle and social constructivism: Is Moodle being used as constructed? A case study analysis of Moodle use in teaching and learning in an Irish Higher Educational Institute. *All Ireland Journal of Higher Education*, *11*(1).
21. Foldnes, N. (2016). The flipped classroom and cooperative learning: Evidence from a randomised experiment. *Active Learning in Higher Education*, *17*(1), 39-49.
22. Gillies, R. M. (2016). Cooperative learning: Review of research and practice. *Australian Journal of Teacher Education (Online)*, *41*(3), 39-54.
23. Haritsah, S. (2022). Penggunaan Model Pembelajaran Kooperatif Tipe STAD (Student Teams Achievement Devision) untuk Meningkatkan Hasil Belajar IPA. *Journal of Indonesian Teachers for Science and Technology*, *1*(2), 12-23.
24. Headley, A. D. (2020). *Organic chemistry : concepts and applications* (1 ed.). Texas A&M University).
25. Hussien, A. M. (2020). The Impact of Combining Communicative Traits of Writing with Cooperative Learning on Trainee Teachers' Pedagogical Knowledge and Attitudes. *International Journal of Instruction*, *13*(1), 813-930. https://doi.org/10.29333/iji.2020.13152a
26. Irawan, F., Zubaidah, S., Sulisetijono, & Astriani, M. (2021). Does Remap-STAD have the potential to promote students' creative thinking skills? AIP Conference Proceedings,
27. Ishtiaq, M. I., Ali, Z., & Salem, M. S. (2017). An experimental study of the effect of Student Teams Achievement Divisions (STAD) on vocabulary learning of EFL adult learners. *Arab World English Journal (AWEJ) Volume*, *8*.
28. Islami, A. I., Budiasih, E., Sukarianingsih, D., & Sulistina, O. (2021). STAD-NHT vs STAD learning models; the difference in students' achievement on redox reaction. AIP Conference Proceedings,
29. Jahanbakhsh, A. A., AliAsgariZamani, M., & Garman, Z. (2019). CIRC and STAD in Iranian context: Through the five elements to cooperative learning of lexical collocations. *Cogent Arts & Humanities*, *6*(1), 1692469. https://doi.org/10.1080/23311983.2019.1692469
30. Johnson, D. W., & Johnson, R. T. (2009). An educational psychology success story: Social interdependence theory and cooperative learning. *Educational researcher*, *38*(5), 365-379.
31. Johnson, D. W., & Johnson, R. T. (2018). Cooperative learning: The foundation for active learning. *Active Learning—Beyond the Future*. https://doi.org/10.5772/intechopen.81086
32. Jolliffe, W. (2007). *Cooperative learning in the classroom: Putting it into practice*. Sage.
33. Kalina, C., & Powell, K. (2009). Cognitive and social constructivism: Developing tools for an effective classroom. *Education*, *130*(2), 241-250.
34. Khidr, Z. H., & Sabri, W. M. N. (2022). The Impact of STAD Strategy on the Academic Achievement of Eighth-Grade Students in Sciences Subject and Developing their Scientific Trends. *Journal of Arts, Literature, Humanities and Social Sciences*, *82*(82), 208-239. https://doi.org/10.33193/jalhss.82.2022.714
35. Kim, D. (2018). A Study on the Influence of Korean Middle School Students' Relationship through Science Class Applying STAD Cooperative Learning. *Journal of technology and Science Education*, *8*(4), 291-309.
36. Klein, D. R. (2021). *Organic chemistry* (4 ed.). John Wiley & Sons.

37. Knapp, N. F. (2019). The shape activity: Social constructivism in the psychology classroom. *Teaching of Psychology*, *46*(1), 87-91. https://doi.org/10.1177/0098628318816181
38. Li, M., & Lam, B. H. (2013). Cooperative learning. *The Hong Kong Institute of Education*, 1-33.
39. Lv, Y. (2014). Cooperative Learning: An Effective Approach to College English Learning. *Theory & Practice in Language Studies*, *4*(9).
40. Mahamod, Z., & Somasundram, B. (2017). Effectiveness of cooperative learning on the achievement and motivation of the student in learning Malay language. *Creative Education*, *8*(15), 2438-2454.
41. Menekse, M., Zheng, X., & Anwar, S. (2020). Computer science students' perceived needs for support and their academic performance by gender and residency: An exploratory study. *Journal of Applied Research in Higher Education*. https://doi.org/10.1108/JARHE-07-2019-0194
42. Mukuka, A., Mutarutinya, V., & Balimuttajjo, S. (2021). Mediating Effect of Self-Efficacy on the Relationship between Instruction and Students' Mathematical Reasoning. *Journal on Mathematics Education*, *12*(1), 73-92. https://doi.org/10.22342/jme.12.1.12508.73-92
43. Mulbar, U., & Minggi, I. (2021). The Development of Mathematics Learning Tools Based on Realistic Approach of Cooperative Model. Journal of Physics: Conference Series,
44. Mwanda, G., & Midigo, R. (2019). Understanding the Bottlenecks in Methodological Adoption of Constructivism in Secondary Schools in Kenya. *Online Submission*, *5*(1), 141-150.
45. Nair, S. M., & Sanai, M. (2018). Effects of Utilizing the STAD Method (Cooperative Learning Approach) in Enhancing Students' Descriptive Writing Skills. *International Journal of Education and Practice*, *6*(4), 239-252.
46. Nasution, M., & Hafizah, N. (2020). Development of students' understanding of mathematical concept with STAD type cooperative learning through student worksheets. Journal of Physics: Conference Series,
47. Obumnenye, N., & Ahiakwo, M. J. (2013). Using stereochemistry models in teaching organic compounds nomenclature: Effect on senior secondary students' performance in rivers state of Nigeria. *African Journal of Chemical Education*, *3*(2), 91-105.
48. Opdecam, E., & Everaert, P. (2018). Seven disagreements about cooperative learning. *Accounting Education*, *27*(3), 223-233. https://doi.org/10.1080/09639284.2018.1477056
49. Oppong, E., Quansah, F., & Boachhie, S. (2022). Improving Pre-service Science Teachers' Performance in Nomenclature of Aliphatic Hydrocarbons using Flipped Classroom Instruction. *Science Education International*, *33*(1), 102-111.
50. Prananda, G., & Hadiyanto, H. (2019). The effect of cooperative learning models of stad type on class v science learning learning sd. *International Journal Of Educational Dynamics*, *1*(2), 47-53.
51. Respati, A. A., & Atun, S. (2023). The Effect of Electronic Modules on Self-regulated Learning and Cognitive Learning Outcomes on Chemical Bonding Material. *Jurnal Penelitian Pendidikan IPA*, *9*(5), 2489-2496.
52. Rojas-Bustos, K., & Panniello, D. (2022). Action Research to Transform Early Language Practice: Exploring Representations of Plurilingualism in a Private Nursery. *International Journal of Educational Methodology*, *8*(1), 129-138. https://doi.org/10.12973/ijem.8.1.131
53. Sarkodie. (2013). *Using jigsaw model to enhance S.H.S chemistry students' performance in organic compounds' classification and nomenclature* (8110130010)[Unpublished master's thesis]. UNIVERSITY OF EDUCATION, WINNEBA
54. Shobirin, M. S., & Hildiana, L. V. (2021). Efforts to Improve The Learning Outcomes of Islamic Education Through The Cooperative Imprisonment Model of Students Teams Achievement Division (STAD). *SCHOOLAR: Social and Literature Study in Education*, *1*(3), 174-179.
55. Silva, H., Lopes, J., Dominguez, C., & Morais, E. (2022). Lecture, Cooperative Learning and Concept Mapping: Any Differences on Critical and Creative Thinking Development? *International Journal of Instruction*, *15*(1). https://doi.org/10.29333/iji.2022.15144a
56. Slavin, R. E. (2011). Instruction based on cooperative learning. *Handbook of research on learning and instruction*, 358-374.
57. Song, Y. (2012). Application of cooperative learning in the college task-based English teaching. *Journal of Exam Week*, *27*(2), 83-84.

58. Suastika, I. N., Suartama, I. K., Sanjaya, D. B., & Arta, K. S. (2021). Application of multicultural-based learning model syntax of social studies learning. *Cypriot Journal of Educational Sciences*, *16*(4), 1660-1679.
59. Syafril, S., Rahayu, T., Wati, W., & Yuberti, Y. (2018). THE APPLICATION OF STAD-COOPERATIVE LEARNING IN DEVELOPING INTEGRATED SCIENCE ON STUDENTS WORKSHEET. https://doi.org/10.24042/jipfalbiruni.v6i2.1933
60. Tabatabaei, O., & Heidari Shahreza, M. A. (2022). Using the STAD Model of Instruction to Enhance Learners' General Achievement and Creativity. *Journal of Language and Translation*, *12*(1), 121-135.
61. Takdir, N. (2021). The Effect of Mind Mapping Stad Assistant Cooperative Learning Model On Biology Learning Outcomes And Students' Learning Retention. *JIRAN: Journal of Southeast Asia Studies*, *2*(3).
62. Tran, V. D. (2013). Theoretical Perspectives Underlying the Application of Cooperative Learning in Classrooms. *International Journal of Higher Education*, *2*(4), 101-115.
63. Webb, N. (2008). Learning in small groups. A TL Good (Ed.). 21st Century Education: A Reference Handbook (pp. 203-211). In: Los Angeles: Sage.
64. Wichadee, S. (2005). The effects of cooperative learning on English reading skills and attitudes of the first-year students at Bangkok University. *BU academic Review*, *4*(2), 22-31.
65. Widana, I. W., & Umam, E. K. (2023). Improving Mathematics Learning Outcomes Using The Mind Mapping Method for Students of SMPN 8 Denpasar. *Mathline: Jurnal Matematika dan Pendidikan Matematika*, *8*(2), 373-388.
66. Yaayin, B., Oppong, E. K., & Hanson, R. (2021). Efficacy of Jigsaw Model in Improving Pre-Service Teachers' Performance in Selected Functional Group Organics Compounds. *Science education international*, *32*(3), 191-196. https://doi.org/10.33828/sei.v32.i3.2
67. Yildiz, E., & Arici, N. Ü. (2021). The Effect of Different Cooperative Learning Methods on Laboratory Activities of Science Teacher Candidates. *Turkish Online Journal of Educational Technology-TOJET*, *20*(2), 116-126.
68. Yusuf, Q., Jusoh, Z., & Yusuf, Y. Q. (2019). Cooperative Learning Strategies to Enhance Writing Skills among Second Language Learners. *International Journal of Instruction*, *12*(1), 1399-1412.
69. Zahara, L., & Maryam, B. S. (2021). Application of Cooperative Learning Type Stad and Hands on Activity to Student Achievement and Learning Activities. 2nd Progress in Social Science, Humanities and Education Research Symposium (PSSHERS 2020),
70. Zubaidah, S., & Corebima, A. D. (2021). The Effect Size of Different Learning on Critical and Creative Thinking Skills of Biology Students. *International Journal of Instruction*, *14*(3). https://doi.org/10.29333/iji.2021.14311a