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Advancing Cooperative Learning Pedagogy in Science Classrooms: Challenges and Possible Solutions

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ABSTRACT

Cooperative learning pedagogy is beneficial among student hence, its adoption for teaching and learning at all levels of education. The concept of cooperative learning pedagogy appears to immerse students and teachers into classroom activities thereby making them active participants during the teaching and learning process. However, cooperative learning faces some challenges that hinders its effective execution in the classroom. These challenges also prevent students and teachers from enjoying the full gains of using cooperative learning pedagogy. This conceptual paper probe into the possible ways of alleviating the challenges faced by cooperative learning pedagogy. We locate the argument within brain-based theoretical framework to discuss the means of executing cooperative learning in the classrooms. Based on this argument, the study proposes possible solutions that include fostering peaceful coexistence among students and teachers, encouraging a call to duty among students, maintaining classroom synergy and learning how to learn among students. The investigation conclude that cooperation should be encouraged among students through the maintenance of a threat free classroom environment. The study recommends that science curriculum developers and planners should encourage peaceful coexistence among students and teachers irrespective of their different backgrounds so as to maximize the achievement of classroom goals and objectives enshrined in positive interaction among students and teachers.

KEYWORDS

Brain-based theory; challenges; cooperative learning pedagogy; science classroom; solutions.

INTRODUCTION

This paper argues extensively the strength of cooperative learning pedagogy in the classroom, along with the theoretical framework of brain-based learning and its relevance. To focus the description, we address a question: what are the possible ways in which cooperative learning pedagogy could be executed towards students' success in the classroom? The integration of cooperative learning appears to be effective among students and thereby adopted in many schools to ensure active participation of students during teaching and learning in the classroom. The degree of adoption of cooperative learning transverses not only the primary and secondary schools but its use is also popular in the tertiary level of education. This revelation perhaps explains the argument of Prastyo and Sansisca (2013) that "cooperative learning can be used at all age levels from kindergarten to university" (p. 444). This implies that the working together of two or more students with the same goal in mind can generate better achievement and result for classroom teaching. The result of their action, which is targeted towards achieving specific learning outcome is called cooperative learning and this can take place among students from different fields of study, between teachers and instructors or even among the students themselves. There are several perspectives to cooperative learning, among which is the focus on five elements: positive interdependence, individual and group accountability, promotive interaction, interpersonal and small group skills, and group processing (Ghaith, 2018; Ibrahim & Ibrahim, 2017; Johnson et al., 2008; Lange et al., 2016). Positive interdependence provides incentives for students irrespective of their level of education, to work as a team and to succeed together. By this, cooperative learning tends to reduce the struggle for competition that exist among students with the goal of ensuring that all students benefit from classroom situation. Individual and group accountability provides for individuals to give stewardship of their activities through rubrics, teacher observations and peer evaluation.

This idea is not only limited to learning but also to teaching, because accountability is usually sought in terms of the lesson. Lesson evaluation involves all the stakeholders who contribute and are also evaluated during and after completing teaching (teacher and students). This means to say that "cooperative learning is more than just a bag of tricks to make teaching run more smoothly, but it is a different way of conceiving teaching" (Prastyo & Sansisca, 2013, p. 444). It involves interaction among students to work together to accomplish shared goals. Buchs et al. (2017) define "cooperative learning as an instructional method that allows students to work in structured groups" (p. 1). According to Singh and Agrawal (2011), cooperative learning emphasizes the importance of cooperation as against competition, which this present educational system seems to encourage. That is, cooperative learning seems to ensure the overall advancement of students through positive interactions and cooperation in order to achieve common task. This argument calls attention to the opinion of Singh and Agrawal (2011) that "how students perceive each other and interact with one another is a neglected aspect of instruction" (p. 2). Cooperative learning thus encourages meaningful cooperation among learners that is devoid of conflict but is imbibed within social coexistence.

Cooperative learning pedagogy represents a turning point from the traditional classroom which seems to be competitive most of the time with students working independently. Students stay in continual competition for grades, praise and recognition from one another (Singh & Agrawal, 2011). In the same way, Felder and Brent (2007) views "cooperative learning as an approach to group work that minimizes the occurrence of unpleasant situation and maximises the learning and satisfaction that results from working in a high-performance team" (p. 1).

According to Johnson and Johnson (2002), cooperative learning is a pedagogical practice that has attracted much attention over three decades because of the large results which indicate that student's gain both academically and socially when they have the privilege to relate and share goals. This means that the positive effect of using cooperative learning in schools outnumbered its negative effect. The positive results recorded from the research carried out in virtually all over the world, using different methodologies, attest that the effective execution of cooperative learning is crucial to the achievement of classroom goals (Chang & Brickman, 2018; Elola & Oskoz, 2010; Hung, 2019; Hung et al., 2018; Mahmoud, 2014; Ning & Hornby, 2014). The positive effects of using cooperative learning include knowledge development and retention of information, students' motivation for learning, undergraduate needs for cognition, building students self-confidence, making students learn easily and stress free, and also making students active participants in the classroom. This means to say that cooperative learning fashion a new method different from the traditional lecture method because it keeps learners active in the classroom. Moges (2019) also assert that cooperative learning pedagogy is often recognised as learner centered having emerged in opposition to the more traditional methods. It is believed that when cooperative learning is effectively used by teachers or instructors to create an affective learning classroom, it is usually referred to as a learner centered approach (Moges, 2019).

As good as cooperative learning pedagogy appears to be widely executed among different levels of education (primary, secondary, tertiary) globally (Ghufron & Ermawati, 2018; Gillies, 2008; Gillies & Boyles, 2010; Johnson et al., 2014; Kelly, 2019; Siciliano, 2001; Slavin, 2014), there are still some challenges that prevent its effective implementation among students. Cooperative learning has its identified challenges along some limitations that constitute its inadequate execution in the classroom. Teachers negative believe regarding learning and instruction strategies (Ruys et al., 2010), teachers' difficulty in implementing cooperative learning (Buchs et al., 2017), unequal mental/cognitive ability among students, complains about weak or unassertive students about being ignored during session and the building of resentment towards some members who fail to meet up with standards (Felder & Brent, 2007), are some of the challenges faced by cooperative learning implementation. Anderson (2019) also identified "differentiation in large mind ability classes, preventing certain learners from dominating in group work and encouraging communication when examination is knowledge focussed, as some of the challenges facing the implementation of cooperative learning" (p. 5). Race and Powell (2000) observed "a decline in the use of cooperative learning in mathematics and science

instruction" from grades 3-8 and this similar situation was recorded by Gillies (2003) among teacher group practices in Australia. These challenges may be due to the inadequate understanding on how to use cooperative learning in science classes at any level of education. With all these mentioned, a high tensioned environment coupled with the spirit of unhealthy competition in classroom prevents cooperation among students and also hinders the realization of classroom goals and objectives.

Therefore, it is important to understand what could be responsible for such challenges in the process of implementing cooperative leaning pedagogy in classroom. Among the reasons as reflected in the literature are: students socializing than working and time management issues (Gillies & Boyles, 2010), evaluating performance in cooperating learners and alignment with official curriculum (Buchs et al., 2017), unequal mental ability/cognitive level (Felder & Brent, 2007), more active participation from the teacher and students and difficulty in management (Ghufron & Ermawati, 2018). These challenges may also be caused by the relative threat that students meet in the classroom as a result of unhealthy competition which the traditional teaching pedagogy has introduced into the classroom. The active participation of high achieving learners can instil fear of being embarrassed into the low achieving learners while sharing thoughts and opinions in the classroom. This may result in low self-esteem and further affect students' achievement in the classroom negatively. The resultant effect is not limited to poor achievement alone, but it can encourage disaffection and unhealthy competition among learners in the classroom. This can hinder the peaceful coexistence of learners and also encourage the formation of social vices that are considered threat to classroom development (Moges, 2019). In order to understand cooperative learning pedagogy, the important height occupied by brain-based theory cannot be over-emphasized.

Cooperative Learning within the Framework of Brain-based Theory

We adopted brain-based theory as a theoretical framework to understand the sociality that is peculiar to cooperative learning pedagogy. Recent research in brain-based teaching focus on a holistic view of the brain, which is considered as a social organ (Cozolino, 2011), and how it is designed to learn. Brain-based theory stem out from the study of neuroscience which looks into how the brain gathers, process and retain information (Caine & Caine, 1994). That is, brain-based learning is concerned with learning with the brain in mind (Jensen, 2000). The adoption of brain-based theory is considered apt because it considers the uniqueness of every student's brain during learning. The goal of every teaching and learning situation is for meaningful learning to take place. This is the goal brain-based education intends to achieve because it emphasizes the realization of meaningful learning while taking the brain's function into consideration.

Research from neuroscience has revealed that incorporating intense emotions associated with celebration, competition or drama can enhance memory in learning (Jensen, 2000). That is, the adoption of the processes and principles of brain-based learning can assist in the

construction of new knowledge and ideas while maintaining peaceful coexistence among the students in their cooperating groups. This is more so because brain-based theory takes adequate consideration of all students irrespective of their cognitive levels. Brain-based education emphasizes how the brain learns naturally and it is based on the structure and function of the human brain at vary stage of development (Froshcl & Sprung, 2005). Hjorth et al. (2005) opine that "constructivism is closely related to brain-based theory because it is also based on the premise that learning is the result of mental construction" (p. 2). This argument was supported by Gonzalez (2017) that "knowing how the brain works best allows educators to create an environment that gives students a higher probability of success in learning" (p. 1). That is, the theory supports that meaningful learning is best achieved in a positive serene environment where students are free from threats and fears. By implication, students must feel physically and emotionally safe among their peers and with their teachers for them to learn meaningfully.

Relating this to classroom practices, this framework suggests that classroom activities, which incorporate and promotes a threat free environment, motivate and stimulate critical thinking and the development of the brain. Brain-based learning suggest that for teaching and learning to achieve its objectives, understanding how the brain learns is crucial. That is, immersing students into a serene environment devoid of threat, fear and rancour can guarantee meaning learning in the classroom (Caine & Caine, 2005). By doing this, better cooperation enshrined in mutual respects for group members can be achieved through positive interactions. With this, it can be said that the use of brain-based principles has the potential to agree with the assumptions of cooperative learning pedagogy.

This theory is important to unpack the challenges of cooperative learning pedagogy among students and teachers because it places value on the different learning styles and background of the students with the motive of promoting cooperation in order to achieve collective goals. We argue that the description of case studies, discussion of issues and debate brings about positive engagement among students thus providing the space for better cooperation because learning engages the entire philosophy of students (Hjorth et al., 2005). We also argue that developing new perspectives, understanding and sharing of multi-perspectives and realities in classroom will make learning meaningful and permanent.

The Applicability of Cooperative Learning

Palmer et al. (2019) argue that cooperative learning pedagogy enables students to acquire critical thinking skills because it creates a situation in which students explains and discuses from different perspectives. It helps to clarify concepts and ideas through interactions, discussion and debates. This interaction and cooperation of students in the classroom can only occur in an environment that is free from threat and fear (Caine and Caine, 2005). Slavin (2013) argue that cooperative learning pedagogy has positive effect than other instructional practices on primary and secondary mathematics and reading. Slavin (2014) also found out that science teaching

method focus on enhancing teachers' instruction such as cooperative learning. This buttress the fact that cooperation in the classroom allows students to be actively involved in sharing ideas and work cooperatively to complete academic task. This can only occur in a classroom environment that is free from fear and threats and also allows students to freely express themselves in the classroom.

Cooperative learning pedagogy promotes positive interdependence, promotive interaction and individual accountability because the success of one student is dependent on the success of the other students (Johnson et al., 2008). Moges (2019) argued that cooperative learning is an active pedagogical tool that have been found effective in a broad range of subjects because it is often recognised as learner centered, having emerged in opposition to the more traditional methods. This buttresses the role active engagement and interaction plays to enhance students' achievement in the classroom. Cooperative learning enhances students' performance (Yamarik, 2007), engagement (Herrmann, 2013), interaction (Gillies, 2016) and the need for cognition (Castle, 2014). The adequate implementation of cooperative learning pedagogy faces a level of challenge because teachers need to maintain a serene classroom environment for students to relate, interact and cooperate with one another before the gains of using cooperative learning can be fully attained. Teachers must therefore maintain a peaceful coexistence that will allow positive engagement and interaction among students in the classroom. Also, teachers should encourage the enhancement of a sense of responsibility and promote cooperation among students in order to achieve the benefits of cooperative learning.

Zakaria and Iksan (2007) argue that cooperative learning is grounded in the belief that learning is most effective when students are actively involved in sharing ideas and work cooperatively to complete academic task. From such cooperation and interactions, peaceful coexistence enshrined in a serene classroom environment which places high sense of responsibility and synergy is promoted among students and teachers. This reveal that the use of cooperative learning encourages active participation in the classroom irrespective of student's background, perspectives and ideas. Effandi (2005) argue that cooperative learning represents a shift in educational paradigm because it creates more opportunities for students to engage in problems solving. When students engage in classroom activities, it encourages the development of critical skills because students discuss from different perspectives to attain better understanding in the classroom. When students interact and cooperate in a classroom environment free from fear and threats, students are motivated to perform better in the classroom. This study therefore has the objective of exploring the possible ways to execute cooperative learning pedagogy in the classroom towards student's success.

Research Question

Having discussed extensively the strength of cooperative learning pedagogy in the classroom, along with the theoretical framework of brain-based learning and its relevance, we ask the

question: what are the possible ways in which cooperative learning pedagogy could be executed towards students' success in the classroom?

According to Gilson and Goldberg (2015), a conceptual paper focus on integrating and proposing new relationships among constructs by developing logical and complete arguments for associations rather than testing data empirically. To adequately answer the research question, the theoretical framework adopted for this study was relied upon to provide possible solutions to the challenges of cooperative learning pedagogy. The assumptions of brain-based theory were used to generate possible solutions to the identified challenges of cooperative learning pedagogy. We consider this appropriate from the recommendation of Caine and Caine (1994) that brain-based theory can be used to enhance any instructional methods because it alleviates the short comings in the different instructional methods. Relying on this theory, we highlight the following as possible solutions: fostering peaceful coexistence among students and teachers, encouraging a sense of call to duty among students, promoting synergy in classrooms and students learning how to learn. We also used literature to buttress the solutions that were proposed from the theoretical frameworks. This is because literature review can be used to validate the proposed solutions to the identified problems of cooperative learning pedagogy.

ANALYSING THE SOLUTIONS

Based on the above exploration, the following points were suggested as possible solutions to the challenges of cooperative learning pedagogy. They are; fostering peaceful coexistence among students and teachers, encouraging call to duty among students, promoting synergy in classrooms and students learning how to learn.

Fostering peaceful coexistence among students and teachers

The place of fostering peaceful coexistence among students and even teachers cannot be overemphasized. This is because peaceful coexistence has been seen as a major means to achieving cooperation among students in the classroom (Stahl, 1994). The classroom is usually made up of students from different backgrounds, ranging from gender, belief, race, ethnic group, greater comprehension of the content and skills (Johnson et al., 2008; Slavin, 1991; Stahl & Vansickle, 1992), and the only means to guarantee success is through the achievement of a peaceful coexistence devoid of fear and threats. Research has shown that cooperative learning builds diversity awareness among students because it encourages students to use their differences to assist each other (Palmer et al., 2019). This is because cooperative learning offers many ways of promoting more equal participation among its members in the classroom (Prastyo & Sansica, 2013). Hence, there is the need for promoting peaceful coexistence among students to ensure the execution of cooperative learning pedagogy. This is, cooperative learning accords importance to cooperation as against the traditional classroom that encourages competition in the classroom (Singh & Agrawal, 2011). This is also in agreement with Tripathy (2004) that cooperative learning assists in creating a non-threatening environment for students to learn

readily and take academic risk. A serene environment which is devoid of fear and threat makes it easier for meaningful learning to take place (Caine & Caine, 1994; 1997; 2005). In this argument, the differences among students can be adequately converted to strengths in the classroom through the use of cooperative learning pedagogy. Felder and Brent (2007) supported the argument that cooperative learning assist in minimizing the occurrence of unpleasant situation in the classroom. That is, it encourages the formation and exhibition of better social skills and higher self-esteem among the students (Springer et al., 1999). This in turn would bring out peaceful coexistence and a serene environment for teaching and learning to take place. Not only does it encourage good social skill among students, it also supports students to develop positive attitude about their educational experience, subject area and the school community (Johnson et al., 1998).

Apart from the fact that cooperative learning fosters peaceful coexistence among students, it also makes students gain both academically and socially when they interact (Johnson & Johnson, 2002). That is, when students interact with one another, students learn better because "social interaction plays a major role in the way students learn" (Gillies 2003, p. 37). From the literature above, one could argue that promoting good social interactions among students is proportional to fostering peaceful coexistence in the classroom. This provides leverage for the proper implementation of cooperative learning pedagogy in the classroom. We therefore argue that promoting peaceful coexistence in the classroom supports cooperative learning pedagogy because it promotes simultaneous interactions (Prastyo & Sansisca, 2013) in the classroom.

Encouraging a sense of call to duty among students

In this study, call to duty means being responsible to oneself, one another and one's society. The school environment in this case is a subset of the larger society hence, when students have a sense of duty to one another, the resultant positive effect is usually felt in the school and in the larger environment. Despite the fact that the classroom is made up of different personalities, the need to encourage individual accountability is of essence (Prastyo & Sansisca, 2013). The classroom consists of different students, but to Stahl (1994), "the goal of cooperative learning is for all students to achieve higher academic success individually than when they study alone" (p. 6). This brings about a sense of responsibility to each of the group members when enjoying cooperation from one another. According to McBrien and Brandt (1997), cooperative learning was used to improve students' attendance in the classroom. This is so because students felt a sense of duty and value in the cooperating group, they found themselves. That is, cooperation among students makes them have a feeling of responsibility because each member has a mastery of their task individually and in the group (Prastyo & Sansisca, 2013). Not only has cooperative learning placed a sense of individual accountability into the students, but it has also placed value on cooperation (Prastyo & Sansisca, 2013). Cooperative learning takes the feeling of all for one and one for all as its watchword. This confirms that students see every task and

assignment as a collective responsibility that must be achieved by all. The collective interest of students therefore supersedes individual interest, which is most time competitive in nature (Singh & Agrawal, 2011). The argument of Singh and Agrawal (2011) indicated that positive interdependence influences students' performance. That suggest that, when students effectively cooperate with one another, it calls the individual students to a high sense of duty.

According to Prastyo and Sansisca (2013), the principle of positive interdependence lies at the heart of cooperative learning. It is believed that any challenge experienced by students in a cooperating leaning group becomes a challenge for all other students in the group. Johnson and Johnson (1999) argue that "positive interdependence is the perception that students are linked with others in a way so that a student cannot succeed unless other succeeds". This promotes a sense of call to duty in the students because the failure or success of one determines the fate of others. Therefore, we argue that introducing a sense of call of duty to students at any level of education will enhance cooperative learning pedagogy.

Promoting Classroom Synergy

Students' capacity to interact and relate with one another is important and crucial to cooperative learning pedagogy. The heterogenous forming of groups and the subsequent successful implementation of cooperative learning pedagogy creates and promotes synergy among students. Slavin (1991) argue that cooperative learning methods can be easily used with students with special needs thus, it further buttresses the flexible nature of cooperative learning pedagogy. That is, cooperative learning tends to create a synergy for success among the students irrespective of their heterogenous composition such as sex, ethnicity, social class and religion to mention a few. Singh and Agrawal (2011) therefore argue that individuals benefit the most from working with different people. When students show synergy on issues that concerns teaching and learning, they exhibit the features of adopting cooperative pedagogy. Based on literature, we argue that students having synergy is crucial to the implementation of cooperative learning. Having established this fact, students must be encouraged to create a level of agreement on classroom task. Such a process can promote good working relationships among students, thus, enhance cooperative learning pedagogy. Literature also has it that synergy among students can enhance their collaborative skills (Prastyo & Sansisca, 2013). When students cooperate or collaborate, they tend to learn collaboration skills which are essential for use in cooperative learning pedagogy. Singh and Agrawal (2011) argue that cooperative learning foster a collaborate atmosphere as opposed to a competitive environment. We therefore argue that the development of appropriate collaborative skills (Johnson et al., 2008) encourage students to develop social virtues that can encourage the formation of synergy when cooperative learning is used in the classroom.

Students Learning How to Learn

This has to do with the development of the skills of learning how to learn. This means that the integration of cooperative learning encourages students to be more responsible for their learning rather than depend solely on the teachers. It equips students with the skills of understanding more about how they can excel at classroom task with little or no guidance. According to Prastyo and Sansisca (2013), the principle of cooperative learning encourages group autonomy because it places more work on the students themselves rather than their teachers. By doing this, students learn how to engage and trust themselves more without putting unnecessary pressure on the teachers. We argue that when students learn from each other, they learn how to learn, cooperate and collaborate more with each other to find solutions to identified problems that may arise during the course of learning. When this happens, cooperation learning pedagogy is better put into practice because it requires a high level of cooperation and understanding among the students. The argument of Singh and Agrawal (2011) that any assignment in any curriculum for any age can be done cooperatively. This places more responsibilities on the students, and it changes the role of the teacher to a facilitator. Literature has it that teacher's role becomes that of a facilitator who monitors cooperating groups in action (Johnson et al., 2008; Sharan 2010; Topping et al., 2017). This is considered an advantage because the adoption of cooperative learning assist students to develop the skills of learning how to learn better.

Another achievement that comes with the integration of cooperative learning is the development of the skill of learning how to learn because it encourages positive interdependence (Felder & Brent, 2007; Prastyo & Sansisca, 2013; Singh and Agrawal, 2011). Stahl (1994) argue that the believe that students have or makes by depending on one another further improves their interdependence positively. This implies that students develop the skill of learning how to learn to guarantee success at tasks. Prastyo and Sansisca (2013) also argue that positive interdependence makes students to support each other. This means that the skill of one student can be positively channelled to improve the skills of another. By doing this, students learn how to learn because they are obliged to rely on one another to achieve group goals. When students do this, they cooperate with each other giving room for what is referred to as cooperative learning pedagogy. We therefore argue that the adoption of cooperative learning pedagogy has the capacity to make students develop the skill of learning how to learn thus, reducing the already cumbersome duties on classroom teachers. The adoption of the use of cooperative learning is seen as an advantage because students cooperate with one another to improve their grades.

CONCLUSION AND RECOMMENDATIONS

The use of cooperative learning pedagogy in classroom is good especially because it can be used across any age group for teaching and learning. As good as it appears to be, it's execution in the classroom still face some challenges. Based on literature, challenges such as unequal

mental/cognitive ability among students, relative threat experienced in the classroom, complain about weak students and students having resentment for each other still exist. Again, literature also revealed that cooperative learning pedagogy is crucial to the realization of classroom goals and objectives because it foster productivity in a threat free and fear free environment among the students and the teachers. Based on this, the study concludes that fostering peaceful coexistence among students and teachers, encouraging a sense of call to duty among students, promoting classroom synergy and the development of the skill of learning how to learn, are elements that can be used to advance cooperative learning pedagogy in classrooms. Based on these solutions that have been identified, the study considered the following as recommendations.

- Science curriculum developers, curriculum planners and other relevant educational agencies should ensure that peaceful coexistence among students and teachers are encouraged and executed during teaching and learning in the classroom. Doing this would create an ambient and threat free environment that would facilitate improved cooperation among the students. This would go a long way in ensuring positive togetherness and would also enhance the performance of students in the classroom because more cooperation guarantees peaceful coexistence. Cooperative learning supports positive coexistence because it assists to guarantee better cooperation that variably improves students' performance in the classroom.
- Science curriculum developers, curriculum planners and other relevant educational agencies should ensure and encourage the implantation of a sense of call to duty into the teaching learning process. When students feel a sense of duty, it allows them to cooperative better to achieve classroom objectives during teaching and learning.
- Science curriculum developers and planners should ensure synergy among students so as to bring out the best in them. When students synergize on classroom task, it allows them to succeed easily during teaching and learning which have a positive resultant effect on the performance in the classroom. Cooperative learning encourages learners to build positive synergy with each other when interacting in the classroom environment.
- Learning how to learn is another feature that science curriculum developers and planners should encourage in students during teaching and learning in science classrooms. This is important to promote the development of inquiry skills in the students. The development of critical skills among students is paramount to science teaching to guarantee improvement in performance. Cooperative learning pedagogy encourages the building of skills learning and formation because it enhances the performance of students in the classroom.

REFERENCES

Anderson, J. (2019). Cooperative learning: Principles and practice, *Main Feature*, *121*, 4-6.

Buchs, C., Filippoua, D., Pulfreyb, C., & Volpé, Y. (2017). Challenges for cooperative learning implementation: Reports from elementary school teachers. *Journal of Education for Teaching*, *43*(3), 296-306. https://doi.org/10.1080/02607476.2017.1321673

Caine, G., & Caine R. N. (1994). *Making connections*: *Teaching and the human brain*. Association for Supervision and Curriculum Development.

Caine, G., & Caine R. N. (1997). *Education on the edge of possibility*. Association for Supervision and Curriculum Development.

Caine, R. N., & Caine, G. (2005). *12 Brain/mind natural learning principles*. https://www.education.sa.gov.au/sites/default/files/12_brain_mind_natural_learning_principles.pdf?acsf_files_redirect

Castle, T. D. (2014). *The impact of cooperative learning on the development of need for cognition among first-year college students*. [Doctoral thesis, University of Iowa]. https://doi.org/10.17077/etd.8j7n5q43

Chang, Y., & Brickman, P. (2018). When group work doesn't work: Insights from students. *CBE-Life Sciences Education*, *17*(3), 1-17. https://doi.org/10.1187/cbe.17-09-0199

Cozolino, L. (2011). *The brain is a social organ*. https://www.futurelearn.com/info/courses/educational-neuroscience/0/steps/112082

Effandi, Z. (2005). *Asas Pembelajaran Koperatif Dalam Matematik.* [*Basic learning cooperation maths*]. Shah Alam Karisma Publications Sdn Bhd.

Elola, I., & Oskoz, A. (2010). Collaborative writing: Fostering foreign language and writing conventions development. *Language Learning and Technology, 14*(3), 51–71. https://scholarspace.manoa.hawaii.edu/bitstream/10125/44226/1/14_03_elolaoskoz.pdf

Felder, R. M., & Brent, R. (2007). *Cooperative learning*. *In P. A. Mabrouk (Ed.) Active learning: Models from the analytical sciences*. American Chemical Society. https://www.engr.ncsu.edu/wp-content/uploads/drive/1PLmbl9qPHpwYV7GFqUgWTHm5YNDzHV8V/2007-CLChapter.pdf

Froschl, M., & Sprung, B. (2005). *Raising and educating healthy boys: A report on the growing crisis in boys' education*. Educational Equity Center at The Academy for Educational Development.

Ghaith, G. M. (2018). Teacher perceptions of the challenges of implementing concrete and conceptual cooperative learning. *Issues in Educational Research, 28*(2), 385-404. http://www.iier.org.au/iier28/ghaith.pdf

Ghufron, M. A., & Ermawati, S. (2018). The strengths and weaknesses of cooperative learning and problem-based learning in EFL writing class: Teachers and students' perspectives.

International Journal of Instruction, 11(4), 657-672. https://files.eric.ed.gov/fulltext/EJ1191701.pdf

Gillies, R. M. (2003). Structuring cooperative group work in classrooms. *International Journal of Educational Research, 39*(1-2), 35-49. *https://doi.org/10.1016/S0883-0355(03)00072-7*

Gillies, R. M. (2008). The effects of cooperative learning on junior high school students' behaviours, discourse and learning during a science-based learning activity. *School Psychology International, 29*(3), 328–347. https://doi.org/10.1177%2F0143034308093673

Gillies, R. M. (2016). Cooperative learning: Review of research and practice. *Australian Journal of Teacher Education, 41*(3), 38-54. http://dx.doi.org/10.14221/ajte.2016v41n3.3

Gillies, R. M., & Boyle, M. (2010). Teachers' reflections on cooperative learning: Issues of implementation. *Teaching and Teacher Education, 26*(4), 933–940. https://doi.org/10.1016/j.tate.2009.10.034

Gilson, L. L., & Goldberg, C. B. (2015). Editors' comment: So, what is a conceptual paper? *Group and Organization Management, 40*(2), 127-130. http://dx.doi.org/10.1177/1059601115576425

Gonzalez, C. (2017, September 14). *The power of the brain*. Featured Articles.

Herrmann, K. J. (2013). The impact of cooperative learning on students' engagement: Results from an intervention. *Active Learning in Higher Education, 14*(3), 175-187. https://doi.org/10.1177%2F1469787413498035

Hjorth, L., Eichler, B., Morello, J., Khan, A. S. (2005). *Brain-based and constructivist strategies for teaching a "Science, Technology, and Society (STS)" course*. Proceedings of the American Society for Engineering Education Annual Conference & Exposition.

Hung, B. P. (2019). Impacts of cooperative learning: A qualitative study with EFL students and teachers in Vietnamese colleges. *Issues in Educational Research, 29*(4), 1223-1240. http://www.iier.org.au/iier29/hung.pdf

Hung, B. P., Vien, T., & Vu, N. N. (2018). Applying cognitive linguistics to teaching English prepositions: A quasi-experimental study. *International Journal of Instruction, 11*(3), 327-346. https://doi.org/10.12973/iji.2018.11323a

Ibrahim, M. K., & Ibrahim, Y. A. (2017). Communicative english language teaching in Egypt: Classroom practice and challenges. *Issues in Educational Research, 27*(2), 285-313. http://www.iier.org.au/iier27/ibrahim.pdf

Jensen, E. (2000). Brain- based learning: A reality check. *Educational Leadership, 2*, 76- 80.

Johnson, D. W., Johnson, R. T., & Smith, K. A. (1998). *Active learning: Cooperation in the college classroom* (2nd ed.). Interaction Book Company.

Johnson, D. W., & Johnson, R. T. (1999). Making cooperative learning work. *Theory Into Practice, 38*(2), 67-73. https://doi.org/10.1080/00405849909543834

Johnson, D. W., & Johnson, R. T. (2002). Learning together and alone: Overview and meta-analysis. *Asia Pacific Journal of Education*, *22*(1), 95-105. https://doi.org/10.1080/0218879020220110

Johnson, D. W., Johnson, R. T., & Holubec, E. (2008). *Cooperation in the classroom* (8th ed.) Interaction Book Company

Johnson, D. W., Johnson, R. T., Roseth, C., & Shin, T. S. (2014). The relationship between motivation and achievement in interdependent situations. *Journal of Applied Social Psychology, 44*(9), 622-633. https://doi.org/10.1111/jasp.12280

Kelly, M. (2019, February 01). *Cooperative Learning Versus Traditional Learning for Group Activities*. ThoughtCo. https://www.thoughtco.com/cooperative-learning-for-group-activities-7749

Lange, C., Costley, J., & Han, S. L. (2016). Informal cooperative learning in small groups: The effect of scaffolding on participation. *Issues in Educational Research, 26*(2), 260-279. http://www.iier.org.au/iier26/lange.pdf

Mahmoud, M. M. A. (2014). The effectiveness of using the cooperative language learning approach to enhance EFL writing skills among Saudi university students. *Journal of Language Teaching and Research, 5*(3), 616–625. https://doi.org/10.4304/jltr.5.3.616-625

McBrien, J. L., & Brandt, R. S. (1997). *The language of learning: A guide to education terms.* Association for Supervision and Curriculum Development.

Moges, B. (2019). Practises and challenges of cooperative learning in selected college of Arsi university: As a motivational factor on enhancing students' learning. *Universal Journal of Psychology, 7*(1), 1-17. https://doi.org/10.13189/ujp.2019.070101

Ning, H., & Hornby, G. (2014). Impact of cooperative learning on tertiary EFL learners' motivation. *Educational Review, 66*(1), 108-124. https://doi.org/10.1080/00131911.2013.853169

Palmer, G., Peters, R., & Streetman, R. (2019, September 26). *Cooperative Learning. In P. Lombardi (ed.). Instructional Methods, Strategies, Math and Technology to Meet the Needs of all Learners*. Granite State College. https://granite.pressbooks.pub/teachingdiverselearners/chapter/cooperative-learning-2/

Prastyo, A. Y. D., & Sansisca, B. F. D. (2013). *Cooperative learning: Theories, principles, and techniques*. *International Conference on Education and Language*. http://artikel.ubl.ac.id/index.php/icel/article/view/235/235

Race, K. E. H., & Powell, K. R. (2000). Assessing students' perceptions of classroom methods and activities in the context of outcomes-based evaluation. *Evaluation Review, 24*(6), 635-646. https://doi.org/10.1177%2F0193841X0002400604

Ruys, I., Keer, H. V., & Aelterman, A. (2010). Collaborative learning in pre-service teacher education: An exploratory study on related conceptions, self-efficacy and

implementation. *Educational Studies, 36*(5), 537–553. https://doi.org/10.1080/03055691003729021

Siciliano, J. I. (2001). How to incorporate cooperative learning principles in the classroom: It's more than just putting students in teams. *Journal of Management Education, 25*(1), 8-20. https://doi.org/10.1177%2F105256290102500103

Sharan, Y. (2010). Cooperative learning for academic and social gains: Valued pedagogy, problematic practice. *European Journal of Education, 45*(2), 300–313. https://www.jstor.org/stable/pdf/40664666.pdf

Singh, Y. P., & Agrawal, A. (2011). Introduction to co-operative learning. *Indian Streams Research Journal, 1*(2), 1-9. http://oldisrj.lbp.world/ViewPDF.aspx?ArticleID=3824

Slavin, R. E. (1991). Synthesis of research on cooperative learning. *Educational Leadership, 45*(5), 91-82. https://files.ascd.org/staticfiles/ascd/pdf/journals/ed_lead/el_199102_slavin.pdf

Slavin, R. E. (2013). Effective programmes in reading and mathematics: Evidence from the best evidence encyclopaedia. *School Effectiveness and School Improvement*, *24*(4), 383-391. https://doi.org/10.1080/09243453.2013.797913

Slavin, R. E. (2014, October 01). *Making cooperative learning powerful*. ASCD. http://www.ascd.org/publications/educational-leadership/oct14/vol72/num02/Making-Cooperative-Learning-Powerful.aspx

Springer, L., Stanne, M. E., & Donovan, S. S. (1999). Effects of small group learning on undergraduates in science, mathematics, engineering and technology: A meta-analysis. *Review of Educational Research, 69*(1), 21–51. https://doi.org/10.3102%2F00346543069001021

Stahl, R. J. (1994). *The essential elements of cooperative learning in the classroom*. Educational Resources Information Center Digest. https://files.eric.ed.gov/fulltext/ED370881.pdf

Stahl, R. J., & VanSickle, R. L. (1992). *Cooperative learning in the social studies classroom: an invitation to social study*. National Council for the Social Studies. https://files.eric.ed.gov/fulltext/ED361243.pdf

Topping, K. J., Buchs, C., Duran, D., & Keer, H. V. (2017, March 27). *Effective Peer Learning*: *From Principles to Practical Implementation*. Routledge.

Tripathy, H. H. (2004). Cooperative learning: A strategy for teaching science. *Indian Journal of Psychometry and Education, 35*(1), 3-8.

Yamarik, S. (2007). Does cooperative learning improve student learning outcomes? *The Journal of Economic Education, 38*(3), 259-277. https://www.jstor.org/stable/pdf/30042780.pdf

Zakaria, E., & Iksan, Z. (2007). Promoting Cooperative Learning in Science and Mathematics Education: A Malaysian Perspective. *Eurasia Journal of Mathematics, Science & Technology Education, 3*(1), 35-39. https://doi.org/10.12973/ejmste/75372