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Effectiveness of Collaborative Learning Strategies in Improving the Performance of Grade 6 Learners in Math

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ABSTRACT

The study evaluates the effectiveness of collaborative learning strategies in improving the performance of grade 6 learners in Mathematics. quasi-experimental research design utilizing the pre-test and post-test assessments to evaluate the effectiveness of collaborative learning strategies in improving the performance of grade 6 learners in Mathematics. Albuera North Central School, Albuera North District, Leyte Division and the twenty-nine (29) Grade 6 learners identified as struggling in Math for the school year 2024-2025 were the subjects of the study. Research instruments included a researcher-made Math test aligned with the 1st quarter Most Essential Learning Competencies (MELCs), administered before and after the implementation of collaborative learning strategies. Moreover, lesson plans were developed which shows collaborative learning strategies in teaching Math. The researcher will formulate activities of which the learners will organize themselves in small groups to answer the problems posed in the lesson. After the group work, the teacher will encourage the members of the group to present their outputs showing the solution on how they arrive at the correct answer. Further, the teacher will encourage the learners to speak and discuss the process of solving the problems. This framework will be incorporated in the lesson plans formulated. Based on the data presented, it was revealed a significant difference in the pre-test and post-test performances of grade 6 learners in Math before and after the integration of collaborative learning strategies in teaching and learning. The dramatic improvement in scores indicates that collaborative learning not only enhances students' understanding of mathematical concepts but also fosters engagement and motivation in the learning process. Hence, educators are encouraged to continue implementing and refining collaborative learning strategies to further enhance student learning in Math and potentially in other subject areas as well.

Keywords — Effectiveness, Collaborative Learning Strategies, Performance, Grade 6 Learners, Math

I. INTRODUCTION

Mathematics is one of the learning areas that must be taught at every level of education, especially in elementary school. Mastery of the mathematics concepts for every grade level is needed. Because mathematics subjects can equip learners with the ability to think logically, analytically, systematically, critically, and creatively and the ability to cooperate among groups. To achieve the desired mastery of the mathematics concepts, teachers were innovative in formulating and producing relevant learning activities which will guide the learners in achieving such goals.

Mathematics plays a significant part in promoting logical thinking, enhances critical thinking and develops problem-solving abilities in students. It describes various numbers and shapes systems (Ma, 2009). Mathematics is a sequential subject where the students learn in sequence i.e., previous learning provides a base for learning new concepts and skills (Mulligan, Mitchelmore, & Crevensten, 2013). It means that to learn how to multiply, one should already have learnt how to add two numbers. Similarly, to learn how to divide, subtraction provides foundations. Mathematics has always been seen as a discipline that sharpens the intellect including systematic, logical and precise thoughts. In the earliest years of 21st century, experts of mathematics found that it is an integral part of human life. The famous

educationalist Frobel and Montessori had the view that mental and cultural development of an individual depends on his/her study of mathematics (Yasoda, 2009). Mathematics play a predominant role in our daily lives and has become an important element in the development of our world today.

Mathematics aims at the improvement of reasoning and logical cognitive abilities that enable individuals to solve numerical and mathematical problems. Every Businessman, Banker, Medical doctor, Laborers, Vendors requires mathematical abilities to fulfill the requirements of his everyday life. Mathematical knowledge and skills are also used in different fields such as Genetics, Physics and Chemistry that calculate various formulas (Morsanyi, McCormack, & O'Mahony, 2018).

Mathematics education is a global concern, as indicated by the Programme for International Student Assessment (PISA, 2018) and low proficiency levels reported by PISA (2013) and the National Center for Education Statistics (NCES, 2013). In the Philippines, the quality of mathematics education remains low, as evidenced by National Achievement Test (NAT) scores and global rankings (Antonio, 2015). Particularly, the Philippines ranked 76th out of 140 countries in Mathematics and Science Education, while Filipino students scored significantly lower than the OECD average in Mathematical Literacy according to the 2018 PISA results (Antonio, 2015; PISA, 2018). Further, low Mathematics performance is also evident in the result of the quarterly assessment of teachers. Most of the learners scored very low especially in analyzing and evaluating word problems and other related competencies. To address these challenges, policymakers and educators prioritize improving learners' mathematics performance by integrating ICT and contextualizing learning resources (Saeed, Ahmed, & Malik, 2018). However, the lack of instructional materials, including manipulatives, poses challenges to effective teaching and learning (Antonio, 2015). Further, teacher's competencies, strategies and activities needs also to be improved for these affects the low performance of the learners in the subject. Hence, the researcher formulated this study on the effectiveness of collaborative learning strategies in teaching Math. Hoping that this strategy will address the needs of the learners to achieve positive learning outcomes. A proposed improvement plan was formulated based on the findings of the study. Likewise, it is in the rationale that the researcher who is currently a grade 6 teacher in the above mentioned local, would like to delve worthy research undertaking that will benefit herself, the school she is currently teaching and that of her Graduate Program she is enrolled at.

This study evaluates the effectiveness of collaborative learning strategies in improving the performance of grade 6 learners in Mathematics of Albuera North Central School, Albuera North District, Leyte Division for School Year 2024-2025. The findings of the study were the basis for the proposed improvement plan.

Specifically, this study sought to answer the following questions:

1. What is the performance of the grade 6 learners in Mathematics before the integration of collaborative learning strategies?
2. What is the performance of the grade 6 learners in Mathematics after the integration of collaborative learning strategies?
3. Is there a significant difference in the performances of the grade 6 learners in Mathematics before and after the integration of collaborative learning strategies?
4. What improvement plan can be proposed based on the findings of this study?

II. METHODOLOGY

Design. This study employed a quasi-experimental research design utilizing the pre-test and post-test assessments to evaluate the effectiveness of collaborative learning strategies in improving the performance of grade 6 learners in Mathematics. The research focused on assessing how this instructional strategy impacted learners learning outcomes.

Albuera North Central School, Albuera North District, Leyte Division. It was nestled along the national highway and facing the LGU rotondas in Brgy. Poblacion, Albuera, Leyte, Albuera North Central School (ANCS) stands as a pillar of educational excellence and community engagement. The school's strategic location not only ensures easy accessibility for students and staff but also positions it at the heart of the community's civic life. ANCS's sprawling campus, accommodating a large student population, is a testament to its status as a leading educational institution in the region. The study targeted twenty-nine (29) Grade 6 learners identified as struggling in Math for the school year 2024-2025, employing a complete enumeration method to select participants. Research instruments included a researcher-made Math test aligned with the 1st quarter Most Essential Learning Competencies (MELCs), administered before and after the implementation of collaborative learning strategies. Moreover, lesson plans were developed which shows collaborative learning strategies in teaching Math. The researcher will formulate activities of which the learners will organize themselves in small groups to answer the problems posed in the lesson. After the group work, the teacher will encourage the members of the group to present their outputs showing the solution on how they arrive at the correct answer. Further, the teacher will encourage the learners to speak and discuss the process of solving the problems. This framework will be incorporated in the lesson plans formulated. Parts of the plan where the teacher can input the intervention is highly recommended. Validation of tests and lesson plans by the District Math Coordinator and School Head ensured alignment with curriculum objectives. The study utilized a matrix to monitor intervention progress, emphasizing the systematic evaluation of educational strategies aimed at improving learner outcomes. This research focused on evaluating the effectiveness of collaborative learning strategies in improving the performance of grade 6 learners in Math through the pre-test and post-test and its significant difference. A Proposed Improvement Plan based on the findings of the study is the output.

Sampling. The respondents of this study were twenty-nine (29) Grade 6 learners who were struggling in Math enrolled in the above-mentioned locale for School Year 2024-2025. Complete enumeration was employed in choosing the respondents for the study.

Research Procedure. After the research approval, data gathering commenced with submission of letter requests for study approval to appropriate authorities. Initially, a letter was sent to the Schools Division Superintendent seeking approval to proceed with data collection from identified respondents. Following SDS approval, permission letters were also submitted to the Public Schools District Supervisor and School Principal. Once approvals were obtained, the researcher proceeded with data gathering activities. An orientation session was conducted for the respondents, and parental consent was obtained for their children's participation in the study. The pre-test was administered during Math period. Subsequently, a four-week intervention was implemented, focusing on teaching Math using collaborative learning strategies. Post-intervention, a post-test was conducted, and responses were collected, tabulated, and prepared for statistical analysis. A Matrix of Activities was maintained to monitor data gathering progress throughout the study.

Ethical Issues. The researcher properly secured the permission to conduct the study from the authorities through written communication. In the formulation of the intervention materials that was used in the study, the use of offensive, discriminatory, or other unacceptable language was avoided. The respondents' names and other personal data were not included in this study to protect their privacy. Participation of the respondents was also voluntary. Orientation was conducted for the respondents with their parents. In the orientation, issues and concerns were addressed and consent to be included in the study were signed. The researcher-maintained objectivity in analyzing and discussing the results. All authors whose works were mentioned in this study were properly quoted and were acknowledged in the reference.

Treatment of Data. The performance of grade 6 learners in Math before and after the utilization of collaborative learning strategies was evaluated using Simple Percentage. Additionally, the t-Test of Mean Difference was employed to assess significant differences in their performances before and after the intervention.

III. RESULTS AND DISCUSSION

Table 1
Pre-Test Performance of Grade 6 Learners in Math

Score Range	Description	PRETEST	
		Frequency	%
41-50	Excellent	0	0
31-40	Very Good	0	0
21-30	Good	5	17
11-20	Fair	15	52
1-10	Poor	9	31
Total		29	100
Weighted Mean		**13.97**	**Fair**

Table 1 presents the pre-test performance of Grade 6 learners in Math, highlighting their scores across various proficiency levels. Notably, none of the learners achieved scores classified as Excellent (41-50) or Very Good (31-40), reflecting a significant lack of high-level performance. In contrast, only 5 learners, or 17%, fell within the good range (21-30), indicating a deficiency in achieving a satisfactory level of proficiency. Most learners, comprising 52% of the sample, scored within the Fair range (11-20). This suggests a basic understanding of Math concepts; however, there remains considerable room for improvement. Additionally, a concerning 31% of students scored in the Poor range (1-10), which highlights substantial challenges in mastering fundamental math skills. Overall, with 29 Grade 6 learners assessed and a weighted mean score of 13.97, the performance is categorized as Fair. The data indicate a pressing need for educational intervention in Math for Grade 6 learners. The complete absence of students in the higher performance categories suggests systemic issues in teaching methodologies or foundational knowledge that may not have been adequately addressed in earlier grades. The high percentage of students scoring in the Fair and Poor ranges further underscores the urgency of implementing targeted support to bolster students' math skills. This implies immediate efforts to enhance instructional strategies and provide additional resources to help students develop a stronger understanding of Math concepts. Professional development for teachers may be beneficial, focusing on effective teaching techniques that cater to diverse learner needs. Additionally, the implementation of remedial programs or tutoring may assist struggling students in bridging gaps in their knowledge and improving their mathematical proficiency. By addressing these challenges proactively, educators can foster an environment where students not only improve their foundational math skills but also gain the confidence necessary for future academic success. This proactive approach will ultimately contribute to better overall educational outcomes and equip learners with essential skills for their academic journey.

Table 2
Post-Test Performance of Grade 6 Learners in Math

Score Range	Description	POST TEST	
		Frequency	%
41-50	Excellent	24	83
31-40	Very Good	5	17
21-30	Good	0	0
11-20	Fair	0	0
1-10	Poor	0	0
Total		29	100
Weighted Mean		**44.48**	**Excellent**

Table 2 illustrates the post-test performance of Grade 6 learners in Math, showing that 83% scored in the Excellent range (41-50), indicating strong mastery of Math concepts. Additionally, 17% scored in the Very Good range (31-40), reflecting solid understanding. Importantly, no learners were in the Good (13-18), Fair (7-12), or Poor (1-6) categories, highlighting a complete absence of underperforming students. With 29 learners assessed and a weighted mean score of 44.48, the overall performance is categorized as Excellent. These results emphasize the effectiveness of the collaborative learning strategies implemented post-intervention in significantly enhancing Math proficiency. The post-test outcomes reflect a significant improvement in student achievement due to collaborative learning strategies. The high percentages in the Excellent and Very Good categories indicate that these approaches successfully facilitated peer interaction and deeper engagement with the material. The lack of lower performance categories shows that all students benefited from this supportive environment. These findings suggest that educators should continue integrating collaborative learning into their teaching practices to foster an inclusive atmosphere that encourages peer learning. Additionally, educational leaders should support professional development focused on collaborative techniques, equipping teachers to effectively implement these strategies. By fostering a collaborative culture, schools can enhance academic excellence and support the holistic development of students.

Table 3
Test of Difference Between the Scores in the Pre-test and Post-test of Grade 6 Learners in Math

Aspects	Test Scores		Computed T	Critical T	Decision	Interpretation
GRADE 6 Learners in Math	Pre Post	13.97 44.48	6.634	1.824	Reject H_o	Significant

Table 3 presents the test results comparing the pre-test and post-test performances of Grade 6 learners in Math, emphasizing the statistical significance of the differences observed. The pre-test average score was 13.97, which reflects a baseline of limited understanding among the learners. In contrast, the post-test scores showed a remarkable increase to 44.48. This significant shift was analyzed using a t-Test, where the critical t-value was set at 1.824. The computed t-value of 6.634 decisively rejects the null hypothesis (Ho), confirming a statistically significant improvement in the performance of Grade 6 learners following the implementation of interventions, particularly collaborative learning strategies. The data indicates a profound enhancement in the learners' mathematical proficiency due to the implemented interventions. The dramatic increase in average scores signifies not only a mastery of concepts but also the effectiveness of collaborative learning as a pedagogical approach. This method appears to have facilitated deeper engagement, peer support, and a better understanding of mathematical principles, ultimately leading to higher academic performance. The statistical significance of the t-Test reinforces the reliability of these findings, suggesting that the educational strategies employed had a substantial and measurable impact. These findings underscore the importance of adopting innovative teaching strategies such as collaborative learning in the classroom. Educators should consider integrating similar methods into their instructional practices, as they can lead to significant improvements in student outcomes. Furthermore, school administrators should promote professional development programs focused on collaborative teaching techniques to prepare educators for successfully implementing these strategies. The results also imply the necessity for ongoing assessments to track student progress and the effectiveness of teaching methods over time, ensuring that interventions remain responsive to learner needs. By fostering a collaborative learning environment, schools can enhance academic achievement not just in Math, but across subjects, thereby contributing to a more engaged and successful student body.

IV. CONCLUSIONS

Based on the data presented, it was revealed a significant difference in the pre-test and post-test performances of grade 6 learners in Math before and after the integration of collaborative learning strategies in teaching and learning. The dramatic improvement in scores indicates that collaborative learning not only enhances students' understanding of mathematical concepts but also fosters engagement and motivation in the learning process. This finding suggests that collaborative learning strategies effectively address the challenges previously faced by learners, leading to a deeper comprehension of material and improved academic performance. The evidence supports the notion that when students work together in a structured environment, they can benefit from peer interactions, diverse perspectives, and shared problem-solving approaches, all of which contribute to a richer educational experience. Ultimately, the study underscores the importance of innovative teaching methodologies in promoting student success. As such, educators are encouraged to continue implementing and refining collaborative learning strategies to further enhance student learning in Math and potentially in other subject areas as well.

V. RECOMMENDATIONS

1. Utilize the proposed improvement plan formulated.
2. School heads should promote and support collaborative learning initiatives within the curriculum by providing resources, time, and training for teachers to implement these strategies effectively.
3. Establish systems for ongoing assessment and feedback regarding the effectiveness of collaborative learning strategies in the classroom. This will allow for data-driven adjustments to teaching methods and curriculum design.
4. Engage parents and the community in supporting collaborative learning efforts, such as organizing workshops or information sessions that highlight the benefits of collaborative approaches in education.
5. Conduct longitudinal studies to assess the long-term impacts of collaborative learning strategies on student performance and retention of mathematical concepts over time, and
6. Future researchers should develop further studies on the methods, strategies, and techniques implemented by problem-based learning school administrators and teachers to effectively meet the learning needs of the learners in mathematics.

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REFERENCES

[1] Abed, A. Z., Sameer, S. A., Kasim, M. A., & Othman, A. T. (2020). Predicting effect implementing the jigsaw strategy on the academic achievement of students in mathematics classes. International Electronic Journal of Mathematics Education, 15(1), em0558. https://doi.org/10.29333/iejme/5940

[2] Agwu, U. D., & Nmadu, J. (2023). Students' interactive engagement, academic achievement and self concept in chemistry: An evaluation of cooperative learning pedagogy. Chemistry Education Research and Practice, 24, 688-705. https://doi.org/10.1039/ d2rp00148a

[3] Ahmad, M., & Dogar, A. H. (2023). Effect of collaborative learning on conceptual understanding ability in mathematics among 5th grade neglected children. Annals of Human and Social Sciences, 4(2), 205-213. https://doi.org/10.35484/ahss.2023(4-II)19

[4] Ailaan, A. (2017). Pakistan district education rankings 2017. Alif Ailaan. https://ikddata.ilmkidunya.com/ docs/Pakistan-District-Education-Ranking-2017 by-Alif-Ailaan.pdf

[5] Akinoso, S. O., Alabi, O. M., & Agoro, A. A. (2021). Effect of station rotation mode of instructional delivery for mathematics in the era of advancing technology. Journal of International Society for Science and Engineering, 24(2), 60-72. http://isfte.org/ index.php/become-a-current-member/

[6] Alam, M. J., Haque, A. K. M. M., & Banu, A. (2021). Academic supervision for improving quality education in primary schools of Bangladesh: Concept, issues and implications. Asian Journal of Education and Social Studies, 14(4), 1-12. https://doi.org/10.9734/ajess/2021/v14i330359

[7] Alam, M. S., & Agarwal, J. (2020). Adopting a blended learning model in education: Opportunities and challenges. International Journal of Early Childhood Special Education, 12(2), 01-07. https://doi.org/10. 9756/int-jecse/v12i2.201050

[8] Almazroui, K. M. (2023). Project-based learning for 21st century skills: An overview and case study of moral education in the UAE. The Social Studies, 114(3), 125 136. https://doi.org/10.1080/00377996.2022.2134281

[9] Alsmadi, M. A., Tabieh, A. A. S., Alsaifi, R. M., & Al Nawaiseh, S. J. (2023). The effect of collaborative discussion strategy think-pair shares on developing students' skills in solving engineering mathematical problems. European Journal of Educational Research, 12(2), 1123-1135. https://doi.org/10.12973/eu-jer.12.2.1123

[10] Areelu, F., & Ladele, O. A. (2018). Adopting jigsaw instructional strategy for improving students' interest in mathematics. International Journal of Education, Learning and Development, 6(3), 53-67.

[11] Ashcraft, M. H., Krause, J. A., & Hopko, D. R. (2007). Is math anxiety a mathematical learning disability? In D. B. Berch, & M. M. M. Mazzocco (Eds.), Why is math so hard for some children? (pp. 329-348).

[12] Brookes Publishing. Bacsal, E. D., Ibanez, E. D., & Pentang, J. T. (2022). Jigsaw strategy: Strengthening achievement and interest in mathematics among elementary pre-service teachers. Palawan Scientist, https://ssrn.com/abstract=4070736 14(1), 35-42.

[13] Batool, S., Tahir, T., & Habib, M. (2018). Relationship of teachers' professional of competence and achievement of students at university level. Turkish Journal Teacher Education, 7(1), 51-60. http://www.tujted.com/files/15/manuscript/ma nuscript_612/tujted-612-manuscript-131141.pdf

[14] Bergmann, J., & Sams, A. (2014). Flipped learning: Maximizing face time. British Journal of Educational Technology, 46(6), E28-E28. https://doi.org/10.1111 /bjet.12368

[15] Bhutta, S. M., & Rizvi, N. F. (2022). Assessing teachers' pedagogical practices and students' learning outcomes in science and mathematics across primary and secondary school level: A nationwide study (2018-21). Aga Khan University. https://ecommons.aku.edu/cgi/viewcontent.cgi? article=1319&context=pakistan_ied_pdck

[16] Bishop, J., & Verleger, M. A. (2013). The flipped classroom: A survey of the research. In Proceedings of the 2013 ASEE Annual Conference & Exposition. https://doi.org/10.18260/1-2--22585

[17] Braun, B., Bremser, P., Duval, A. M., Lockwood, E., & White, D. (2017). What does active learning mean for mathematicians? Notices of the AMS, 64. https://doi.org/10.1090/noti1472

[18] Brusilovsky, P., Karagiannidis, C., & Sampson, D. (2004). Layered evaluation of adaptive learning systems. International Journal of Continuing Engineering Education and Lifelong Learning, 14(4-5), 402-421. https://doi.org/10.1504/IJCEELL.2004.005729

[19] Busari, A. O., & Akinoso, S. O. (2020). Mathematics anxiety and personality characteristics of secondary schools' students in Lagos State, Nigeria. Journal of Positive Psychology and Counselling, 6, 12 23. https://www.researchgate.net/publication/ 344451904_Mathematics_Anxiety_and_Personality _Characteristics_of_Secondary_Schools_Students_ in_Lagos_State_Nigeria#fullTextFileContent

[20] Campbell, T. (2023). Examining how middle grade mathematics students seize learning opportunities through conflict in small groups. Mathematical Thinking and Learning, 25(2), 208-231. https://doi.org/10.1080/10986065.2021.1949529

[21] Capar, G., & Tarim, K. (2015). Efficacy of the cooperative learning method on mathematics achievement and attitude: A meta-analysis research. Educational Sciences: Theory & Practice, 15(2), 553-559. https://doi.org/10.12738/estp.2015.2.2098

[22] Carlos Torrego-Seijo, J., Caballero-García, P. Á., & Lorenzo-Llamas, E. M. (2021). The effects of cooperative learning on trait emotional intelligence and academic achievement of Spanish primary school students. British Journal of Educational Psychology, 91, 928-949. https://doi.org/10.1111/ bjep.12400

[23] Chen, J., Wang, M., Kirschner, P. A., & Tsai, C. C. (2018). The role of collaboration, computer use, learning environments, and supporting strategies in CSCL: A meta-analysis. Review of Educational Research, 88(6), 799-843. 0034654318791584 https://doi.org/10.3102/

[24] Chiuphae, P. (2023). Cooperative learning management using jigsaw puzzle techniques to promote achievement in learning democracy for grade 1. In Proceedings of the International Academic Multidisciplinary Research Conference in Zurich (pp. 213-218).

[25] Chu, H. C., Chen, J. M., & Tsai, C. L. (2017). Effects of an online formative peer-tutoring approach on students' learning behaviors, performance, and cognitive load in mathematics. Interactive Learning Environments, 25(2), 203-219. https://doi.org/10. 1080/10494820.2016.1276085

[26] Cohen, L., Manion, L., & Morrison, K. (2017). Research methods in education. Routledge. https://doi.org/10.4324/9781315456539

[27] Coman, E. N., Picho, K., McArdle, J. J., Villagra, V., Dierker, L., & Iordache, E. (2013). The paired t-test as a simple latent change score model. Frontiers in Psychology, 4, 738. https://doi.org/10.3389/fpsyg. 2013.00738

[28] De Backer, L., Van Keer, H., & Valcke, M. (2021b). The functions of shared metacognitive regulation and their differential relation with collaborative learners' understanding of the learning content. Learning and Instruction, 77, 101527. https://doi.org /10.1016/j.learninstruc.2021.101527

[29] Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining gamification. In Processing of 15th Mind Trek Conference, Tampere (pp. 9-15). https://doi.org /10.1145/2181037.2181040

[30] Dolmans, D. H. J. M. (2019). How theory and design based research can mature PBL practice and research. Advances in Health Sciences Education, 24(5), 879-891. https://doi.org/10.1007/s10459-019 -09940-2

[31] Domingo, J. G., Ibañez, E. D., Subia, G. S., Pentang, J. T., Gamit, A. M., Pascual, L., Mina, J., Tomas, A., & Liangco, M. (2021). Cognitive skills achievement in mathematics of the elementary pre-service teachers using Piaget's seven logical operations. Turkish Journal of Computer and Mathematics Education, 12(4), 435-440. https://doi.org/10.2139/ssrn.3974762

[32] Egodawatte, G. (2012). Mathematics performance and principal effectiveness: A case study of some coastal primary schools in Sri Lanka. Alberta Journal of Educational Research, 58(2), 169-184. https://doi.org/10.11575/ajer.v58i2.55585

[33] Fisher, M. J., and Marshall, A. P. (2009). Understanding descriptive statistics. Australian Critical Care, 22(2), 93-97. https://doi.org/10.1016/j.aucc.2008.11.003

[34] Flipped Learning Network. (2014). Definition of flipped learning. https://flippedlearning.org/definition-of -flipped-learning/

[35] Foldnes, N. (2016). The flipped classroom and cooperative learning: Evidence from a randomized experiment. Active Learning in Higher Education, 17(1), 39-49. https://doi.org/10.1177/14697874156 16726

[36] Fong-Yee, D., & Normore, A. H. (2013). The impact of quality teachers on student achievement [Paper presentation]. The 3rd Annual College of Education Research Conference.

[37] Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences, 111(23), 8410 8415. https://doi.org/10.1073/pnas.1319030111

[38] Gacia, & Martinez. (2021). Interventions to improve students' attitudes towards mathematics. https://doi.org/10.1016/j.nedt.2022.105269

[39] Ganley, C. M., Conlon, R. A., McGraw, A. L., Barroso, C., & Geer, E. A. (2020). The effect of brief anxiety interventions on reported anxiety and math test performance. Journal of Numerical Cognition, 7(1), 4 19. https://doi.org/10.5964/jnc.6065

[40] Garcia, A., Abrego, J., & Robert, R. (2017). Using the jigsaw method for meaningful learning to enhance learning and retention in an educational leadership graduate school course. Global Journal of Human Social Science: Linguistic & Education, 17(5), 4-16. https://socialscienceresearch.org/index.php/GJH SS/article/view/2249

[41] Gillies, R. M. (2016). Cooperative learning: Review of research and practice. Australian Journal of Teacher Education, 41(3), https://doi.org/10.14221/ajte. 2016v41n3.3

[42] Gillies, R. M. (2019). Promoting academically productive student dialogue during collaborative learning. International Journal of Educational Research, 97, 200 209. https://doi.org/10.1016/j.ijer.2017.07.014

[43] Gillies, R.M., Millis, B., & Davidson, N. (2023). Contemporary global perspectives on cooperative learning: Applications across educational contexts. Routledge. https://doi.org/10.4324/97810032681 92

[44] Ginsburg, H. P. (2009). Early mathematics education and how to do it. In O. A. Barbarin, & B. H. Wasik (Eds.), Handbook of child development and early education (pp. 403-428).

[45] Guilford Press. Goodrich, A. (2018). Peer mentoring and peer tutoring among K-12 students: A literature review. Update: Applications of Research in Music Education, 36(2), 13 21. https://doi.org/10.1177/8755123317708765

[46] Hadwin, A., Järvelä, S., & Miller, M. (2017). Self-regulation, co-regulation, and shared regulation in collaborative learning environments. In D. H. Schunk, & J. A. Greene (Eds.), Handbook of self regulation of learning and performance (pp. 83-106). Routledge. https://doi.org/10.4324/97813156970 48-6

[47] Hamdan, N., McKnight, P., McKnight, K., & Arfstrom, K. (2013). A white paper based on the literature review titled a review of flipped learning. Flipped Learning Network. https://flippedlearning.org/wp content/uploads/2016/07/WhitePaper_FlippedL earning.pdf

[48] Shimazoe, J., & Aldrich, H. (2010). Group work can be gratifying: Understanding and overcoming resistance to cooperative learning. College Teaching, 58(2), 52-57. 87567550903418594 https://doi.org/10.1080/

[49] Simon, M. A. (2020). Reconstructing mathematics pedagogy from a constructivist perspective. Journal for Research in Mathematics Education, 26(2), 114-145. https://doi.org/10.2307/749205

[50] Simpson, F. S. (2023). Exploring teachers' experiences of educators' preparation programs implementing mathematical content and pedagogy: A case study [Doctoral dissertation, University of California].

[51] Slavin, R. E. (2015). Cooperative learning in elementary schools. Education, 43(1), 3-13. https://doi.org/10. 1080/03004279.2015.963370

[52] Sun, Z., Lin, C. H., Lv, K., & Song, J. (2021). Knowledge construction behaviors in a mobile learning environment: A lag-sequential analysis of group differences. Educational Technology Research and Development, 69(2), 533-551. https://doi.org/10. 1007/s11423-021-09938-x

[53] Tapia, M., & Marsh, G. E. (2004). An instrument to measure mathematics attitudes. Academic Exchange Quarterly, 8(2), 16-21. https://files.eric.ed.gov/ fulltext/ED449045.pdf

[54] Tayyaba, S. (2010). Mathematics achievement in middle school level in Pakistan: Findings from the first national assessment. International Journal of Educational Management, 24(3), 221-249. https://doi.org/10.1108/09513541011031583