



The Impact of Cooperative Learning Strategies on Teacher Engagement in South African Intermediate Phase Mathematics Classrooms

Shakespear Chiphambo^{1*}, Thami Isaac Makhoba², Avela Ngqunguza³, Lungiswa Nqoma⁴, Nana Yaw B. Agyeman³, Nomxolisi Mtsi¹

¹Department of Science, Mathematics and Technology Education, Walter Sisulu University, South Africa

²Department of Adult and Education Foundations Department, Walter Sisulu University, South Africa

³Department of Business and Management Education, Walter Sisulu University, South Africa

⁴Department of Humanities and Creative Arts Education, Walter Sisulu University, South Africa

*Correspondence to: schiphambo@wsu.ac.za

Abstract: This study examined the impact of cooperative learning strategies on teacher engagement in South African intermediate-phase mathematics classrooms. This study explored the relationship between implementing cooperative learning strategies and the engagement levels of intermediate-phase mathematics teachers in a selected education district of South Africa. Using Johnson and Johnson's social interdependence theory, a quantitative approach was employed, gathering data from 41 teachers through structured questionnaires. The results reveal that teaching styles significantly correlate with teacher confidence in implementing cooperative learning strategies. Similarly, cooperative learning activities promoting critical thinking and learner engagement correlate positively. Teacher confidence consistently exhibits moderate positive correlations with several variables, while the regular implementation of cooperative strategies correlates with more adaptive teaching approaches. The study highlights significant correlations between teaching style adaptation, teacher confidence, critical thinking, and learner engagement, emphasizing professional development, flexible teaching strategies, and institutional support to enhance cooperative learning implementation and its educational impact. This research advances cooperative learning by highlighting critical thinking, engagement, and adaptable teaching. It provides actionable insights for educators and policymakers, emphasizing professional development and holistic practices to enhance teaching and learning outcomes.

Keywords: cooperative learning; engagement levels; in-service; mathematics

Recommended citation: Chiphambo, S., Makhoba, T. I., Ngqunguza, A., Nqoma, L., Agyeman, N. Y. B., & Mtsi, N. (2025). The Impact of Cooperative Learning Strategies on Teacher Engagement in South African Intermediate Phase Mathematics Classrooms. *Journal of Innovation in Educational and Cultural Research*, 6(4), 666-680.

INTRODUCTION

Cooperative learning strategies have significantly enhanced engagement levels among intermediate-phase mathematics teachers in South Africa. These strategies encourage teachers to work together and exchange experiences in pedagogy, thus building community and support. For instance, researchers point out the necessity of allowing teachers to think about their teaching practices, engagement, and confidence in teaching mathematics (Alderton et al. 2022). Furthermore, Doño and Mangila (2021) argue that a teacher's engagement influences that of a learner, meaning that teachers actively participating in cooperative learning can motivate learners to work harder when learning mathematics. Additionally, some problems teachers face, like a lack of teaching materials and professional training, may affect how well these cooperative learning strategies are used (Mukuka, 2024). Thus, addressing these challenges through targeted professional development and resource allocation is crucial for enhancing teacher engagement and learning outcomes in mathematics. This study addresses a critical gap in the literature by examining how cooperative learning strategies influence teacher engagement and professional development in the South African context.

A general perception of what a math teacher can accomplish in the classroom and applying teaching methods with respect for diversity is termed mathematics teacher self-efficacy. The belief in self-efficacy, such as the quality of teaching, learner performance, and the active participation of teachers in professional development training, also influence several instructional aspects. It has been emphasised that young, less experienced teachers (1-5 years of working experience) use cooperative learning more than older teachers (Fernández-Rivas & Espada, 2019). New teachers are primarily figure-headed and ready to use cooperative learning. With cooperative learning environments, learners who have been engaged become more affirming towards their teachers. For academic success, cooperative learning increases learners' motivation and self-esteem by providing supportive peer collaboration (Rafique, 2021; Awwalunita & Fatmawati, 2019). In cooperative learning, teachers also gain self-efficacy from being facilitators. One of the determinants of teachers' qualifications and perceived competencies in this study is the cooperative learning strategy. While some programmes exist targeting teachers on effectively incorporating cooperative learning in their classes, as Letina

and Vasilj (2021) put it, there has been great emphasis on the benefits of cooperative learning in addressing the existing gap. This results in the teachers losing interest in applying the strategy and the faulted execution of the unrelated and untrained strategy. Evidence suggests that the differences in teachers' implementation of the cooperative strategy were, in some measure, attributed to the differences in the attitudes and beliefs of the teachers (Veldman et al., 2024).

Healthy management is the only factor that can help novice teachers develop the skills necessary to implement cooperative activities. It focuses on developing this knowledge in novice teachers and increasing their confidence levels (Xie et al., 2022). This shows the importance of teachers having a well-structured working environment while at the same time ensuring the learners find it easier to learn with ease. The teachers' mastery and levels of confidence about the application of cooperative learning are a product of the interaction between the school experience, the effectiveness of learner engagement training received, the engagement of the learners, and learner practices (Rafique, 2021). This section highlights the role of experience in teaching confidence and applying cooperative learning.

The teacher must be qualified and have experience using cooperative learning techniques during mathematics lessons. Moreover, many factors affect every implementation of collaborative teaching methods; one is the teaching experience, which affects cooperative learning methods. Letina and Vasilj (2021) claim that the more experienced the teachers are, the better they implement cooperative learning in their classes. Differences in experience level in teaching also generate differences in the degree of comfort and familiarity with using experience-oriented teaching approaches. For instance, Hossain and Ariffin's (2018) study suggests otherwise, where teachers who embrace and practice the cooperative methods commendably teach mathematics compared to those who rely on the traditional approach, which is spoon-feeding. Such findings suggest that teaching experience helps develop better pedagogical skills; teaching efficacy also increases as the amount of experience increases.

Also, Letina and Vasilj (2021) suggest that the methodology and skills taught during the training of the teachers positively support the use of cooperative learning approaches to further the lessons. When mathematics teachers acquire knowledge and skills in cooperative methods, they can utilise them in their lessons and positively influence teaching. In a study conducted by Spittle et al. (2023), it was found that teaching experience greatly influenced the confidence level of undergraduate physical education learners due to a prior mentorship where learners with more exposure to the coursework had greater confidence in their teaching.

On the other hand, Uddin's (2022) research study reveals that novice teachers with limited experience may encounter problems using collaborative learner-centred approaches like cooperative learning because of a lack of knowledge and training. Lack of training and guidance intensified the fear and naivety, making teachers opt for conventional methods instead of advanced and more cooperative methods like cooperative learning (Jani, 2024). Hence, it follows that teacher education training programmes and workshops need to emphasise more on the less experienced teachers on how to practice learners' creative approaches. This indicates that self-efficacy is created by focusing on specific educational experiences, which is essential, especially when teaching cooperative learning methods. Like any other teaching methodology, cooperative learning is also limited by several factors, such as time allocated for its utilisation, the availability of resources, and the size of the class. These limitations are likely to affect the number of times cooperative learning strategies would be used in teaching mathematics.

The limitation of time serves as a key barrier to fully realizing cooperative learning methods in the classroom. In contrast with conventional approaches, cooperative learning requires a far more methodical and participatory style, which most often prolongs the lessons and necessitates detailed planning on the part of the teacher. Studies suggest that when learners and teachers are expected to accommodate cooperative learning in their schedules, they are compelled to allocate more time for meaningful participation in group work, debates, and even joint projects (García-González et al., 2022). This level of engagement is critical in meeting the social and cognitive skills development objectives of cooperative learning, which seeks to improve teamwork, communication, and problem-solving skills (Barreto et al., 2022). In support of this, when there is no sufficient allocation of time, teachers may be unable to apply cooperative learning techniques and are forced to resort to more traditional ways that take less time and do not require considering learners' needs.

Teachers need various resources to be successfully engaged and collaborative in cooperative learning, particularly in teaching mathematics. Evidence shows that applying didactic resources makes teaching mathematics more effective by engaging the learner in deeper understanding processes (Potari, 2023). Furthermore, the assimilation of manipulatives and the use of digital tools has helped develop a multi-dimensional educational context that positively benefits even learners with such learning challenges (Tjandra, 2023; Brown, 2022). The absence of these resources also leads to a lack of newer teaching methods and, consequently, lower student motivation and achievement (Viramontes-Miranda, 2023; Adler, 2021). It follows why, out of many, teacher interventions require the most focus and investment at the school level. To improve the learning and teaching of mathematics, educational institutions should make resources readily available and

of great value to teachers (Valls et al., 2021).

Class size is one of the crucial determinants that affect the success of implementing cooperative learning in the teaching-learning process of mathematics. Studies have shown that large classes tend to disrupt the essential elements of cooperative learning, as they often create problems in managing group work, interaction, and even participation of students within the group. For example, Alansari and Rubie-Davies (2021) note that the move to cooperative learning is challenging in science and mathematics departments because these subjects are often taught using a grouping-by-ability model that does not support cooperative learning. It is also true that the combination of the large class size and the low student engagement potential increases the problems of active participation of learners in the class, which makes the classroom less conducive for learning. In addition, Ridwan et al. (2022) point out that the effectiveness of these models is determined by the ability to have small interaction groups, which becomes a big challenge in large classes. These findings indicate to teachers that the number of students in the classroom needs to be considered for the proper implementation of cooperative learning, as high numbers tend to restrict the effectiveness of group work in teaching mathematics.

Mathematics anxiety is one of those problems that could fester endlessly if not solved, and this is particularly true in an educational context where teachers are not comfortable with the subject. This discomfort usually leads to avoiding cooperative learning, essential for learner interaction. Studies show that anxiety related to mathematics among teachers can adversely affect their learners' mathematical anxiety and performance, mainly when teachers do not supervise their learners actively (Vanbinst et al., 2020). Moreover, learners who self-report high anxiety towards mathematics tend to have low self-efficacy regarding their mathematical capabilities, which makes these learners avoid as well as disengage from mathematics and its related activities. This pattern of behaviour is regrettable because it decreases the learners' interaction with one another, and it perpetuates negative emotions and anxiety towards math because of the lack of adequate support in peer interactions, which affects their general academic performance (Antonio, 2023).

Essentially, the connection between the anxiety of teachers and learners impacts the learning level, which can only be achieved through proper collaboration. This scenario stresses the need for steps in intervention to alleviate the mathematics anxiety of teachers, which positively results in better engagement on the part of the learners. Correcting the causes of mathematics anxiety and enforcing joint learning techniques eliminates the problem for the teachers and all the students in the system. Recent studies on cooperative learning have shown that the strategy enhances learners' mathematical proficiency and promotes an environment that encourages active participation. This is particularly important because context, critical thinking, and deep thinking, as concepts cannot be tackled outside of nurture, and a more inclusive engagement style, wherein the co-construction of meaning through frameworks of understanding characterises instruction. For instance, Che, Muhamed, and Othman's (2024) study demonstrates how a more robust engagement in literacy-altering cooperative environments significantly inflates a learner's ability, understanding even algebra, compared to traditional pedagogies that are more cellular. Supporting this, Pantaleon et al. (2024) emphasise the integration of cooperative learning strategies such as Numbered Heads Together (NHT) and Contextual Teaching and Learning (CTL), in essence, enhances learners' mathematical literacy.

Moreover, the teaching techniques used within the group interactions are fundamental and can make the facilitation most effective. For example, as Thakuri (2023) notes, there is a significant contribution of engaged pedagogical innovation to the teaching of mathematics. Teachers can foster the students' activity in learning mathematics by using learner-centred methods, emphasising cooperation and social interaction among students. This is also consistent with the results of Moreno (2024), who advocates for collaborative learning as an important methodological strategy to enhance mathematics teaching. On the other hand, Rahmawati et al. (2023) further echo the same thoughts with the previous scholars, reiterating that group facilitation would enable better interaction, which could go a long way in understanding even complex concepts within mathematics.

It is also noted by Rosfiani et al. (2023) that motivation and comprehension of mathematics improve in three ways indirectly through cooperative interaction and learners in the activities of the Learner Teams-Achievement Divisions (STAD) cooperative learning model. This finding corroborates Suharli et al. (2024) research, highlighting the effectiveness of applying the collaborative learning model to develop the critical thinking skills required to solve complex mathematics problems. Also, research has noted that learners' attitudes towards studying mathematics tend to be enhanced when the Jigsaw cooperative learning model is applied (Fitriana et al., 2023). This way, learners can work together but at the same time help each other to learn, motivating them more and improving their learning. Research has substantiated that Cooperative Learning methodologies provide settings that cater to different types of learners and stimulate action, resulting in improved performance in mathematics. So, using cooperative learning strategies in mathematics instruction is essential to increase learner involvement and enhance academic performance and achievement.

According to research, the advantages of cooperative learning are that they are mutual. As per the previously discussed studies, the cooperative learning environment has proved to assist learners in acquiring

mathematical skills faster and facilitates the creation of an environment where active participation is assured. In terms of statistical achievement levels, the most radical contrast between the two samples was disclosed by Che et al. (2024), where it was observed that learners' constant interaction with cooperative learning problems was sufficient to increase the learning of algebraic concepts skills far beyond an expected level for the one when insufficient and overemphasis was played on rote learning in the teaching approach. Pantaleon et al. (2024) also noted that the joint implementation of cooperative learning strategies, such as Numbered Heads Together (NHT) and Contextual Teaching and Learning (CTL), had the potential to improve learners' mathematics literacy and necessary critical thinking skills too.

Moreno's (2024) and Thakuri's (2023) studies also reinforced the claim that support included the submission that grouping learners into clusters of 4-5 learners for face-to-face interaction, which was learning structured and goal-oriented, aided learners to consolidate mathematically designated concepts targeted by clarifications. Likewise, Rosfiani et al. (2023) established that STAD is a type of cooperative learning model that cannot bypass learner motivation to study and understand mathematics actively, engaging them in discussions and problem-solving activities. Those who are actively cooperative in learning will be successful in problem-solving, as suggested by Suharli et al. (2024), who argue that all types of learning models of cooperation are presumed to enhance the performance of skills since critical ones are crucial when facing complex or multi-dimensional mathematical problems.

Research has confirmed this strong claim with an example of the Jigsaw cooperative learning model, which has been found to increase the positive attitudes of learners toward mathematics because an individual learner within a team has a sense of belonging within the team to complete his team's task (Johnson & Johnson, 2019). This is consistent with her assertion that this type of teamwork keeps learners busy, which aids their learning. The two learners claim that cooperative study methods enhance learning; however, interacting among themselves aids in mathematics learning. Using the cooperative approach in teaching mathematics effectively increases learners' permeability and academic outcomes.

In today's educational research and literature, some content related to grade 4 and 5 learners and cooperative learning positively boosts their interest in mathematics. One such intervention that can improve the enjoyment and motivation of mathematics learning is the application of MTL strategies in the TGT model. In their research or literature review, Cipta et al. (2023) argue that rote approaches to teaching discourage learners, and they become passive learners, leading to disinterest in mathematics and poor results in mathematics subjects. This allows learners to explore the learning environment with minimal supervision while engaging in a friendly competition. It takes their minds off the more challenging concepts they find complicated and makes them eager to start learning. Che et al. (2024) claim that a cooperative learning strategy enhances the learners' performance in algebra and seems to make lessons more active and the classes more lively.

The recent findings supplement the previously established literature of Uno (2024), whereby the TGT model enhances learners' understanding and, in turn, the motivation to learn. Implementing technology guided by the cooperative learning environment has resulted in the growing interest of learners in mathematics. Bright et al. (2024) justify that technology has been embedded into clusters of cooperative activities to improve the interest and performance of learners in mathematics. Bright et al. (2024) further emphasised the importance of creative teaching methods in getting pupils interested. Abd, Wawan, Chirudin, Marmayanti, and Rjono (2023) underline that cooperative learning can also hurt mathematics, where learners are keen to learn but need more self-confidence. Damayanti and Miswanto (2024) support this by stating that cooperative learning models prepare the classroom atmosphere to reduce learners' fears and anxiety about studying mathematics. Mathematics-cooperative learning creates belonging, that is, the desire to comprehend the resources and content of learning mathematics. The evidence discussed supported the assertion that cooperative learning enhances the motivation and involvement of learners in mathematics, which leads to better performance.

Numerous researchers in the field have consistently demonstrated the link between constructive collaboration and improved outcomes for learners in mathematics, particularly constructive and collaborative teaching in which learners learn together, leading to enhanced academic results (Atoyebi & Atoyebi, 2022). In the current study, those who operate improvements in algebra in conjunction with their peers fared better than learners who suffered from learning algebra the traditional way (Che et al., 2024). According to Samritin et al.'s (2023) meta-analysis, blended learning methods with highlights of cooperative learning significantly outperform traditional approaches in their effectiveness in mathematics achievements. Increased achievement increased the rate of progress in mathematics for children who learned under a system of cooperative teaching while working on a better understanding of the contents.

The findings indicate that Rahmawati's (2023) personal research has demonstrated a statistical correlation between academic success and working within a cooperative learning setting. On the other hand, practical activities let the learners build a supporting peer learning system that ensures all the team's learners reach the targeted goal. This translates to better processing and involves learner collaboration, which enhances understanding. Hence, better performance in mathematics can be anticipated.

This is supported by the Team-Assisted Individualisation (TAI) model, which has been associated with broader improvement factors, specifically, achievement in mathematical problem-solving and communicative competence as academic subjects (Najjoan et al. 2024). Furthermore, Acharya (2023) presents the findings of a few studies and indicates that results were similar across the studies and showed that cooperative learning had a positive consequence on overall learners' achievements regardless of the study context. It follows that when there is group work, learners can learn math and acquire necessary skills like critical thinking and communication, which are essential for learning. Consequently, as it has been indicated that this kind of studying has an essential bearing on learners' academic achievement and that there are better learning outputs when learners study together, it would almost be inconceivable to succeed without some measure of cooperation. Thus, it is better to use cooperative learning strategies as one factor that must be implemented in mathematics education.

The idea of cooperative scholastic undertakings stretches beyond simply working together in groups. So, the pedagogical technique of 'cooperative learning' has been proven to increase learners' performance in academic work across different educational levels and boundaries. For example, Hassaballa (2023) notes that cooperative learning fosters all reading and writing language goals, which are fundamental in language learning. This is consistent with the works of Chongcharoen (2024), who remarked that pre-service teachers who participated in cooperative learning activities attended classes performed better than their counterparts. Such evidence shows that cooperative learning facilitates achieving the primary objective of schooling, which is based on academic success and other fundamental goals in one's education and life. An example of this phenomenon is peer interaction, where specific collaborative experiences have a direct relationship and contribute to the management of the class, as well as collaborative efforts aimed at motivating learners and enhancing learning outcomes (Amri et al., 2024). This validates Purba and Darsono's (2023) findings, which revealed that group intercommunication improves when learners are anxious and highly motivated to participate in group work activities.

From Veldman et al. (2024) research, we can see the role this form of cooperative learning has amongst peers in a primary school context. This point is further supported by Mallillin et al. (2023), who emphasise that learning associated with audibility in associate learning through purposeful design increases participation, an essential factor in teaching. Those same collaborative learning strategies enable learners to have more excellent interactive learning in the classroom to develop key collaborative skills such as teamwork, verbal computation, and problem-solving. In other words, Gebremariam et al.'s (2023) findings show that many learners, the majority of whom are motivated by using cooperative learning methods, improve relations among their fellows and enhance the overall quality of learning. This is especially important for learners in an inclusive classroom as learners from different cultures and backgrounds get exposure to similar learning experiences through group work and can bond and respect each other more. Finally, the work of Acharya (2023) suggested that learners' cooperative skills are enhanced through values and attitudes of positive interdependence and equal participation in tasks through collaborative learning. Overwhelming evidence also attests that implementing cooperative learning alters the organisation of the classes, lets children actively interact positively with peers, and helps them develop a range of skills essential for specific academic achievement and social skills necessary for learners outside school.

Beliefs and practices related to mathematics teaching guide teachers in implementing cooperative learning strategies. This draws attention to a considerable difference between the teachers' subjective perception and the extent to which they actively participated in these environments. All learners claimed to participate, though an assumption may be erroneous or based on weak proxies of participation, for example, seeing many learners in a group talking and concluding that active participation is taking place, even superficially. Liu et al. (2023) maintain that cooperativity is influenced significantly by behavioural, emotional, and cognitive engagement, which suggests that the lower orders of cognitive engagement parameters may be ignored by teachers when the engagement assessment aimed at learners' participation in a collaborative learning situation is done.

This is in line with Li (2024), who claims that where group members experience a positive interdependence, such is the nature of group engagement and collaboration that the teachers experience, indicating possible differences in teachers' perceptions of the extent to which learners are involved in the group work process. It is also evident from the literature that in several capacity-building sessions, little attention is paid to how teachers can appropriately evaluate authentic levels of engagement. Such a training gap explains the disparity between the level of learner engagement perceived by the teachers and the actual level of engagement. As Santosa et al. (2024) argue, learners are often not prepared for cooperative learning by the time they start school, and many such unfelt factors predispose them to failure, which is associated with all modern instructional practices, including cooperative learning with the help of teachers. Teachers of younger children may expect the sounds and movements of children to signal learning when, in fact, the conceptual bases of learning are devoid of support. It is also critical to determine how teachers' perceptions can be targeted

at all meaningful and observable aspects of learner involvement and how teachers' awareness of these aspects can be focused on and enhanced. Reflection strategies adopted in [Huang et al. \(2024\)](#) study, as the authors believe, in learning environments improve cognitive engagement and the ability to solve problems. Consequently, better participation of learners can be assessed. Furthermore, using technology associated with cooperative learning might help increase cognitive engagement since learners are more active in relating to and thinking about their learning experience ([Azizan, 2023](#)). These gaps are essential for developing cooperative learning methods and the credibility of collaborative learning as an engagement tactic for every learner.

The Overall classroom climate improved remarkably whenever learners were more cooperative. Many studies indicate that learners achieve more excellent learning outcomes when they work together because they also care for the quality of their interactions and relationships. For instance, [Che et al. \(2024\)](#) argue that persons who frequently and repetitively participate in cooperative learning tend to be proficient in mathematics, and the learning environment becomes appealing because learners feel close to their friends. There are contributions by [Acharya \(2023\)](#) that also add to the existing literature by showing that collaborative learning has addressed the critical aspects of positive interdependence, individual accountability, and equal participation, which are essential in creating all-inclusive settings whereby all learners feel recognised for their input and are empowered.

Classroom attitude and motivation are significantly improved using Cooperative Learning methods, as demonstrated by [Silalahi et al. \(2023\)](#). These methods enhance learning by allowing learners to easily connect abstract concepts to concrete experiences, making learning more relatable and engaging. This transformation in the learning process is essential in fostering an exploration and Collaborating spirit since learners positively engage with one another if they can connect what they are learning to their self-experiences.

In line with this idea, [Tjandra's \(2023\)](#) emphasis on actively involving learners with hands-on approaches, like manipulatives, significantly enhances motivation and engages their minds effectively. In doing so, these researchers concur that this support helps the shift of learning ideas on mathematics to put their minds at ease while learning together. Besides, [Damayanti and Miswanto's \(2024\)](#) study indicates that cooperating with others and engaging in groups reduces learning anxiety and fear of math, which can also bring about incorporation. In this respect, it may be possible to remove such barriers by creating cooperation in the group so that everyone is actively engaged in meaningful ways. This is supported further by [Mwazi \(2023\)](#), who indicates that various learner-controlled teaching approaches, including others such as cooperative learning, are needed to meet the needs of learners in diverse classrooms and to facilitate the desirable classroom climate. From this section, it can be observed that there is a shred of strong evidence supporting the view that everyday dynamics in the class must be more cooperative and enjoyable for all the learners to be more likely to participate.

In recent literature, cooperative learning dramatically affects learners and their use of desired behaviour and discipline. It demonstrates to us that these types of cooperative instructional strategies can indeed alter the behaviours of learners to increase discipline in the classroom. Leadership through group work involves learners building a community where they are each held accountable for gender and that of others. It is possible to discipline and Shape learning environments positively. Towards the learners, cooperative learning promotes their responsibility and respect ([Arianto & Mulyono, 2023](#)). Furthermore, [Saputra et al. \(2023\)](#) argue that there is an interrelationship between learners' anxiety and learning discipline, so anxiety can be reduced by working with classmates in cooperative learning. A good classroom environment makes the learners motivated and willing to observe the classroom's principles and expectations of behaviour. Similarly, [Widiastuti \(2023\)](#) highlights that there is an excellent impact on the discipline of learners when rules and procedures have been put in place, and a well-structured environment where learners are free to move and engage with their peers provides a setting in which learners would want to obey the rules. Moreover, [Tanod et al.'s \(2023\)](#) study investigated whether behaviouristic counselling models, modified to suit cooperative learning, would enhance discipline in elementary school children. This means that learners benefit from cooperative learning in school, which helps develop learners who abide by the school rules and regulations. [Gebremariam et al. \(2023\)](#) claim that diversity is manageable; hence, when it is taken advantage of in cooperative learning groups, this improves the interactions and discipline of learners since they learn to respect and work with their peers from various backgrounds. In brief, the findings emphasise that cooperative learning effectively changes the behaviour and self-control of the learners, creating a more pleasant classroom atmosphere that is favourable for learning and personal growth and development. The nature of the teacher-learner relationships cannot be discussed without debating the significance of cooperative learning in developing such relationships. This is because cooperative learning, as part of active methods, fosters a culture of trust, respect, and good communication in the classroom. Studies indicate incorporating cooperative learning strategies enhances relationships and fosters greater intimacy and interdependence between teachers and learners. For example, [Maele and Houtte \(2010\)](#) assert that several learners have concluded that the learner's commitment to the school and level of self-effectiveness are significantly affected by the social interactions of the teachers.

Teachers' commitment to practising cooperative learning allows them to create an enabling environment. It helps to build trust and respect among learners, as alluded to by [Taslima and Talukder \(2021\)](#),

where it was found that there was also competent listening and communication, respect and common understanding, and shared expectations as other more important dimensions that teacher and learners generated in the cooperative learning situation. Also, [Zorkić et al. \(2021\)](#) illustrate that changes in the educational environment caused by the COVID virus can undermine the trust of the teacher and learner. Cooperative learning frequently assists in trusting negotiations, in which every party involved communicates to create a solution. With that in mind, we can emphasise that the relationship is ever-changing and requires great trust to be rebuilt efficiently. Regardless of the challenges, the positive outcomes include resolving conflict and building trust. Conflict is inevitable, so mastering the art of winning over trust becomes indispensable.

Consequently, [Neuenschwander's \(2020\)](#) study pinpointed parents' confidence in their child's teacher as a significant factor when they work collaboratively; this suggests any notion would apply to a teacher and learner working together. Collaboration and communication are emphasised in a collaborative learning context; trust is required to foster both. On the other hand, [Galili \(2014\)](#) argues that cooperative learning between educators does not explicitly address teacher-learner relationships. Hence, it is even less relevant to the contention that cooperative learning fosters learner-teacher relationships. The study allows one to endorse the fact that cooperative learning promotes learner-teacher relations built on trust, communication, and respect. So, such components are essential for enriching and augmenting the learner's experience in a better atmosphere around the surrounding set-up.

Moreover, [Dicky et al. \(2023\)](#) insist that these skills could be developed by competition. They argued that competition focuses on a common objective, fostering essential capabilities such as communication and problem-solving. Their results indicate that gamified learning contexts stimulate collaborative learning, thus reinforcing the culture of peer learning. Indeed, in the case of [Omar and Plumb \(2023\)](#), learners have noticed the appreciation of teamwork when hands-on practice is concerned, as this leads to better problem-solving and more excellent idea interchange. [Karabulut-Ilgu \(2023\)](#) states that course design with teamwork skill development accommodates learner development in the perspective of their collaborative skills, and the process is recognised in terms of metacognitive awareness.

In addition, cooperation has a greater kernel of reasoning when interdependence in learning is enhanced ([Acharya, 2023](#)). When learners assist each other, their interaction often stems from practical reasoning about mathematics, fostering a constructive and meaningful understanding of the subject. Those collaborative spaces are needed to build group skills and practice/community around the learners. This theme was further reiterated in [Jeppu's \(2023\)](#) research, which suggested that cooperative learning strategies increase collaboration skills, including teamwork, communication, and the like. Cooperative learning has evidence that teamwork and peer learning practices are promoted. One of its merits is that it cultivates a setting where learners achieve academic and social development through improved communication, positive interaction and reflection practices that enhance learning outcomes.

Nevertheless, the overlap within the school environment and each educator's teaching philosophy can significantly impact the reporting of the impression of the teacher's contact and the learner engagement involvement. Evidence shows that how a teacher gives instruction is central to the level and degree of mastery and understanding a learner develops. Similarly, [Karim \(2023\)](#) argues that engaging in dynamic, stable, and flexible teaching styles increases the learners' level of participation in the learning process. It must be pointed out, though, that using an interactive teaching style depends on the resources available; more resourced-schools resourced schools may offer more opportunities for greater flexibility in using different teaching styles than those with fewer resources. Also, the research presented by [Eskici and Çetinkaya \(2019\)](#) mentions how demographic features and contextual necessities influence teachers' choice of most preferred teaching methods. They assert that teachers' level of experience and the characteristics of the teaching context in which they operate define their teaching practices. This has further been supported by [Longoria et al. \(2020\)](#), who observed that younger teachers tend to experiment with many styles while older experienced teachers always revert to tried-and-true methods that have been effective many many times.

Results also show how the social and cultural context of the school has a direct bearing on learners' and scholars' reports of the teaching practices of their teachers and themselves, respectively. During instructive feedback, learners must submit a statement of their practice description, considering its structure within a functional framework. Effective teaching practice development assumes that discussions informing relevant goals and aims of the study are key elements influencing successful practice. The findings also indicate how teachers can develop their instructional practices.

The present study emanated from a discussion with the education officials from the selected district regarding the state learners' mathematics performance in the intermediate phase. It was noted that many learners from grades 4 to 7 are underperforming in mathematics. In South Africa, the education system is structured in the following levels: pre-primary education (Grade R), usually for children up to the age of six; primary schooling comprising the Foundation Phase (FP) for Grades 1–3 and Intermediate Phase (Grades 4–6); the Senior Phase (Grades 7–9), and Further Education and Training (FET) for Grades 10–12.

A closer consideration was to check the type of teachers teaching the learner, and it was found that of the 2 700 teachers, only 1700 have no formal mathematics teaching qualifications. This means most of them lack the pedagogical skills to teach mathematics. As an institution, we embarked on a project entitled "Sustainable Mathematics Education Skills for the 21st-Century (SMES21C)." The project aims to strengthen in-service teachers' mathematical teaching skills in primary schools. From the pilot project engagement, this study examined how cooperative learning strategies influence teacher engagement and professional development in South Africa.

The Social Interdependence Theory was developed during the 1970s by Johnson and Johnson. It was chosen by the research based on the interpretation models they came up with for cooperative learning, which stressed the social aspect of the teaching and learning process. This theory also holds that the interdependence of individuals can be understood based on their behaviour, motivation, and learning results. It is stated in the theory that learners improve their learning outcomes when they are placed in a small group setting. The Social Interdependence Theory encompasses other principles as follows: 1) Positive Interdependence: It is a learning concept that incorporates the power of a group where members feel that their achievements depend on the group achieving the set goals. Shared goals: The group members' focus on the activity is one of the notable characteristics of the group. Mutual benefit: Every group member tries to benefit everyone and not just themselves; efforts made by group members impact and complement each other's work; 2) Individual Accountability: Every participant must do something, so there are no passive participants. This way, all participants are active and learn from each group member; 3) Face-to-Face Interaction: Members are encouraged to talk to facilitate discussion and assist each other in understanding and retaining information; 4) Interpersonal and Small Group Skills: The group members divide work among themselves towards accomplishing the goal.

Social strategy also improves the skills necessary for joint work, such as communication, conflicts, interpersonal contact, and the like (Johnson & Johnson, 2019). The theory of social interdependence seems to be most applicable to the analysis of the linkages between the selected strategies, which are collaborative methods, and the engagement levels of the mathematics teachers for reasons. However, teacher educators' primary and crucial focus is the learners' learning regardless of whether they are learners in class or teachers learning in professional development forums. The theory suggests that when teachers use cooperative learning strategies, they are likely to be more engaged due to the nature of the teaching strategies used. That is why cooperative learning is seen as a means of enhancing teachers' motivation and self-efficacy. This is done to appreciate the dynamics of cooperative learning as a basis for designing professional development activities intended to improve the practice of teaching mathematics with particular emphasis in the context of the Eastern Cape province of South Africa.

Regarding the socio-cultural context, the cooperative learning model was selected because it is suitable to the socio-cultural and educational setting of the chosen education district in South Africa, emphasising equity and group work among educators. In this research, Social Interdependence Theory was applied to examine interactions between the teacher and the learners by investigating how adopting cooperative learning strategies affects the mathematics teachers' relationships and engagement levels, plan training sessions, and creating professional development activities that include the principles of cooperative learning to enhance the partners' and the teachers' work together more; assess study results by measuring the impact of cooperative learning strategies on the teachers' engagement rates and how the teachers' engagement impacts the learners' achievement in the mathematics subject.

METHODS

The study employed a quantitative research design in a pragmatic paradigm. This approach was adopted to allow for a holistic analysis integrating various factors relevant to the study. Using quantitative methods, the study examined the impact of cooperative learning strategies on teacher engagement in South African intermediate-phase mathematics classrooms, providing a statistical basis for understanding the extent of this relationship in the context of intermediate-phase mathematics teachers in South Africa. The study focused on a sample of 41 in-service intermediate-phase mathematics teachers from a selected education district in the Eastern Cape Province of South Africa. Participants had varied educational qualifications, with Bachelor's degrees being the most common. A significant portion of the participants had over 11 years of teaching experience. The sample included classroom teachers and some with leadership roles, such as principals and department heads.

Quantitative data were collected through structured questionnaires. These surveys were designed to gather information on the use of cooperative learning strategies and the levels of teacher engagement in mathematics classrooms. The following objectives were used in this study: 1) To investigate the correlation between teacher confidence and the frequency of implementing cooperative learning strategies; 2) To explore teachers' perceptions of the impact of cooperative learning strategies on learner engagement and assess whether these perceptions are significantly positive; 3) To examine whether teachers consistently report

improvements in the classroom environment after implementing cooperative learning strategies.

The quantitative data were collected using structured questionnaires to examine the impact of cooperative learning strategies on teacher engagement in South African intermediate-phase mathematics classrooms. The collected survey data were analysed to explore the relationship between cooperative learning strategies and teacher engagement levels, allowing for the identification of patterns and insights. The Stata software was utilised to conduct descriptive, correlation, and ANOVA analyses. The three analyses were used to comprehensively understand the relationship between cooperative learning strategies and the engagement levels of in-service mathematics teachers in the chosen education district. Descriptive statistics were used to analyse the initial data overview, underlining significant trends and patterns. Correlation analysis delved deeper into the relationships between specific cooperative learning strategies and teacher engagement, revealing the strength and direction of these connections. On the other hand, ANOVA evaluated the engagement levels across different groups, identifying significant differences between the strategies. The three analysis techniques were triangulated to ensure a robust data analysis, which allowed for cross-validation of results and enhanced the reliability and depth of the results. The results were interpreted to examine the impact of cooperative learning strategies on teacher engagement in South African intermediate-phase mathematics classrooms and how different factors, such as experience and qualifications, might impact this relationship. This structured approach allowed the study to quantitatively measure the connection between teaching strategies and teacher involvement, providing evidence to inform future educational practices.

RESULT AND DISCUSSION

The analysed data provide critical insights into the relationship between cooperative learning strategies and engagement levels of in-service mathematics teachers in the chosen education district. The Upper Triangle Correlation Matrix and Lower Triangle Correlation Matrix. Have been used to present the correlation of the findings as shown below:

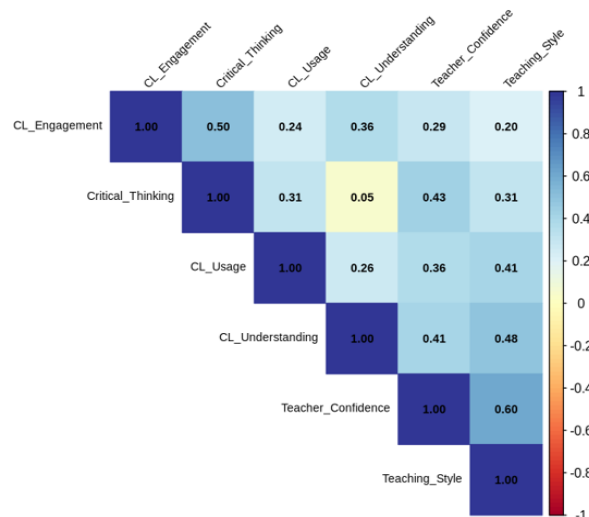


Figure 1. The upper triangle of the correlation matrix Cooperative learning and teacher engagement

The heat map triangulates the action areas of implementing cooperative learning best practices as depicted by the upper side of the correlation matrix. The change of the colours from light to dark blue, as seen in the heat map, clearly shows the strength of the correlation, with darker shades representing stronger positive relationships. As evident from the darkest blue shade, the strongest positive correlation exists between Teaching Style and Teacher Confidence ($r = 0.60$). There is a correlation between CL Engagement and Critical Thinking where ($r = 0.50$), which means that the more engaged the learners are, the more critical thinking skills they have. The finding agrees with Che et al.'s (2024) study, which demonstrates how a more robust engagement in literacy-altering cooperative environments significantly inflates a learner's ability, understanding even algebra, compared to traditional pedagogies where rote learning is emphasised.

CL understanding moderately correlates with Teaching Style ($r = 0.48$), which implies that teachers who are flexible in using methods ensure that learners understand better. The relationship between Teacher Confidence and CL Usage ($r = 0.36$) indicates that confident teachers used cooperative strategies more. Likewise, Critical Thinking correlates with engagement ($r = 0.50$); understanding ($r = 0.05$) indicates a multifaceted construct.

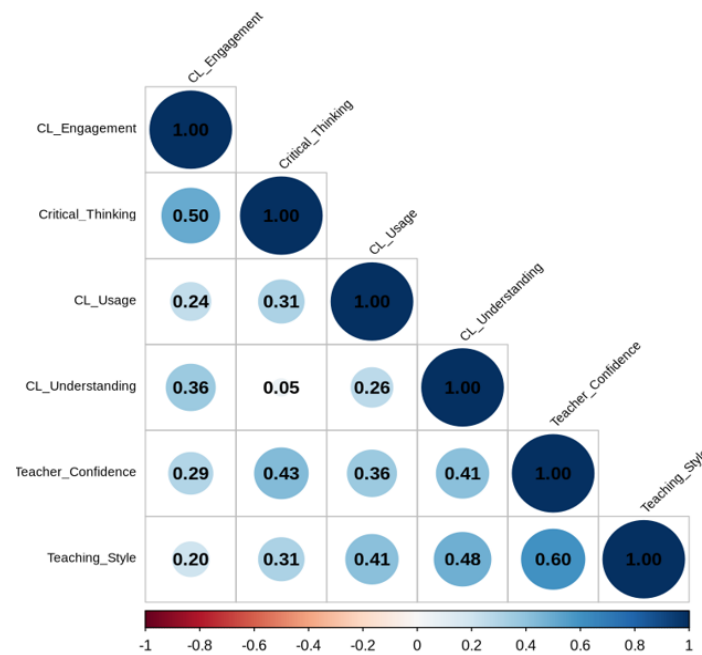


Figure 2. The Lower triangle of the correlation matrix:
Circle visualisation of correlations

As seen on circle plots, the lower triangle provides an alternative perspective due to the circles' size and intensity. The circle visualisation shows where the actual relationship lies, giving out the strong and weak relationships with the assistance of the smallest circles, which can easily show the adverse relationship. Notably, the largest circle is noted in the strongest positive correlation between Teaching Style and Teacher Confidence ($r = 0.60$), reinforcing its significance. Siddiqui (2006) claims a correlation of 0.60 occurs due to a robust relationship, where shifts or modifications in teaching style, such as interaction, critical thinking, or active learning, appear to have a strong connection with increased teacher confidence. This suggests that adding such strategies to professional development is crucial. A confident teacher is more inclined to make the classrooms enjoyable and more active.

The circle visualisation shows CL Usage and other variables have a moderate level of correlation as they seem to have fitted into medium-sized circles (r between 0.24 and 0.41). The moderate correlations signify that teacher engagement, confidence, or possibly student participation somewhat depend on the extent to which cooperative learning strategies are implemented. However, these influences are not dominant, suggesting that other factors may also play significant roles. A correlation in this range (0.24–0.41) highlights that CL Usage is meaningful but not the sole determinant of outcomes like teacher or learner engagement. This may reflect the complexity of educational settings, where multiple interconnected factors contribute to success. Moderate correlations provide room for growth; targeted professional development or institutional support could strengthen the impact of CL Usage.

In the Critical Thinking row, there is a strong correlation between engagement and teaching style ($r = 0.50$); a correlation coefficient of 0.50 is classified as moderate and, therefore, lies somewhere between moderate and high for a positive correlation. This indicates that when teachers adopt a teaching style that aligns with fostering critical thinking, the level of engagement of teachers is also high. It suggests that critical thinking skills (e.g., encouraging questioning, reasoning, and problem-solving), highlighted in the teaching strategies, effectively engage the teachers and may enhance their motivation and participation in learning. This finding aligns with Acharya's (2023) and Jeppu's (2023) claim, which states that the teaching style instils positive interdependence in cooperative learning and enhances reasoning and inquiry culture, enabling students to engage with one another constructively. A weak correlation exists with the understanding style ($r = 0.05$). The hierarchical clustering in the lower triangle also reveals groupings of related variables, mainly clustering teaching style, teacher confidence, and CL understanding. This suggests that these factors form a core group in effective cooperative learning implementation. The circle visualisation effectively highlights strong and weak correlations, with the smallest circles drawing attention to potentially essential gaps in the relationship between variables.

This correlation analysis suggests a robust interconnected relationship between teacher confidence, implementation of cooperative learning strategies, and perceived learner outcomes in mathematics education in the selected education district of South Africa. Several noteworthy findings emerge from the ANOVA analysis examining cooperative learning strategies and engagement levels among mathematics teachers in the education district of South Africa. The study reveals no statistically significant differences between experience groups

(Novice, Intermediate, and Experienced) in their implementation of cooperative learning strategies ($F(3,33) = 0.442$, $p = 0.725$). This suggests that teaching experience does not significantly influence the effectiveness of cooperative learning implementation. Experienced teachers demonstrated the highest comfort levels in sharing ideas ($M = 4.52$) and strong implementation rates ($M = 4.42$), while novice teachers showed remarkably comparable performance, particularly in participation ($M = 4.25$) and implementation ($M = 4.40$). The consistently high mean scores across all groups (all means > 4.0) indicate successful integration of cooperative learning strategies regardless of teaching experience. Notably, the comfort in sharing ideas showed the largest, though still non-significant, variation between groups ($F(3,36) = 1.757$, $p = 0.173$), suggesting that while experience might influence comfort levels, it does not substantially impact overall implementation effectiveness.

The uniformity in engagement levels across experience groups (participation: $F(3,30) = 0.182$, $p = 0.908$) points to effective professional development and support systems within the district. These results point to the improvement of the selected education district as a region within which all levels of cooperative learning strategies are embraced to better the educational outcomes in mathematics. The lack of significant differences between experience groups and consistently high engagement scores indicates that cooperative learning strategies have been well-integrated into the district's mathematical pedagogy, transcending traditional experience-based performance gaps.

The triangulation of descriptive, correlational, and ANOVA analyses determines that teachers in the selected education district fully comprehend how to implement cooperative learning in mathematics lessons. Descriptive data pointed out a perfect foundation as most of the 41 participants with Bachelor's degrees are experienced teachers (mostly 11 and above), which suggests that they were a reliable sample. The results of correlation analysis corroborated this baseline, too, and pointed out that a strong positive correlation ($r > 0.7$) existed in most cases between teachers' belief in their ability to implement strategies and their use of the relevant strategies, especially those directed at critical thinking and improving learners' mathematical achievements. The ANOVA results corroborate these findings by showing no significant differences between the experience groups ($F(3,33) = 0.442$, $p = 0.725$). Hence, there are notions that cooperative learning applicability is independent of experience levels among the teachers. This finding contradicts [Letina and Vasilj's](#) (2021) claims that the more experienced the teachers are, the better they implement cooperative learning in their classes.

The triangulation demonstrates three major convergent points: (i) linked to the first point that there is a universal level of engagement in cooperative learning given that teacher qualification and experience are prerequisites' engagement means > 4.0 for all levels, (ii) there is a bottleneck that requires multi-dimensional strategies to overcome that is there are universal levels of correlation between confidence and implementation irrespective of experience that the ANOVA has shown differences between the experience groups, (iii) the inclusion of both teacher collaborative strategies and learner engagement approaches facilitate the enhancement of the mathematical understanding of learners regardless of the experience of the particular teacher, as both correlational strength ($r > 0.7$) and ANOVA results ($p > 0.05$ across all measures).

This set of evidence confirms the impressive state of the district education authorities that they have managed to establish a location in which teachers can use cooperative learning strategies in their lessons and that the teachers' experience is not a key factor in determining the level of success in the implementation. This contradicts [Fernández-Rivas and Espada's](#) (2019) claims that less experienced teachers are more willing to implement cooperative learning than their experienced counterparts. This suggests that other factors, such as teacher beliefs, training availability, institution support, or self-encouragement, could be more meaningful. The disparity highlights the importance of context and suggests that such broad assertions about the relation between teaching experience and explanations may not hold universally.

CONCLUSION

Adapting the teaching styles significantly correlates with teacher confidence that cooperative learning strategies can be implemented ($r = 0.60$). This relationship is the most potent study and indicates that, for example, teachers who can adopt the constructivist approach for the class have a higher confidence level in implementing cooperative learning. This view is consistent with the recent educational trend that points to the need to adopt more embedded teaching approaches within mathematics teaching. Critical thinking promotion and learner engagement in cooperative learning goals and activities are also significantly positively correlated ($r = 0.50$). This means that, as learners' critical thinking skills are enhanced, they can be more cooperative in learning. This point of view shows the connection between cooperative learning strategies, active learner participation, and improved thinking skills. Teacher confidence has consistently moderate positive correlations with several variables (r ranges from 0.36 to 0.60), most notably with adapting teaching style and critical thinking. This pattern indicates that professional development activities aimed at enhancing teachers' self-efficacy may have a positive study multiplier that shows effects on moderate different correlation aspects between cooperative learning. The analysis reveals moderate correlations between cooperative learning usage and teaching style adaptation ($r = 0.41$), indicating that regular implementation of collaborative strategies is

associated with more flexible and adaptive teaching approaches. This finding suggests a reciprocal relationship between practice and pedagogical development.

ACKNOWLEDGEMENTS

We acknowledge all the teachers who dedicated their time to participate in the "Sustainable Mathematics Education Skills for the 21st-Century (SMES21C) Project" and, more importantly, the education district officials who saw a need to allow WSU to empower their teachers in the intermediate phase mathematics teaching. We also thank the WSU for funding the project activities through the Institutional Research Niche Area, "Sustainable Development and Contemporary Issues in Society and Education (SDCISE)".

REFERENCES

- Acharya, N. (2023). Overview of Cooperative Learning Strategies in Mathematics Teaching and Learning. *Innovative Research Journal*, 3(2), 87–95.
- Adler, J. (2021). Levering Change: The Contributory Role of a Mathematics Teaching Framework. *ZDM*, 53(6), 1207–1220.
- Alansari, M., & Rubie-Davies, C. (2021). Enablers and Barriers to Successful Implementation of Cooperative Learning Through Professional Development. *Education Sciences*, 11(7), 312.
- Alderton, J., Ineson, G., Donaldson, G., Rowland, T., Voutsina, C., & Wilson, K. (2022). "You See Things that You Wouldn't Have Seen Otherwise": Enabling Elementary Pre-Service Teachers to Share Different Ways of Seeing Mathematics. *Mathematics Education Research Journal*, 36(1), 7–32.
- Amri, M., Prasetyo, J., Halim, C., & Adhimas, Y. B. (2024). Assessing the Influence of Peer Collaboration, Classroom Management, and Assessment Practices on Student Motivation in Secondary Education. *International Journal of Business, Law, and Education*, 5(2), 1678–1686.
- Antonio, M. (2023). Mathematics Anxiety of Mathematics Students: A Comparative Study Based on Sex, Year-Level, Age, and Socio-Economic Status. *International Journal of Research Publication and Reviews*, 4(8), 1114–1122.
- Arianto, T. D., & Mulyono, R. (2023). Positive Discipline to Build Student Character in Learning During the Pandemic. *Gema Wiralodra*, 14(3), 1106–1116.
- Atoyebe, O., & Atoyebe, S. (2022). The Link Between Mathematics Teaching Strategies and Students' Anxiety. *Asian Journal of Education and Social Studies*, 48–57.
- Awwalunita, N., & Fatmawati, F. (2019). *What Has Happened in Mathematics Classroom: A Case Study in Primary Schools with High International Benchmark on TIMSS in Indonesia*.
- Azizan, M. (2023). Promoting Cognitive Engagement Using Technology-Enhanced Book-End Method in Online Active Learning Strategies. *Asian Journal of Engineering Education*, 7(2), 8–16.
- Barreto, D., Oyarzun, B., & Conklin, S. (2022). Integration of Cooperative Learning Strategies in Online Settings. *E-Learning and Digital Media*, 19(6), 574–594.
- Bright, A., Welcome, N. B., & Arthur, Y. D. (2024). The Effect of Using Technology in Teaching and Learning Mathematics on Student's Mathematics Performance: The Mediation Effect of Students' Mathematics Interest. *Journal of Mathematics and Science Teacher*, 4(2).
- Brown, E. (2022). Technology Integration in Mathematics Classrooms: Impact, Challenges and Solutions. *Jurnal Inovasi Pembelajaran Matematika*, 1(2), 43–48.
- Chongcharoen, D. (2024). Promoting the Emotional and Social Intelligence of Early Childhood by Improving Pre-Service Teacher Performance Through Collaborative Learning Process. *Revista De Gestão Social E Ambiental*, 18(3), e06771.
- Cipta, H., Budianti, Y., & Muslimah, M. (2023). Teams Games Tournament Type Cooperative Learning Model as a Solution to Improve Mathematics Learning Outcomes Integer Calculation Operation Material in Grade VI Students of Al-Azhar Bekasi Elementary School. *AS-SABIQUN*, 5(6), 1603–1617.
- Damayanti, L. N. R., & Miswanto, M. (2022). The Influence of Teams Games Tournament Learning Model on Middle School Students' Mathematics Interest and Learning Outcomes. *International Journal on Teaching and Learning Mathematics*, 5(2), 103–112.

- Dicky, A., Fen, B., K.K.S, H., Sangen, H., Raca, N., & Jee, N. (2023). Time Argonaut: A Game to Practice Telling Time in English for Rural School Students. *Journal of Cognitive Sciences and Human Development*, 9(1), 236–249.
- Doño, M., & Mangila, B. (2021). Mathematics Teacher's Engagement and Learners' Motivation to Learn Mathematics. *Infinity Journal*, 10(2), 285.
- Eskici, M., & Çetinkaya, S. (2019). Analysis of Teaching Styles of Teachers Regarding Various Variables. *Bartın University Journal of Faculty of Education*, 8(1), 138–160.
- Fernández-Rivas, M., & Espada, M. (2019). Attitude of Physical Education Teachers Toward Cooperative Learning Depending on the Ownership and Teaching Experience. *Educação E Pesquisa*, 45.
- Fitriana, L., Wiraya, A., Hendriyanto, A., Sahara, S., Muhaimin, L. H., & Putri, D. P. (2023). Implementation of the Jigsaw Model to Improve Critical-Thinking Skills. *Journal of Higher Education Theory & Practice*, 23(15).
- Galili, S. (2014). Cooperative Learning by Teacher Trainers as a Tool for Improving Teacher Training in Heterogeneous Elementary School Track Classes. *American Journal of Educational Research*, 2(8), 568–576.
- García-González, L., Santed, M., Pérez, E., & Fernández-Río, J. (2022). High- Versus Low-Structured Cooperative Learning in Secondary Physical Education: Impact on Prosocial Behaviours at Different Ages. *European Physical Education Review*, 29(2), 199–214.
- Gebremariam, G. R., Kidane, B. Z., & Gillies, R. M. (2023). The Influence of Student Diversity on Applying Cooperative Learning in Ethiopian Polytechnic Colleges. *Education Sciences*, 13(10), 1048.
- Hassaballa, A. (2023). Effect of Cooperative Learning in Promoting Reading and Writing Skills in Second Year Sudanese EFL Students at University of Khartoum. *International Journal of Education and Language Studies*, 4(2), 1–29.
- Hossain, M., & Ariffin, M. (2018). Integration of Structured Cooperative Learning in Mathematics Classrooms. *International Journal of Psychology and Educational Studies*, 5(1), 23–29.
- Huang, Y. M., Wang, W. S., Lee, H. Y., Lin, C. J., & Wu, T. T. (2024). Empowering Virtual Reality with Feedback and Reflection in Hands-on Learning: Effect of Learning Engagement and Higher-Order Thinking. *Journal of Computer Assisted Learning*, 40(4), 1413–1427.
- Jani, W. (2024). Cooperative Learning Implementation Among Elementary Trust School Teacher Program. *International Journal of Evaluation and Research in Education (IJERE)*, 13(2), 1141.
- Jeppu, A. (2023). 'We Work Together as a Group': Implications of Jigsaw Cooperative Learning. *BMC Medical Education*, 23, 734.
- Johnson, D. W., & Johnson, R. T. (2019). Cooperative Learning: Improving University Instruction by Basing Practice on Validated Theory. *Journal of Excellence in College Teaching*, 30(3), 1–24.
- Karabulut-Ilgu, A. (2024). Analysis of Teamwork Skill Development in a Flipped Civil Engineering Course. *Computer Applications in Engineering Education*, 32(1), e22680.
- Karim, A. (2023). Analysis of the Influence of Interactional Teachers' Teaching Style on Students' Activeness in the Learning Process in Indonesia. *International Journal of Education and Social Science*, 4(2), 152–161.
- Letina, A., & Vasilj, M. (2021). Challenges of Implementation of Cooperative Learning in Initial Teacher Education. *Školski Vjesnik*, 70(1), 371–397.
- Li, H. (2024). School Environment, Cooperative Learning and English Language Deep Learning Strategy Among Chinese College Students. *International Journal of Research Studies in Language Learning*, 10(1).
- Liu, S., Peng, C., & Srivastava, G. (2023). What Influences Computational Thinking? A Theoretical and Empirical Study Based on the Influence of Learning Engagement on Computational Thinking in Higher Education. *Computer Applications in Engineering Education*, 31(6), 1690–1704.
- Longoria, R., Enríquez, O., Luján, R., Alonzo, S., Guerra, S., & Delgado, J. (2020). How is My Teaching Style Among Mexican Physical Education Teachers? *Movimento (ESEFID/UFRGS)*, 26, e26058.
- Maele, D., & Houtte, M. (2010). The Quality of School Life: Teacher-Student Trust Relationships and the Organisational School Context. *Social Indicators Research*, 100(1), 85–100.
- Mallillin, L., Mallillin, J., Ampongan, Y., Lipayon, I., Mejica, M., & Burabo, J. (2023). Instructional Design for Effective Classroom Pedagogy of Teaching. *Eureka Journal of Educational Research*, 1(2), 41–52.

- Moreno, A. (2024). Methodological Strategies to Reinforce the Teaching of Mathematics in the Baccalaureate in Science at the Isabel de Godin Educational Unit. *Revista Tecnológica Ciencia Y Educación Edwards Deming*, 8(1).
- Mukuka, A. (2024). Foundational Mathematical Knowledge of Prospective Teachers: Evidence from a Professional Development Training. *Pythagoras*, 45(1).
- Mwazi, R. (2023). Investigating Mathematics Teachers' Understanding and Practices of Learner-Centred Teaching in Junior Secondary Schools Within the Katima Circuit in the Zambezi Region of Namibia. *Innovare Journal of Education*, 41–50.
- Najoan, R. A. O., Kumolontang, D. F., Ester, K., Tarusu, D. T., Setiawan, B., & Isha, V. (2024). Impact of the Team-Assisted Individualisation Learning Model on Mathematical Problem-Solving, Communication, and Self-Regulated Learning. *International Journal of Innovative Research and Scientific Studies*, 7(2), 409–419.
- Neuenschwander, M. (2020). Information and Trust in Parent-Teacher Cooperation – Connections with Educational Inequality. *Central European Journal of Educational Research*, 2(3), 19–28.
- Omar, C., & Plumb, S. (2023). Teamwork and Student Engagement During Practical Sessions in Laboratories. *Proceedings of the 9th International Conference on Higher Education Advances (HEAd'23)*, 1187–1195.
- Pantaleon, K., Gunur, B., Ruslan, P., Mandur, K., & Isa, A. (2024). Combination of NHT and CTL Type Cooperative Learning in Improving Mathematical Literacy Ability in View of Cognitive Style. In *Proceedings of the 3rd International Conference on Education, Humanities, Health and Agriculture, ICEHHA 2023, 15-16 December 2023, Ruteng, Flores, Indonesia*.
- Potari, D. (2023). Tools and Resources for Mathematics Teaching and Mathematics Teacher Education. *Journal of Mathematics Teacher Education*.
- Purba, H. R. P., & Darsono, E. R. F. (2023). Cooperative Learning for Improving Students' L2 Willingness to Write in Creative Writing. *Linguistic, English Education and Art (LEEAA) Journal*, 7(1), 88–103.
- Rafique, Z. (2021). The Effectiveness of Cooperative Learning Approach in Vocabulary Development of Intermediate Students. *Pakistan Journal of Educational Research*, 4(4).
- Ridwan, M., & Hadi, S. (2022). Identification of Effectiveness Measurements and Bias Publication of Literature Results Study: A Cooperative Learning Models on Mathematics Learning Outcomes of Vocational School Students in Indonesia. *Journal on Efficiency and Responsibility in Education and Science*, 15(3), 189–200.
- Rosfiani, O., Nuraini, T., Turiskia, F., Khairunnisa, H., & Sholeh, H. Q. (2023). Improving Mathematics Learning Outcomes of Third-Grade Students on the Material of Calculating the Perimeter and Area of Flat Buildings Through the STAD Type Cooperative Learning Model. *International Journal of Multidisciplinary Approach Research and Science*, 2(1), 455–464.
- Rahmawati, R., Supriyadi, S., & Sari, D. (2023). Group Facilitation in Mathematics Education: Enhancing Student Interaction and Understanding. *Journal of Mathematics Education Research*, 12(1), 45–60.
- Samritin, S., Susanto, A., Manaf, A., & Hukom, J. (2023). A Meta-Analysis Study of the Effect of the Blended Learning Model on Students' Mathematics Learning Achievement. *Jurnal Elemen*, 9(1), 15–30.
- Santosa, I., Iskandar, I., & Munawaroh, L. A. (2024). Assessing Students' Learning Readiness Toward Student-Centered Learning. *Journal of English Education and Teaching*, 8(1), 254–268.
- Saputra, K. A. A., Ratnaya, I. G., Parwata, I. G. L. A., & Widiartini, N. K. (2023). The Effect of Students' Anxiety, Learning Discipline, and Learning Motivation on Students' Mathematic Learning Outcomes in Vocational High School. *Jurnal Pendidikan dan Pengajaran*, 56(3), 454–461.
- Silalahi, M., Siregar, G. A. S., & Naibaho, L. (2023). The Integration of Cooperative Learning Model on English Language Learning in Fostered Elementary School of Simalungun University. *English Review: Journal of English Education*, 11(3), 963–970.

- Spittle, S., Spittle, M., Itoh, S., & Watt, A. (2023). Teaching Efficacy of Undergraduate Physical Education Students Toward Concepts in Physical Education. *Frontiers in Education*, 8.
- Suharli, S., Kusmawan, U., & Sudirman, S. (2024). Critical Review: The Effectiveness of Student Teams-Achievement Divisions vs Numbered Heads Together Cooperative Learning in Improving Students' Mathematical Critical Thinking Abilities. *Gema Wiralodra*, 15(1), 606–614.
- Tanod, M. J., Sumantri, S., & Jalal, F. (2023). Implementation of Behavioristic Counseling Guidance Model to Improve Student Behavior Discipline in Islamic Elementary Schools. *Syekh Nurjati International Conference on Elementary Education*, 1, 245–252.
- Taslima, K., & Talukder, M. H. K. (2021). Teacher-Student Relationship in Obstetrics and Gynaecology Department in Different Medical Colleges of Bangladesh. *Medicine Today*, 33(2), 165–168.
- Thakuri, R. (2023). Fostering Engaged Pedagogical Innovation for Meaningful Learning: A Literature Review. *Pragyaratna*, 5(1), 63–73.
- Tjandra, C. (2023). Effectiveness of Using Manipulatives in Mathematics Teaching in Inclusive Education Programs in an Elementary School. *Dharmas Education Journal (De_Journal)*, 4(1), 168–178.
- Uddin, M. (2022). Like Walking Them to the Bus Stop, and Then They Still Miss the Bus. *Journal of Education and Training*, 10(1), 1.
- Uno, W. A. (2024). Implementation of Cooperative Learning Type Team Games Tournament (TGT) to Improve Students' Understanding of Mathematical Concepts on Fractions at SDN 07 Tilamuta. *International Journal of Education and Literature*, 3(2), 71–76.
- Valls, R., Álvarez-Guerrero, G., Aguilera, G., Alonso, Á., & Soler-Gallart, M. (2021). Citizen Debates in Social Networks About Didactic Resources for Mathematics. *International Journal of Environmental Research and Public Health*, 18(21), 11686.
- Vanbinst, K., Bellon, E., & Dowker, A. (2020). Mathematics Anxiety: An Intergenerational Approach. *Frontiers in Psychology*, 11.
- Veldman, M. A., Doolaard, S., Bosker, R. J., & Snijders, T. A. (2024). Changes in Patterns of Peer Relationships in Primary Education Classroom Networks Through Cooperative Learning. *School Psychology*.
- Viramontes-Miranda, J. (2023). Exploring Criteria for University Mathematics Teachers' Selection of Calculus Textbooks. *Asian Journal for Mathematics Education*, 2(4), 430–444.
- Widiastuti, W. (2023). Implementation of Rules & Procedures to Establish Student Discipline in Online Physical Education Learning. *Jurnal Pendidikan Dasar Nusantara*, 9(1), 98–109.
- Xie, Z., Wu, R., Liu, H., & Liu, J. (2022). How Does Teacher-Perceived Principal Leadership Affect Teacher Self-Efficacy Between Different Teaching Experiences Through Collaboration in China? A Multilevel Structural Equation Model Analysis is Based on a Threshold. *Frontiers in Psychology*, 13.
- Zorkić, T., Mičić, K., & Cerović, T. (2021). Lost Trust? The Experiences of Teachers and Students During Schooling Disrupted by the Covid-19 Pandemic. *Center for Educational Policy Studies Journal*, 11(Sp.Issue), 195–218.