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COOPERATIVE LEARNING AND MATHEMATICAL PROBLEM SOLVING IN STUDENTS IN THE FIRST GRADE OF SECONDARY EDUCATION OF A PUBLIC EDUCATIONAL INSTITUTION

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ABSTRACT

The objective of the research was to determine the relationship between cooperative learning and mathematical problem solving in secondary school students of a public educational institution. A quantitative, basic, non-experimental cross-sectional design and correlational level approach was applied. The sample of 180 students was selected by non-probabilistic convenience sampling. The survey technique was implemented through the administration of a questionnaire comprising 20 items, which served as the primary variable, and an objective test comprising 18 items, which served as the secondary variable. The findings indicated that Pearson's correlation coefficient was 0.940, with a p-value of 0.00, indicating a highly significant relationship between the variables. Given that the p-value was less than 0.5, the null hypothesis was rejected, and the alternative hypothesis was deemed valid. This hypothesis suggests a relationship between cooperative learning and the resolution of mathematical problems. It can be concluded that cooperative learning and problem solving in secondary school students of a public educational institution are conducive to the development of 21st-century skills.

KEYWORDS: Education, Cooperative learning, Mathematical problem solving.

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RESUMEN

La investigación intitulada Aprendizaje cooperativo y la resolución de problemas en estudiantes de educación secundaria de una institución educativa publica tuvo como objetivo general, determinar la relación entre el aprendizaje cooperativo y la resolución de problemas matemáticos en estudiantes de educación secundaria de una institución educativa pública. Se aplicó un enfoque cuantitativo, de tipo básico, diseño no experimental transversal y de nivel correlacional. La muestra constituida por 180 estudiantes fue seleccionada por muestreo no probabilístico por conveniencia. Se utilizó la técnica de la encuesta con un cuestionario (20 ítems) para la primera variable y una prueba objetiva (18 ítems) para la segunda variable. Los resultados mostraron que el coeficiente de correlación de Pearson fue de 0,940 con un valor de significancia p-sig de 0,00; siendo menor que 0,5 se rechazó la hipótesis nula y se da por válida la hipótesis planteada, porque sostiene que el aprendizaje cooperativo está relacionado con la resolución de problemas matemáticos. Esto permite concluir que el aprendizaje cooperativo y la resolución de problemas en estudiantes de educación secundaria de una institución educativa pública.

Palabras clave: Educación, Aprendizaje cooperativo, Resolución de problemas matemáticos

1. INTRODUCTION

Cooperative learning, as defined in the extant literature, refers to pedagogical methods where students are organized into small teams with the objective of supporting each other to train and optimize their learning outcomes (Johnson et al., 1999). In the context of contemporary employment models, there is a growing emphasis on individualistic work approaches that prioritize personal advancement over collective objectives. This shift has given rise to a paradigm characterized by heightened competition, intricate task segmentation, and the fragmentation of work into discrete subtasks. This structural transformation has the potential to erode the sense of accomplishment and engender frustration among employees, impeding the effectiveness of work processes (Domingo, 2008). However, it is imperative to acknowledge that both competition and cooperation are unique capacities that can be cultivated in students. Competition fosters individuals to achieve their objectives, while cooperation facilitates support among group members (Robles, 2015).

At the international level, a study conducted by Adl-Amini et al. (2024) demonstrated that cooperative learning was implemented in a very limited capacity, with only 7% of the surveyed teachers reporting its integration in their pedagogical practices. The implementation of group objectives and individual accountability was observed in a mere 175 of the total sessions under review. It is noteworthy that only one of the 21 teachers investigated implemented the five fundamental elements. This discrepancy underscores the importance of distinguishing between theoretical knowledge and practical application in the context of professional training and certification. The peer-to-peer interaction and contribution of students has been demonstrated to generate a considerable impact on the acquisition of knowledge of approximately 70% of Turkish university students. This finding suggests that cooperative learning not only facilitates the collective construction of knowledge, but also ensures deep and high-quality assimilation by the student. In 86% of schools in Washington, United States, the strategy to combat the competitive nature, culturally desired in North America, is through cooperative learning (Yavuz & Arslan, 2018).

A study conducted by Prieto-Saborit, et al. (2021) counted on a staggering 14,122 adolescent students in order to analyze the influence of teamwork on gender equity in mathematics. The findings of this study indicate that male students exhibit a stronger relationship between both variables, with an approximate difference of 0.26 points compared to female students. This suggests that cooperative learning has a more significant impact on the development of mathematical skills in male students. At the national level, the Report on the National Assessment of Learning Achievements (ENLA) for the 2023 school year presents a comprehensive examination of the mathematical performance of students in the second grade of secondary school. On the whole, the analysis indicates a six-point decrease in comparison with the data from 2022. Notably, the proportion of students who attained the "Satisfactory" level decreased by 2%, reaching 11.3% this year. Concurrently, the "In process" level exhibited a decline, dropping from 20.9% in the preceding evaluation to 18.4% in the current one. Conversely, the "At Start" level exhibited a substantial increase, rising from 37.2% in 2022 to 42.5% in 2023. These measurements indicate a widening gap in mathematical achievement and a disturbing shift toward lower achievement categories. As stated by the Ministry of Education (Minedu) in 2023.

The data from the ENLA 2023 constitute a critical educational diagnosis for La Libertad. According to the findings, approximately 44.5% of schoolchildren are classified in the "At Start" category, while 29.5% are in the "Prior to Start" stage. As indicated by the data presented, the percentages of satisfactory and in-process results are 17.2% and 8.6%, respectively. When evaluated through the lens of educational statistics, this configuration reveals a negative concentration in the lowest sectors of the performance scale (Minedu, 2023).

At the regional level, there is a well-established correlation between cooperative learning and social skills. This relationship is evidenced by an index of 0.645, as determined by the Rho Spearman test. This index suggests a strong association between cooperative learning and social skills, with higher levels of cooperative learning corresponding to higher levels of social skills. Social skills that are completely immersed in the development of teamwork, in this way, in addition to affecting academic performance, also contribute to the comprehensive training of the student (Cueva, 2021). The implementation of cooperative learning methodologies in educational settings enables educators to achieve multiple significant objectives in a single instructional session. Firstly, it has been demonstrated to enhance the academic performance of all students, including those with exceptional abilities and learning disabilities. Secondly, it facilitates the establishment of positive relationships with students, lays the foundation for a community, and enables the identification of areas where diversity is appreciated. Thirdly, it offers students the

experiences required for social, intellectual, and psychological growth. The capacity of cooperative learning to address these three dimensions simultaneously distinguishes it from other learning strategies (Johnson et al., 1999).

In order to facilitate the development of cooperative skills in students, it is imperative that the education system incorporate team learning and social skills into the curriculum. The objective is to establish a comprehensive educational institution that caters to the diversity, interculturalism, and individual requirements of its student body. To this end, pedagogical structures predicated on cooperative principles must be incorporated to foster the academic success of high achievers and assist those requiring assistance in achieving their academic objectives through group dynamics. (Robles, 2015)

Consequently, cooperative learning emerges as a strategy to address inadequate academic performance, as it fosters collaborative learning among students through goal-oriented teams. In this case, it is also possible to point out the indifferent attitude of teachers when applying teaching strategies that should focus on the progress of students to the extent of their abilities. It has been asserted that mathematics educators are involved in all school activities as a result of various traditional tasks, yet they do not prioritize student learning. In this theoretical framework, the focus is on the individual student's pursuit of their own interests, often at the expense of those shared with their peers.

The cooperative approach has been demonstrated to contribute positively to the development of mathematical skills, as well as scientific and technological aptitude. Furthermore, it has been shown to facilitate the preparation of individuals for civic engagement. Moreover, in contrast to a more individualistic or competitive approach, it fosters a collective orientation, emphasizing shared objectives and a concern for the well-being of others. Furthermore, it fosters the development of civic skills, including the capacity for dialogue, acceptance of diverse perspectives, the establishment of criteria for evaluating and addressing issues of collective interest, and the ability to lead. (Domingo, 2008)

The present study seeks to examine the relationship between cooperative learning and problem solving in students in the first grade of secondary education in a public educational institution.

The theoretical basis of this research is to strengthen current theories and concepts on cooperative learning. In this regard, it is proposed that in the first grade of secondary education, an examination be conducted of the manner in which cooperative work among students is articulated with the approach to mathematical problems. The research's primary axis is to estimate the association of both theories in order to identify and examine the elements that intercede in the progression of the mathematical algorithm.

The results obtained provide a methodological foundation that is evident in the products, methods, resources, and conclusions utilized. The proposal outlines a series of strategies and substantial modifications designed to stimulate interest in cooperative work, thereby enhancing mathematical aptitude. Interaction between peers, anchored to its five components, is essential not only to enhance the cognitive growth of students, but also for coexistence in the classroom.

The present study identified several rationales. Initially, the positive statistical indices pertaining to the relationship between its variables will motivate students to enhance their academic endeavors, consequently leading to improved performance. Moreover, this will foster more favorable relationships among students, thereby enhancing their overall mental well-being.

In practical terms, the procedures, techniques, and instruments employed during the research process, once validated and reliable, establish a solid foundation that can be utilized in subsequent research endeavors. This will enable a greater deepening towards innovative learning and teaching perspectives by promoting a culture of research and analysis from a holistic perspective, favoring a significant improvement in educational guidelines.

The objective of this study is to ascertain the correlation between cooperative learning and problem solving in students in the first grade of secondary education in a public educational institution. The objective of this study is to establish a relationship between positive interdependence and problem solving in students in the first grade of secondary education in a public educational institution. The present study aims to establish the relationship between individual and team responsibility and problem solving in students in the first grade of secondary education at a public educational institution. Furthermore, the relationship between stimulating interaction and problem solving in students of the first grade of secondary education at a public educational institution will be investigated. The objective of this study is to establish a correlation between the internal management of the team and the resolution of problems in students of the first grade of secondary education at a public educational institution. The objective of this study is to establish a correlation between the team's internal evaluation and the resolution of problems in students

enrolled in the first grade of secondary education at a public educational institution.

A substantial correlation has been identified between cooperative learning and problem-solving skills in first-grade students enrolled in a public secondary educational institution.

Cooperative learning, as defined by Suárez (2010), signifies a method of teamwork and, consequently, an inherent characteristic of each individual. This is due to the rationality of negotiating between action and mind to achieve collective, but not individual, objectives. This pedagogical approach fosters interaction among students, who are divided into smaller groups, thereby enabling them to attain a high level of learning.

In this manner, cooperation suggests the presence of multiple individuals rather than a single entity. However, this does not imply the provision of assistance to others in the pursuit of their objectives, nor does it entail the facilitation of the achievement of goals by individuals. Rather, it signifies the collective endeavor to attain a shared objective for the benefit of all parties involved.

According to Johnson et al. (1998), cooperative learning is a pedagogical approach that involves the implementation of instructional strategies in small-group settings. In these groups, students and their peers collaborate to enhance their own learning and promote team development.

According to the research of Johnson et al. (1999), the following components of cooperative learning are identified.

A. Positive interdependence

The term "interdependence" signifies mutual dependence, characterized by self-sufficiency, self-responsibility, and the sharing of a common principle. In order to facilitate cooperative learning, it is first necessary to ensure that each team member is committed to the team's work objectives. This phenomenon occurs when students recognize the interconnection between individual performance and the collective effort of the team. The enhancement of each member's performance leads to an augmentation in the collective learning process.

This component fosters a sense of responsibility among students for their own achievements as well as those of their peers, thereby promoting a shared responsibility for both individual and group accomplishments. This shared commitment serves as the fundamental foundation of cooperative learning, fostering active engagement in both collective and individual achievements.

The initial component fosters the concept of teamwork, wherein each member plays a pivotal role and directs their efforts not solely towards their own benefit, but also towards the benefit of the collective. In this context, personal development is inextricably linked to the collective development of the team. This dynamic fosters a paradigm of cooperation, shared responsibility, and reciprocal assistance among its members.

B. Individual and team responsibility

It is imperative that the entire community exhibits solidarity in pursuit of the established objectives. Each member is accountable for executing their designated task. They are committed to the execution of their respective tasks and align closely with the group's objective.

The concept of individual responsibility becomes evident when analyzing the specific performance of each student, whose achievements are then disclosed to the team and reported directly to the evaluated. This approach facilitates the identification of individuals who require additional support, guidance, and reinforcement to engage effectively with the activity. Consequently, team members must be cognizant of who requires additional assistance to complete the task, and they must exercise caution to ensure that they do not exploit the efforts of their colleagues. In this sense, this view rejects any form of exploitation or abuse in which one member of the group obtains an unfair advantage from the work of others.

At this juncture, the exertion of each member to attain collective learning must be esteemed, both in the execution of their designated task and their engagement in the provision of support and guidance to their peers.

C. Stimulating interaction

This phenomenon occurs when team members provide encouragement and assistance to their colleagues, thereby exemplifying behaviors that enhance both individual and collective motivation. In this context, students are expected to cooperate in shared tasks, promoting joint achievement through the exchange of resources, offering mutual assistance, providing encouragement, and recognizing their individual efforts in the learning process.

This dynamic exchange encompasses verbal explanations among students regarding problem-solving methodologies, reflection on employed strategies, and content analysis. In this process, students are expected to convey to their peers the knowledge and skills they have acquired. They are also tasked with establishing connections between their recent acquisitions and previous knowledge.

The fundamental characteristic of this third dimension is its capacity to promote growth and active development. This process occurs not only

through the transmission of information but also by stimulating ideas, creativity, and action.

D. Internal management of the team.

To ensure effective team management, it is imperative that team members organize and coordinate their activities through processes and procedures, and through the division of labor to achieve the collective goal of the group. This dynamic engenders a system in which each member is assigned specific tasks, contributing to the effective functioning of the group.

Consequently, team members are expected to demonstrate a commitment to leadership, collaborate in decision-making processes, foster an environment of mutual trust, employ productive communication, and manage discrepancies in a constructive manner. It is imperative that the instructor approach the group work exercise with the same level of seriousness and precision demonstrated in their instruction of the aforementioned school subjects.

E. Internal evaluation of the team.

The evaluation of the team is based on continuous dialogue among its members to analyze the level of achievement of the established goals and verify how effective the working relationships between the members are. It is incumbent upon teams to identify the positive or negative behaviors exhibited by their members and determine which behaviors should be maintained or modified. To refine the process of curriculum development, team members are required to critically examine their collaborative dynamics and identify strategies to enhance collective efficiency.

In the context of working groups, it is imperative to acknowledge that the workload should not be perceived as being diminished merely due to an increase in the number of members. The active involvement of each member is imperative, as the fulfillment of individual responsibilities exerts a direct influence on the group's performance. In the event that a member neglects their responsibilities, the entire team is adversely affected. The success of one member is considered a victory for the collective. This approach posits that the success of one is indicative of the success of all, thereby underscoring an interdependence in which each individual contributes to both personal and collective progress.

2. PROBLEM-SOLVING IN THE CLASSROOM

Nieto (2004) posits that problem-solving is evident in the endeavor to identify solutions to the challenges encountered in both daily life and the scientific realm by students. Consequently, it is defined and organized through concrete actions, through which an individual discovers routes to solve a problem.

As Monereo (1998) asserted, the resolution of a mathematical problem necessitates the demonstration of two distinct competencies. Firstly, the individual must exhibit expository knowledge, which encompasses the integration of previously acquired knowledge with newly acquired information. Secondly, the individual must demonstrate a grasp of the procedural knowledge, i.e., the plan to be followed, in order to utilize the information, execute the methods to establish connections, and formulate a solution to the problem posed. It is imperative to acknowledge the significance of both skills as fundamental elements in problem-solving methodologies.

2.1. Process for solving mathematical problems

Polya (1989) proposes a structured method to solve mathematical problems, which is governed by four stages:

A. Understanding the problem

This process involves the interpretation of both the statement and the circumstances of the problem, the differentiation of the various types of data presented in the situation, and the comprehension of how these data should be utilized to adequately address the task at hand.

The set of statements delineates the situation to be resolved, yet it does not elucidate the methodology for its resolution. The identification of the solution is a responsibility of the solver, who must interpret the content of the statement and translate it into mathematical language, thus enabling progress in the resolution process. Therefore, it can be deduced that the challenges encountered when comprehending a problem statement differ from those encountered when understanding a text of another nature.

Students will be able to verify the parts of the problem, such as the question, data, and circumstances. The following inquiries are instrumental in this process: The initial inquiry seeks to ascertain the specific request or inquiry posed by the statement. It also prompts consideration of the pertinent information and the prevailing circumstances within the given context. Furthermore, it poses a question regarding the feasibility of representing the problem through the medium of a graph or diagram. Finally, it invites a reformulation of the problem in one's own words, with the objective of assessing one's comprehension and understanding of the problem.

B. Devising a plan

After understanding the proposed problem and defining the goal to be achieved, it is time to organize Following an understanding of the proposed problem and the establishment of the objective to be accomplished, the subsequent step is to arrange the actions that will result in the realization of that objective. It is imperative to address issues such as the utilization of the data stipulated in the statement, the inferences that can be derived from them, the operations that must be implemented, and the sequence in which they must be executed.

It is imperative to record the resolution strategy in a clear, simple, and organized manner. In the majority of cases, mathematical structures are established, thereby enabling the utilization of mathematical language in a manner consistent with conventional language. In order to adequately address this phase, it is imperative to respond to the following inquiries: Have you encountered any analogous problems in the past? Is it feasible to organize the data in tabular or graphical form? What strategy do you intend to implement to address the issue? What tactics do you anticipate employing?

C. Execution of the plan

The objective is to implement each of the steps that have been established in the planning phase. The execution of this task requires meticulous attention to detail, necessitating a systematic approach that encompasses a thorough review of each step. This entails both intuitive and formal assessments to ensure that every decision and action aligns with the established criteria for appropriateness. This stage culminates in a precise and contextual manifestation of the response achieved.

Furthermore, it is imperative to demonstrate that, subsequent to comprehending the problem and determining the solution strategy, the strategy is meticulously executed, thereby ensuring that each step is systematically verified. The sequence of events that is recommended for this phase is as follows: The implementation of the aforementioned plan is to be carried out in accordance with the prescribed procedure, with each step being meticulously examined. The execution of the operations delineated in the plan is imperative, and the implementation of all proposed tactics is to be undertaken, ensuring the attainment of diverse solutions to the same problem.

D. Retrospective view

The resolution of a problem is not complete upon the discovery of the solution. The objective of problem-solving is to facilitate learning throughout the process, which culminates when the solver determines that all potential avenues for acquiring new knowledge from the situation have been exhausted.

From this perspective, it is necessary to verify the process carried out, to examine whether the procedure is correct to reach the solution. Consequently, it is imperative to: It is imperative to ascertain whether the result obtained sufficiently addresses the issue raised. A comprehensive analysis should be conducted to determine whether the solution was reached through diverse approaches or strategies. Furthermore, any potential challenges that emerged during the process must be identified and examined, assessing the methods employed to overcome these obstacles. Finally, the applicability of the method utilized to the resolution of other analogous cases must be evaluated.

According to Martínez (2012), population is defined as the enumeration of all subjects who share a common trait and is employed to describe the group from which the sample is taken. The present study focused on a population of 180 students enrolled in the first grade.

3. CONTRAST DESIGN

The objective of correlational research is to demonstrate the relationships, or lack thereof, between concepts, variables, or attributes. Consequently, it is feasible to interpret the behavior of a concept or variable based on the analysis of other variables related to it (Hernández-Sampieri & Mendoza, 2018).

The study employs a correlational design.

3.1. Data collection tools

The methods employed in data collection included survey and evaluation as methodological procedures. In accordance with Niño's (2011) conceptual framework, the survey method has been developed as a tool to systematically collect data from specific population segments or samples. This technique facilitates the identification of judgments, estimates, interests, practices, and other elements through the administration of questionnaires developed with the objective of collecting such data. According to Medina et al. (2023), evaluation is defined as a research process aimed at collecting information about the mental capacities of an evaluated person, such as knowledge, interpretation, and the ability to solve situations.

The present study employed both a questionnaire and an objective test as instruments. Ríos (1991) elucidates that the questionnaire is composed of a series of inquiries meticulously formulated by the researcher and designed to amass pertinent

information on the subjects addressed by the research. Arias (2020) posits that the objective test is a tool that can be used to assess the level of learning that an individual has achieved in a specific topic. The assessment is determined by the unknowns that are elaborated according to the research objectives. The utilization of this evaluation instrument facilitates the evaluator's capacity to ascertain the individual's reasoning and knowledge.

The estimation of both variables in this study was carried out through the application of two methodological procedures: survey and evaluation, in combination with a questionnaire and an objective test, which was designed as a particular instrument.

3.2. Cooperative learning

The technique employed was consistent with the survey, and the instrument utilized was congruent with the questionnaire. The latter comprised 20 items that addressed the variable of cooperative learning, encompassing the five distinct dimensions that comprise it. The initial category, designated as positive interdependence, encompassed items 1 through 4. The subsequent category, entitled individual and team responsibility, comprised items 5 through 8. The third dimension, stimulatory interaction, was formed by items 9 to 12. The fourth component of the evaluation entailed the assessment of the team's internal management practices, which were evaluated through items 13 to 16. The final dimension pertains to the internal evaluation of the team, encompassing items 17 through 20. The score of the aforementioned questionnaire was determined in accordance with the Likert scale, with consideration given to the following alternatives: The following categories were used to assign a score: Never (N), Almost Never (CN), Sometimes (A), Almost Always (CS), and Always (S). The possible scores were 1, 2, 3, 4, and 5.

3.3. Troubleshooting

The technique and instrument utilized were the evaluation and the objective test, respectively. The latter comprised 18 items designed to evaluate the variable resolution of mathematical problems. Each item was formulated according to the four dimensions that constitute the test. The initial dimension, which pertains to the comprehension of the problem, encompasses items 1, 2, 3, 4, and 5. The subsequent dimension involves the formulation of a strategy or plan, derived from items 6, 7, and 8. The third dimension encompasses the execution of the strategy or plan, derived from items 9, 10, 11, 12, 13, 14, and 15. The final dimension involves a reflective examination of our development and results, derived from items 16, 17, and 18. The items in the aforementioned questionnaire were assigned values ranging from 0 to 1, with the exception of items 1 and 3, which were assigned values between 0 and 2 inclusive.

3.4. Validity

According to Ríos (2017), the concept of validity signifies the extent to which an instrument can accurately assess the variable under analysis, in accordance with the predetermined objectives. In this context, validity is defined as the relevance of the study's instruments.

To ensure the validity of the instruments utilized, a technical evaluation process was implemented by three specialists. These specialists meticulously examined the items contained within each instrument. To support the judgments issued, Aiken's V test was used, which yielded a coefficient of 1.00 in the two instruments. The result obtained lends further credence to the reliability and safety of the instruments utilized in the study.

3.5. Reliability

According to the work of Ñaupas et al. (2018), the degree of consistency that an instrument presents is of paramount importance. In order to be considered reliable, the measurements obtained must demonstrate consistency and show no significant alterations.

This reliability was calculated using Cronbach's alpha coefficient, a statistical indicator that estimates the degree of internal consistency of the items that comprise the scales used. For the instrument corresponding to the first variable, a value of 0.9147 was obtained, indicating an excellent level of reliability. Conversely, the instrument linked to the second variable attained a coefficient of 0.817, signifying a satisfactory degree of reliability.

3.6. Processing and analysis techniques

In this research, the data will be processed through the use of procedures typical of descriptive statistics. Descriptive statistics employs a range of techniques and procedures to examine, explain, decipher, and create summaries based on datasets available in an analysis (Ñaupas et al., 2018).

The information collected on the variables was organized in Microsoft Excel, and the items corresponding to each student were individually graded. Subsequently, the global scores obtained for both variables were entered into the SPSS version 25 statistical software to perform a normality analysis. Given the nature of the sample, consisting of 30 students, it was decided to use the Shapiro-Wilk test,

as it is considered suitable for sample dimensions below 50. The findings indicated that the data exhibited a normal distribution. Consequently, the decision was made to employ Pearson's correlation coefficient, a statistical measure that facilitates the examination of the intensity and orientation of the association between the two variables under consideration in the research study.

Consequently, frequency tables and graphical representations in the form of bars were designed to verify and analyze the distribution of the levels observed in the study variables, taking as a reference the scores obtained by the sample.

The normality test yielded a p-value greater than 0.5 for the first variable, thereby supporting the hypothesis that the data follows a normal distribution. In a similar manner, the p-value in the second variable also exceeded the 0.5 threshold. This finding once again confirmed the presence of a normal distribution in the analyzed data.

4. RESULTS

Table 1: Levels of cooperative learning in the participants of the sample

Levels	f_i	%
Low	12	7%
Middle	114	63%
High	54	30%
TOTAL	12	100%

Note: Information derived through the measurement instrument.

The data presented in Table 5 indicates that 63% of the students demonstrate a medium level of cooperative participation, characterized by interaction, mutual support, and shared responsibility in a balanced manner. Conversely, a mere 7% attained a low level, indicating that a limited number of individuals encounter challenges in proactively integrating.

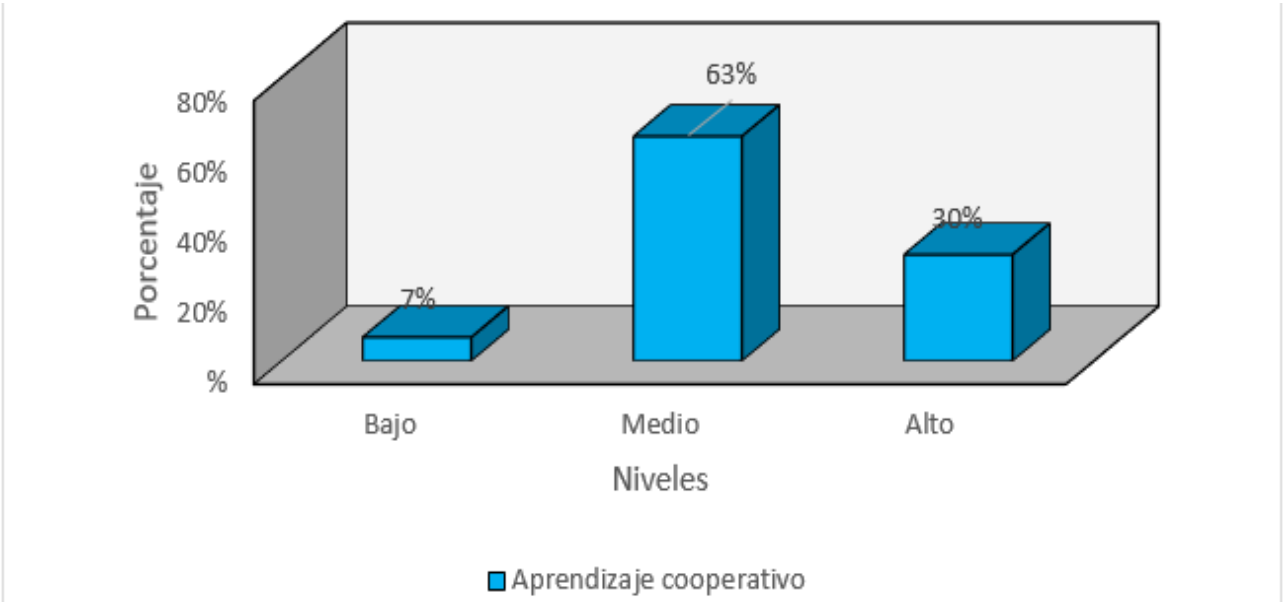

Figure 1: Percentage levels of cooperative learning in the sample participants
Source: Table 1.

The data illustrated in Table 5 and Figure 1 indicate that 63% of the students have a medium level of cooperative learning, followed by 30% who reach the high level and only the remaining 7% are at the low level.

Table 2: Levels of mathematical problem solving in the participants of the sample.

Level	Frequency	Percentage
Bad boy	0	0%
Regular	36	20%
Well	144	80%
TOTAL	180	100%

Note: Information derived through the measurement instrument.

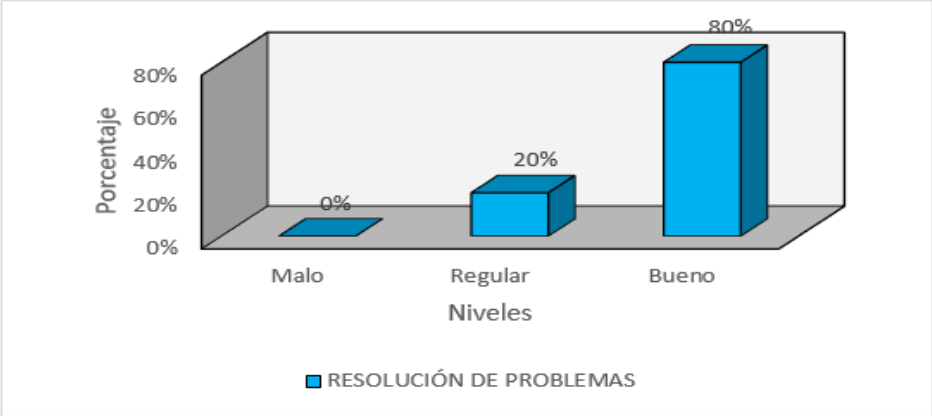

Figure 2: Levels of problem-solving of the sample participants.
Source: Table 6.

The data illustrated in Table 6 and Figure 2 indicate that no student is at the bad level; in contrast, at the regular level there are 20% of students and at a good level with 80% of students.

4.1. Normality test

Since the number of participants in the study is greater than 50 individuals, the Kolmogorov-Smirnov normality test was chosen. This decision guided the formulation of the null and alternate hypotheses necessary to verify the distribution of data.

H_0: The sample data follow a normal distribution.

H_1: Sample data do not follow normal distribution.

Decision Rule:

If the p-value is less than 0.05, the null hypothesis is discarded.

If the p-value is equal to or greater than 0.05, the null hypothesis is not ruled out, so the data follow a normal distribution indicate that the Kolmogorov-Smirnov normality test obtained a p-value of 0.107 for cooperative learning and 0.096 for problem-solving, both values exceeding the threshold of 0.05. These results show that the two variables are normally distributed. For this reason, Pearson's correlation coefficient was chosen, a procedure that is considered appropriate for the analysis of relationships between variables that adopt the normal distribution.

4.2. Hypothesis testing

Table 3: Correlation test between the variables Cooperative Learning and Problem Solving

		Cooperative learning	Troubleshooting
Cooperative learning	Pearson correlation	1.000	0,940
	Sig. (bilateral)		0.000
	N	180	180
Troubleshooting	Pearson correlation	0,940	1.000
	Sig. (bilateral)	0.000	
	N	180	180
The correlation is significant at the 0.01 level (bilateral).			

Source: Processing done with SPSS v25, author's design.

Table 3 shows that Pearson's correlation index was placed at 0.940, thus indicating a perfectly positive correlation. The bilateral significance value is less than 0.01, which allows the null hypothesis to be rejected with certainty and the alternative hypothesis is supported. In this sense, it is established that the relationship observed between the first and second variables, evaluated in the participants of the sample, is statistically significant.

4.3. Specific Hypothesis 1

Table 4: Correlation test between problem solving and the positive interdependence dimension

		Positive interdependence dimension	Troubleshooting
Troubleshooting	Pearson correlation	1.000	0,815
	Sig. (bilateral)		0.000
	N	180	180
Positive interdependence dimension	Pearson correlation	0,815	1.000
	Sig. (bilateral)	0.000	
	N	180	180
The correlation is significant at the 0.01 level (bilateral).			

Source: Processing done with SPSS v25, author's design.

Table 4 shows that the Pearson correlation index reached the value of 0.815, which suggests a very high positive correlation. Given that the bilateral significance value was p=0.000, i.e., below 0.01, the null hypothesis is rejected with certainty, and the alternative hypothesis is supported. Consequently, a significant correlation is maintained between the second variable and dimension 1 of the first variable in the group represented by the sample analyzed.

4.4. Specific hypothesis 2

Table 5: Specific hypothesis 2

		Individual and team responsibility dimension	Troubleshooting
Troubleshooting	Pearson correlation	1.000	0,824
	Sig. (bilateral)		0.000
	N	180	180
Individual and team responsibility dimension	Pearson correlation	0,824	1.000
	Sig. (bilateral)	0.000	
	N	180	180
The correlation is significant at the 0.01 level (bilateral).			

Source: Processing done with SPSS v25, author's design.

Table 185 shows that the Pearson correlation index has stood at 0.824, thus indicating a perfectly positive correlation. Given that the bilateral significance value was p=0.000, i.e., below 0.01, the validity of the hypothesis is invalidated, and the alternative hypothesis is supported. Consequently, it is established that the relationship observed between the second variable and dimension 2 of the first variable, evaluated in the participants of the sample, is statistically significant.

4.5. Specific hypothesis 3

Table 6: Correlation test between problem solving and the stimulatory interaction dimension

		Stimulatory interaction dimension	Troubleshooting
Troubleshooting	Pearson correlation	1.000	0,819
	Sig. (bilateral)		0.000
	N	180	180
Stimulatory interaction dimension	Pearson correlation	0,819	1.000
	Sig. (bilateral)	0.000	
	N	180	180
The correlation is significant at the 0.01 level (bilateral).			

Source: Processing done with SPSS v25, author's design.

Table 6 shows that the Pearson correlation index has stood at 0.819, thus indicating a perfectly positive correlation. Since the bilateral significance value was p=0.000, i.e., below 0.01, the validity of the null hypothesis is invalidated, and the alternative hypothesis is supported. Consequently, it is established that the relationship observed between the second variable and dimension 3 of the first variable, evaluated in the participants of the sample, is statistically significant.

4.6. Specific Hypothesis 4

Table 7: Correlation test between Problem Solving and the internal team management dimension

		Internal team management dimension	Troubleshooting
Troubleshooting	Pearson correlation	1.000	0,822
	Sig. (bilateral)		0.000
	N	180	180
Internal team management dimension	Pearson correlation	0,822	1.000
	Sig. (bilateral)	0.000	
	N	180	180
The correlation is significant at the 0.01 level (bilateral).			

Source: Processing done with SPSS v25, author's design.

Table 7 shows that the Pearson correlation index has stood at 0.822, thus indicating a perfectly positive correlation. Since the bilateral significance value was p=0.000, i.e., below 0.01, the validity of the null hypothesis is invalidated, and the alternative hypothesis is supported. Consequently, it is established that the relationship observed between the second variable and dimension 4 of the first variable, evaluated in the participants of the sample, is statistically significant.

4.7. Specific hypothesis 5

Table 8: Correlation test between problem solving and the internal evaluation dimension of the team

		Internal team evaluation dimension	Troubleshooting
Troubleshooting	Pearson correlation	1.000	0,802
	Sig. (bilateral)		0.000
	N	180	180
Internal team evaluation dimension	Pearson correlation	0,802	1.000
	Sig. (bilateral)	0.000	
	N	180	180
The correlation is significant at the 0.01 level (bilateral).			

Source: Processing done with SPSS v25, author's design.

Table 8 shows that the Pearson correlation index has stood at 0.802, thus indicating a perfectly positive correlation. Since the bilateral significance value was p=0.000, i.e., below 0.01, the validity of the null hypothesis is invalidated, and the alternative hypothesis is supported. Consequently, it is established that the relationship observed between the second variable and dimension 5 of the first variable, evaluated in the participants of the sample, is statistically significant.

5. DISCUSSION

The general objective of the present study was to establish a relationship between cooperative learning and mathematical problem solving among the participants in the sample. The statistical analysis of the data set, in conjunction with the implementation of Pearson's correlation, yielded a significant parametric test, given the nature of the variables. The findings of this test projected a correlation coefficient of 0.940, signifying a robust positive association. The degree of bilateral significance was found to be 0.000, which remained below the critical threshold of 0.01. This finding allows for the rejection of the null hypothesis with a high degree of statistical confidence. Pursuant to the parameters delineated, a statistically significant association has been identified between the variables.

These results align with the findings reported by Rafael (2021), who, through statistical analysis, evidenced a positive correlation between cooperative learning and students' ability to solve mathematical problems. In the present study, a correlation coefficient of 0.823 was determined using Spearman's Rho coefficient. This finding indicates a bilateral significance of 0.00, resulting in an error margin of less than 1%. The latter enabled the null hypothesis to be refuted, thereby substantiating the existence of a statistically significant link and demonstrating a negligible margin of statistical error.

In a similar vein, Macedo (2021) demonstrated a moderate positive correlation, substantiated by a Spearman coefficient of 0.504 with a bilateral significance value of 0.00, indicating an error margin of less than 1%. This outcome substantiated the rejection of the null hypothesis, thereby corroborating the existence of a substantial correlation, which manifested itself with a residual error level of negligible magnitude.

In consideration of the aforementioned findings, the present analysis of cooperative learning in the participants of the sample yielded results consistent with the theoretical foundation proposed by Johnson et al. (1999). The aforementioned researchers argue that the implementation of cooperative learning in an orderly manner within the pedagogy strengthens both personal and collective development. The present research corroborates this theory. The successful performance of an individual is contingent upon the successful performance of the collective, wherein the achievement of the individual's solution is predicated upon the achievement of the goals of the other members of the unit.

The initial specific objective was to establish the relationship between positive interdependence and mathematical problem solving in the established sample. The statistical analysis of the data, employing Pearson's correlation coefficient, yielded a value of 0.815, signifying a substantial positive correlation. Conversely, the level of bilateral significance attained fell below the maximum permissible error threshold, thereby enabling the rejection of the null hypothesis. Consequently, it was established that positive interdependence maintains a significant correlation with the resolution of mathematical problems in the population studied.

This finding aligns with the results reported by Berrospi and Marti (2023), who identified a moderately positive correlation between positive interdependence and academic performance in students of a police institution. Their study utilized a Spearman's Rho correlational index of 0.50 to measure the relationship, indicating that 61% of students attained outstanding academic achievements.

However, Castillo and Rivera (2022) demonstrated that positive interdependence with the stressors and symptoms of academic stress exhibits a highly

significant correlation, with indices of -0.215 and -0.18 indicating an inverse correlation. The present findings align with those of Johnson et al. (1999), who posited that positive interdependence fosters the concept of teamwork, wherein each member plays a pivotal role and directs their efforts not solely towards their own benefit, but also towards the benefit of the collective. In this setting, personal growth is inextricably linked to the collective advancement of the team, fostering a collaborative environment characterized by shared responsibility and reciprocal assistance among its members. This approach circumvents the potential intervening factors that might otherwise compromise the relationship, such as academic stress.

The second specific objective was to determine the degree of relationship between individual and team responsibility and mathematical problem solving in the established sample. Pearson's correlation coefficient yielded a value of 0.824, indicating a very strong positive correlation. Furthermore, the bilateral significance value that was obtained fell below the established significance level, which consequently led to the rejection of the null hypothesis. Consequently, the present study confirms that responsibility, both at the individual and group level, maintains a relevant relationship with the resolution of mathematical problems within the sample studied.

As demonstrated by Berrospi and Marti (2023), a high positive correlation was consistently exhibited, with a Spearman's Rho correlational index of 0.710 measuring the relationship between individual and team responsibility and academic performance in students of a police school. This indicates that 95.40% of students demonstrate proficiency in both individual and group responsibilities. Accordingly, Johnson et al. (1999) posit that this secondary component comprises two elements: the first being the commitment to execute the assigned tasks of each member, and the second being the alignment with the group's objective. This process facilitates the identification of individuals requiring augmented support, guidance, and reinforcement to engage in the activity. Consequently, this enhances the academic performance of students. The collective learning effort, the fulfillment of assigned tasks, and the participation in supporting and guiding their peers are recognized and valued.

The third specific objective was to examine the relationship between stimulating interaction and mathematical problem solving in the established sample. Pearson's correlation test yielded a coefficient of 0.819, indicating a positive relationship with high intensity. Furthermore, the bilateral significance value was found to be below the 1% error threshold, thereby allowing the null hypothesis to be rejected. Consequently, it is suggested that the stimulating interaction maintains a statistically significant relationship with the resolution of mathematical problems in the sample evaluated.

This outcome aligns with the findings of Berrospi and Marti (2023), who reported a moderate positive correlation between promoter interaction and academic performance in students of a police school. Their study utilized Spearman’s Rho correlational index of 0.685 to measure the relationship between the two variables. The analysis revealed that 88.89% of students demonstrated a high level of proficiency in promoter interaction, suggesting a strong correlation between the two variables.

Furthermore, Castillo and Rivera (2022) demonstrated that the stimulatory interaction with the stressor dimensions and symptoms of academic stress entailed a highly significant correlation, since the indices -0.152 and -0.139 showed an inverse correlation. The findings are based on Johnson et al. (1999) because it is here that the team encourages and supports the optimal performance of its colleagues, demonstrating attitudes that strengthen both personal and team motivation. In this context, students are expected to cooperate in shared tasks, promoting joint achievement through the exchange of resources, offering mutual assistance, providing encouragement, and recognizing individual efforts in the learning process. They are also expected to leave aside pressure and stress in academic tasks.

The fourth specific objective was to analyze the relationship between the internal management of the team and the resolution of mathematical problems in the established sample. Pearson's statistical correlation test yielded a coefficient of 0.822, a value that demonstrates a very strong positive correlation. Consequently, the level of bilateral significance achieved fell below the established margin of error, thereby enabling the rejection of the null hypothesis with a high degree of certainty. Consequently, it is confirmed that the internal management of the team maintains a statistically significant relationship with the resolution of mathematical problems in the sample analyzed.

Castillo and Rivera (2022) demonstrated that interpersonal and team skills with the stressor and symptom dimensions of academic stress exhibited a highly significant correlation, with indices of -0.142 and -0.125, respectively, indicating an inverse correlation. In practical terms, this suggests that enhancing students' social interaction skills frequently leads to a reduction in academic stress.

Consequently, the cultivation of these competencies not only enhances group dynamics within the educational milieu but also functions as a protective mechanism against the deleterious effects of stress on academic performance.

In contrast, Berrospi and Marti's (2023) study reported a significant positive correlation between social skills and academic performance in police institution students, as measured by a Spearman's Rho correlational index of 0.79. This indicates that a substantial proportion of the student population, specifically 96.17%, demonstrated a high level of social skills. The findings of this study are consistent with the contributions of Johnson et al. (1999), who posited that ensuring optimal team performance necessitates the establishment of structured processes and procedures, as well as the delineation of roles and responsibilities, thereby facilitating the collective realization of the group's overarching objectives.

The fifth specific objective was to analyze the relationship between the team's internal evaluation and the resolution of mathematical problems in the established sample. Pearson's correlation coefficient yielded a value of 0.802, indicating a positive correlation of high magnitude. Furthermore, the bilateral significance value was found to be less than the critical threshold of 1%, thereby permitting the rejection of the null hypothesis. Consequently, it is concluded that the internal evaluation of the team maintains a statistically significant relationship with the resolution of mathematical problems in the sample studied.

This finding aligns with the observations reported by Munayco (2020), which demonstrated a direct and positive relationship between the team's internal evaluation and its social skills in mathematics. This correlation exhibited a strength of 0.409, indicating a medium-to-strong association between the variables. In a similar vein, Berrospi and Marti's (2023) study found that an index of 0.80 correlation between group processing and academic performance resulted in a 95.40% success rate for students achieving high levels in this dimension.

Castillo and Rivera's (2022) study found a highly significant correlation between the internal evaluation of the team and the stressors and symptoms of academic stress. The indices of -0.184 and -0.149 demonstrate an inverse correlation. The findings align with the assertions put forth by Johnson et al. (1999). To enhance the development of the curriculum, it is imperative that team members critically examine their collaborative dynamics and proactively seek strategies to augment collective efficiency. This approach enables them to establish clearly defined responsibilities and foster an environment of mutual support, thereby mitigating academic pressure and stress.

6. CONCLUSIONS

A significant positive correlation has been observed between cooperative learning and mathematical problem-solving skills in first-grade students at the Pedro Mercedes Ureña Educational Institution in Trujillo, as evidenced by data collected in 2023. The application of Pearson's parametric test yielded a value of 0.940, thereby affirming the hypothesis that the development of cooperative practices positively impacts students' performance in solving mathematical problems.

In the context of positive interdependence, a significant positive correlation was identified with the resolution of mathematical problems, as evidenced by a statistical significance of 0.815, calculated based on Pearson's parametric test. This finding suggests a positive correlation between the extent of positive interdependence within a team and the subsequent enhancement of students' problem-solving performance.

A significant positive correlation was identified between the resolution of mathematical problems and both individual and team responsibility, with a statistical significance of 0.824. This finding indicates that the delineation of distinct responsibilities for individual contributors, in conjunction with the establishment of collective commitment, has a positive impact on the enhancement of mathematical competencies that are oriented towards problem-solving.

In the stimulatory interaction, a correlation coefficient of 0.819 was evidenced, indicating a substantial positive correlation with the resolution of mathematical problems. This component fosters the exchange of ideas, inquiries, and clarifications among peers, thereby reinforcing the cognitive processes essential for more efficacious mathematical problem-solving.

A significant positive correlation of 0.822 was identified between the team's internal management and the resolution of mathematical problems. Consequently, it can be concluded that adequate internal organization, distribution of roles, and group coordination have a direct impact on the students' ability to face and solve mathematical situations.

The team's internal evaluation revealed a substantial positive correlation of 0.802 with the resolution of mathematical problems. This finding lends further credence to the notion that the collaborative evaluation process within the team

fosters collective reflection and the refinement of strategies, which are pivotal for enhancing the efficacy of mathematical problem-solving.

Furthermore, the validity of the general hypothesis is confirmed as a positive and statistically significant correlation between cooperative learning and mathematical problem solving is demonstrated. This relationship is empirically substantiated by the correlation coefficients obtained in each of the dimensions analyzed, which reveal that the systematic implementation of cooperative strategies contributes substantially to the problem-solving capacities of mathematical problems. Therefore, it can be posited that cooperative learning not only fosters interaction and commitment among group members but also has a direct impact on the cognitive development required to effectively address mathematical problems in school contexts.

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