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The Cooperative Method In The Teaching-Learning Of Mathematics And Academic Achievement In High School Students, San Juan De Lurigancho

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Abstract

The present article entitled: The cooperative method in the teaching - learning of mathematics and academic performance in high school students, San Juan de Lurigancho. The general objective was to determine the relationship between the cooperative method in the teaching - learning of mathematics and the academic performance of the students of the VI Cycle of the Educational Institution "Saúl Cantoral Huamaní" of the district of San Juan de Lurigancho. Lately, there has been a lot of talk about cooperative learning in schools as a resource or strategy to address diversity. However, cooperative learning in schools is not something new. In many unitary schools it has been practiced and continues to be practiced for a long time: some students -generally the older or more advanced ones- teach the others -generally the younger or less advanced ones-. Ovejero (1990) recalls that Commenius, a 17th century pedagogue (1592-1670), firmly believed that students would benefit as much from teaching other students as from being taught by them. As early as the 18th century, Joseph Lancaster and Andrew Bell used cooperative learning groups in England, which they later exported to the United States. This tradition, in the United States, was continued by Francis Parker - who popularized cooperative learning to the extent that more than 30,000 teachers joined this cooperative movement (according to Campbell, 1965, cited by Ovejero, 1990) - and by John Dewey, who introduced cooperative learning as an essential element of his democratic instructional model. The results have allowed us to infer that in fact the use of the cooperative method in the teaching of mathematics really allows to generate a better academic performance in students, having satisfactorily proved the hypotheses raised for the present study.

Keywords: Cooperative learning, learning strategies, academic performance, interaction, cooperation.

1.   Introduction

En Research on cooperative learning began in the 1920s. According to Fernandez & Melero (1995), it appears, in these years already, in relation to a laboratory research on the subject of cooperation. Deutsch, in 1949, presented an influential theory on cooperation and competition, a theory inherited from Kurt Lewin, which would serve as the basis for the first studies on cooperative learning in the 1970s. Deutsch was a student of Kurt Lewin and applied Lewin's theory of motivation to interpersonal situations. From this theory it can be stated that it is the drive towards the goal that motivates people to behave cooperatively, competitively or individually.

In the 1970s, research on specific applications of cooperative learning emerged (Slavin, 1994). In these years there are four research groups that independently began to examine and analyze different cooperative learning techniques in the school environment. Three in the USA, led by brothers David and Roger Johnson at the University of Minnesota (1975), Elliot Aronson at the University of Santa Cruz (1978), California and Robert Slavin at Johns Hopkins University (1977) and one in Israel, led by Shlomo Sharan and Raqhel Lazarowitz, who developed their cooperative learning techniques at the University of Tel-Aviv (1976).

Research in the 1970s attempts to apply cooperative learning techniques to different contents: language, reading, mathematics, natural sciences, social studies, psychology, artistic activities and physical education. The tasks involve concept acquisition, special problem solving, retention and memory, motor performance, and guessing, judgment and prediction tasks. Thus, researchers from numerous disciplines, including educational psychology, developmental psychology, social psychology, cognitive psychology, mathematics, and various fields of science, focus on the study of learner interaction as a critical variable in learning and cognitive development (Webb 1989a).

In the 1980s, studies were based on comparing three types of interaction and organization: cooperative, competitive and individual (Johnson, Skon and Johnson 1980; Skon, Johnson and Johnson 1981) and analyzing the results and consequences on different academic (learning, performance, productivity), affective (motivation, self-esteem) and social (social skills, integration, acceptance) variables. Also noteworthy is the meta-analysis carried out by Johnson, Maruyama, Johnson, Nelson and Skon (1981), in which they reviewed all the studies, from 1924 to 1981, that compared the effectiveness on performance and productivity of cooperative, competitive and individualistic methods.

Also at this stage, numerous investigations focused on the comparison of different cooperative learning techniques. Thus, for example, Slavin (1985) compared the effectiveness of STAD, TGT and TAI methods on performance and interactions among participants, using 41 field experiments in primary and secondary schools. From the 1980s onwards, there was a change in the research on cooperative learning, which modified the object of study from the comparison of cooperative, competitive and individualistic situations to the analysis of the factors that condition the effects of cooperative learning. In the words of Vicente and Fajardo (1997), the aim is to find out the causes of the positive results of cooperative learning and the mechanisms involved.

In the early 1990s, the focus of research was mainly directed towards resolving questions related to the effectiveness of cooperative learning and the mediating mechanisms involved. The goal of the research revolves around two axes: the first one focuses on the nature and quality of the interactive process, while the second one refers to antecedent factors that condition the effectiveness of cooperative learning. Some research related to the interactive process analyzes the speech used by the components of a cooperative group (Bennet, 1985; Bennet and Dunne, 1991). These authors specifically address the nature and quantity of speech in cooperative groups and its variability in relation to the content and demands of the tasks and the type of cooperative group.

Other research studies cognitive processes that take place in peer interaction, such as the importance of asking for and giving help and explaining oneself, explaining to others (Johnson and Johnson, Stanne and Garibaldi, 1990; O'Donnell, Dansereau, Hall, Skaggs, Hythecker, Peel and Rewey, 1990). In relation to the previous factors that condition the effectiveness of cooperative learning, throughout the 1990s a series of studies have shown how certain individual characteristics may be influencing the positive results of cooperative learning; some of these individual differences studied are: verbal ability and cognitive style (Rewey, Dansereau, Dees, Skaggs and Pitre, 1992).

It has also been found that the effectiveness of cooperative learning may be stronger for certain individuals: high in induction and extroversion cognitive skills (Hall, Rocklin, Dansereau, Skaggs, O'Donnell, Lambiotte, & Young, 1988) and in social orientation (O'Donnell & Dansereau, 1992). However, we lack research demonstrating the influence of interpersonal variables on cooperative learning outcomes. It is logical to think that, in these situations, variables related to social interactions and interactive processes that occur in group work are more important. In this sense, the social skills of the participants and certain interpersonal dimensions are considered relevant. For this reason, the character of the participants: introverted, extroverted, independent, gregarious, shy, can affect the success and failure of cooperative learning.

On the other hand, there is hardly any research that examines the importance of prior training in social skills and/or group dynamics. All this despite the fact that many authors emphasize the importance of the social skills of group members and group maturity (Echeita, 1995; Fabra, 1992; Johnson & Johnson, Holubec and Roy, 1984; Johnson & Johnson Stanne and Garibaldi, 1990; Slavin, 1983a). In that sense, social skills and group maturity are important, why not test their influence on performance and interactive processes in cooperative learning situations? The more social interaction resources are consolidated in the group, the higher the performance of cooperative systems will be. Therefore, the teaching of cooperative social skills is an important prerequisite for the success of cooperative learning situations.

In the late 1990s and at the present time, the focus of research is again on the results and consequences of cooperative learning on academic, affective and social variables. Likewise, most research has focused on the study of the relationship between cooperative learning and motivation. In the meantime, researches that analyze the use of cooperative learning techniques as an adequate method for the acquisition of skills and social competences follow.

The rest of the researches analyze the influence of cooperative learning: on the learning of mathematics, language, reading, chemistry and on the use of computers. Under the research there are interesting attempts to link cooperative learning and computers, even to use them together for learning to write (Hertz-Lazarowitz and Bar-Natan, 2002; Latchmen, 2001).

The concept of cooperative learning encompasses a very different set of techniques and methods that sometimes have little in common and usually differ in terms of the degree of interdependence of rewards, degree of interdependence of the task, degree of individual responsibility, degree of structure imposed by the teacher or by the task itself, and degree of use of competition that can go as far as non-competition (Fabra, 1992). Therefore, based on the criteria of goal interdependence and reward

interdependence proposed by Fabra (1992) and following a chronological order, the different conceptual approaches to the definition of cooperative learning are analyzed. Thus, there are two totally different meanings of cooperative learning: the first from social psychology and the second from behaviorist positions.

From the point of view of social psychology (Deutsch, 1949), according to Kurt Lewin's perspective, he defines a cooperative social situation as one in which the goals of separate individuals are so closely linked that there is a positive correlation between the attainment or achievement of their objectives; an individual achieves his objective if and only if the other members also achieve theirs. A competitive social situation is one in which the goals of the separate components are related to each other in such a way that there is a negative correlation between the attainment of their goals. Consequently, an individual will achieve his goal if and only if the others do not achieve theirs. Hence, an individualistic situation is one in which there is no correlation between the attainment of the participants' objectives; the attainment of an objective by one member does not influence the attainment of his objective by the other participants. Consequently, each participant will seek to achieve his or her objective, without any regard for the actions of the others.

From the behaviorist perspective, Kelley and Thibaut (1969) defined a cooperative structure as one in which the rewards or reinforcements of the individual are directly proportional to the quality of the group work. Within this perspective we can place Slavin's (1985) definition, according to which cooperative learning methods are methods to give incentives for cooperation, and to give students recognition, rewards and grades based on the academic success of their groups. That is why, in a competitive organization, it is only one member of the group who receives the maximum reward, while the others receive lesser rewards.

In the individual organization the participants are rewarded according to their results with total independence of the results of the others; as can be appreciated, the incentive or reward structure refers to the way of distributing the reinforcements or incentives among the members of a group, this supposes an added problem that, far from clarifying the concept of cooperative learning, makes it even more difficult; how to plan the rewards in the group? There is great disagreement on the criteria used to apply reinforcement, so that there are cooperative learning techniques that do not use the reward structure. Likewise, Fandt, Cady and Sparks (1993) divide cooperative learning methods and techniques into three groups according to the way rewards are distributed.

In the first group are those methods that use an interdependent reward structure; this structure consists of rewarding the group depending on the individual rewards. Thus, incentives are given on the basis of individual learning, as in the case of Slavin's methods: Team Learning Teams by Performance Divisions (STAD), Team Learning Tournaments (TGT) and Team Assisted Individual Learning (TAI). The second group includes methods that use a dependent reward structure; this structure rewards the group based on group productivity. Examples of these methods are: Johnson & Johnson's Learning Together and Sharan's Group Investigation.

In the opinion of the researchers, the two previous definitions of cooperative learning are the most widely accepted by the scientific community. However, there are other definitions that emphasize the characteristics or properties that cooperative learning techniques must meet in order to be effective. For Gage and Berliner (1988), cooperative learning situations are characterized by the fact that success and failure are distributed among the participants, with each student contributing to the group the benefit of his or her most appropriate characteristics.

According to Johnson & Johnson (1987), cooperative learning groups are based on positive interdependence among group members. Goals are structured so that students are interested not only in their own effort and performance but also in the performance of others. There is a clear individual responsibility where each student's mastery of the assigned material is evaluated; information is provided to the group and its members about each one's progress, so that the group knows who needs help.

For Coll & Colomina (1990) cooperative learning is a label used to designate a wide range of approaches, these have in common the division of the class group into subgroups or teams of up to six people who develop an activity or perform a previously programmed and structured task. Cooperative learning is characterized, in principle, by a high degree of equality; team members are usually heterogeneous in terms of skills to perform certain activities. According to Echeita (1995), Johnson & Johnson (1989) and Slavin (1990), there are three basic requirements for cooperative learning. The first of these refers to the existence of a group task, i.e., an objective that the different students working together must achieve as a group. Therefore, the situation must involve not only doing things together but also facing and solving a common task or problem and, as a consequence, learning together. The second implies the resolution of that task or problem; the contribution of each and every one of the components of the group is required; the third refers to the resources of the group, which must be sufficient to maintain and progress its own activity, both from the point of view of the regulation of interpersonal relationships, as well as in relation to the development and execution of the task.

After the analysis of the problematic reality, the general problem was formulated as: What is the relationship between the cooperative method in the teaching-learning of mathematics and the academic performance of the students of the VI cycle of the Educational Institution "Saúl Cantoral Huamani" of the district of San Juan de Lurigancho? Being the specific problems: (i) What is the level of development of the essential components of cooperative learning in the students of the VI cycle of the educational institution "Saúl Cantoral Huamani" of the district of San Juan de Lurigancho? and (ii) What is the level of academic performance of the students of the VI cycle of the educational institution "Saúl Cantoral Huamani" of the district of San Juan de Lurigancho?

The general objective was also formulated: To determine the relationship between the cooperative method in the teaching-learning of mathematics and the academic performance of the students of the sixth cycle of the educational institution "Saúl Cantoral Huamani" of the district of San Juan de Lurigancho. The specific objectives are: (i) To determine the level of development of the essential components of cooperative learning of the students of the vi cycle of the educational institution "Saúl Cantoral Huamani" of the district of San Juan de Lurigancho; and (ii) To determine the level of academic

performance of the students of the VI cycle of the educational institution "Saúl Cantoral Huamani" of the district of San Juan de Lurigancho.

2. Métodos

The present research is descriptive and explanatory, non-experimental, longitudinal: (i) It is descriptive: this research focuses on the description of phenomena, activities, processes, people and objects that make up the context of the educational process. It is intended to describe the essential characteristics of the situation under investigation: What is the relationship between the cooperative method in the teaching-learning of mathematics and the academic performance of the students of the VI Cycle of the educational institution "Saul Cantoral Huamani" of the district of San Juan de Lurigancho; (ii) It is explanatory: the objective of the research is to establish causal factors about the facts that occur or happened in relation to the application of the cooperative method in the teaching-learning of mathematics. From the analysis, formulations, planning and others that improve the given processes are suggested; (iii) It is experimental: The observation will be made respecting the context itself, from which the analysis of the facts will be made; and (iv) It is longitudinal: the data will be collected at different times, with the purpose of describing variables and analyzing their incidence and interrelation throughout the development of the quasi-experimental design.

Table 1. Official research sample

Cycle	Section	Sample	Percentage
Experimental Group	A	40	50%
Control Group	B	40	50%
	Total	80	100%

Note: author's own elaboration.

3. Resultados

According to the findings of the study, as shown in table 1, we worked with a sample of 80 students from the educational institution, which yielded the results indicated below:

General Hypothesis Test:

Ho: There is no significant relationship between the cooperative method in the teaching-learning of mathematics and the academic performance of students in the VI cycle of the educational institution "Saúl Cantoral Huamani" of the district of San Juan de Lurigancho.

Hg: There is a significant relationship between the cooperative method in the teaching-learning of mathematics and the academic performance of the students of the VI cycle of the educational institution "Saúl Cantoral Huamani" of the district of San Juan de Lurigancho.

Table 2. Statistical results

		Cooperative Metod	Academic performance
Cooperative	Pearson's correlation	1	.465(**)

Metod	Sig. (bilateral)	-	.006
	N	40	40
Academic performance	Pearson's correlation	.465(**)	1
	Sig. (bilateral)	.006	-
	N	40	40

** The correlation is significant at the 0.01 level (bilateral).

Interpretation: According to table 2, Pearson's correlation coefficient r=0.465. Then the degree of correlation between the variables cooperative method and academic performance according to the obtained values the correlation is medium and positive, according to Pearson's indexes.

Specific hypothesis 1.
Ho: The level of development of the essential components of cooperative learning does not influence the students of the VI cycle of the educational institution "Saúl Cantoral Huamani" of the district of San Juan de Lurigancho.
H1: The level of development of the essential components of cooperative learning significantly influences the students of the VI cycle of the educational institution "Saúl Cantoral Huamani" of the district of San Juan de Lurigancho.

Table 3. Statistical results of the T-test for equality of means.

		T-test for equality of means						
				Sig. (bilateral)	Diferencie of means	Standard error of the difference	95% Confidence interval for the upper lower difference	
		t	gl				Lower	Upper
Academic performance	Equal variances have been assumed	3.376	61	.001	2.02941	.60112	.82741	3.23142
	Equal variances have not been assumed	3.276	47.949	.002	2.02941	.61942	.78395	3.27487

Interpretation: According to Table 3, it can be inferred with a significance level of 0.05 that, the performance of the experimental group in the exit test is higher than the academic performance of the control group in the exit test. Therefore, the level of development of the essential components of

cooperative learning significantly influences the students of the VI cycle of the educational institution "Saul Cantoral Huamani" of the district of San Juan de Lurigancho.

Specific hypothesis 2.
Ho: u1≤u2, the experimental group have lower or equal performance than the control group in the exit test in the students of the VI cycle of the educational institution "Saul Cantoral Huamani Cantoral" of the district of San Juan de Lurigancho.
H2: u1>u2, the experimental group has better performance than the control group in the exit test in the students of the VI cycle of the educational institution "Saúl Cantoral Huamani" of the district of San Juan de Lurigancho.

Table 4. Statistical results of the experimental and control groups.

GROUPS	EXPERIMENTAL			CONTROL		
Moments	INPUT	PROCESS	OUTPUT	INPUT	PROCESS	OUTPUT
N	40	40	40	40	40	40
Mean	12,00	14,85	16,03	11,97	12,24	14,00
Median	12,00	14,50	16,00	12,00	12,00	15,00
Mode	12	14	18	13	11	16
Standard deviation	2,256	1,480	1,915	1,918	3,280	2,828
Variance	5,091	2,190	3,666	3,677	10,761	8,000
Minimum	8	11	12	8	7	7
Maximum	16	18	19	16	18	17

Interpretation: According to Table 4, it can be evidenced that the output test is higher than the input test in the experimental group. Therefore, the level of academic achievement of the students of the VI cycle of the Educational Institution "Saúl Cantoral Huamani" of the district of San Juan de Lurigancho, after applying the cooperative method is significant.
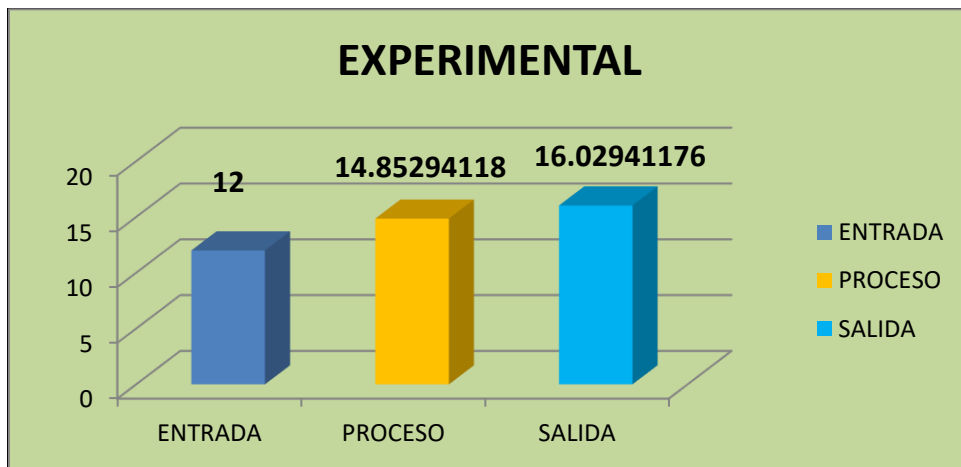
Figure 1. Arithmetic mean of mathematics performance in the experimental group.

Interpretation: According to figure 1, in the experimental group the arithmetic mean is increasing according to the input, process and output moments. The difference between the input test and the output test in high school students is significant.
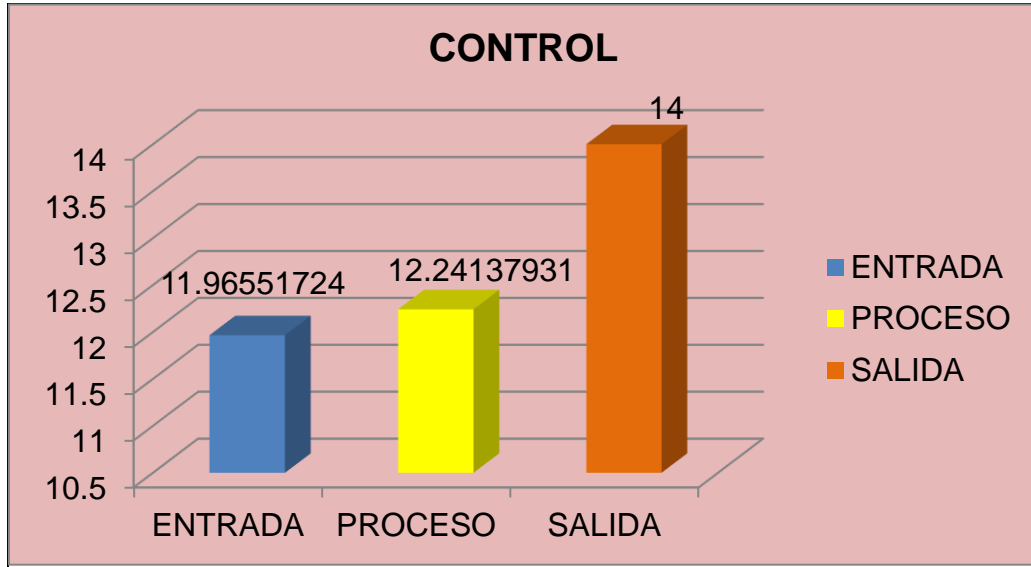

Figure 2. Arithmetic mean of mathematics performance in the control group.

Interpretation: According to figure 2, in the control group, the arithmetic mean is increasing according to the input, process and output moments. However, the difference between the input test and the output test in high school students is not significant.
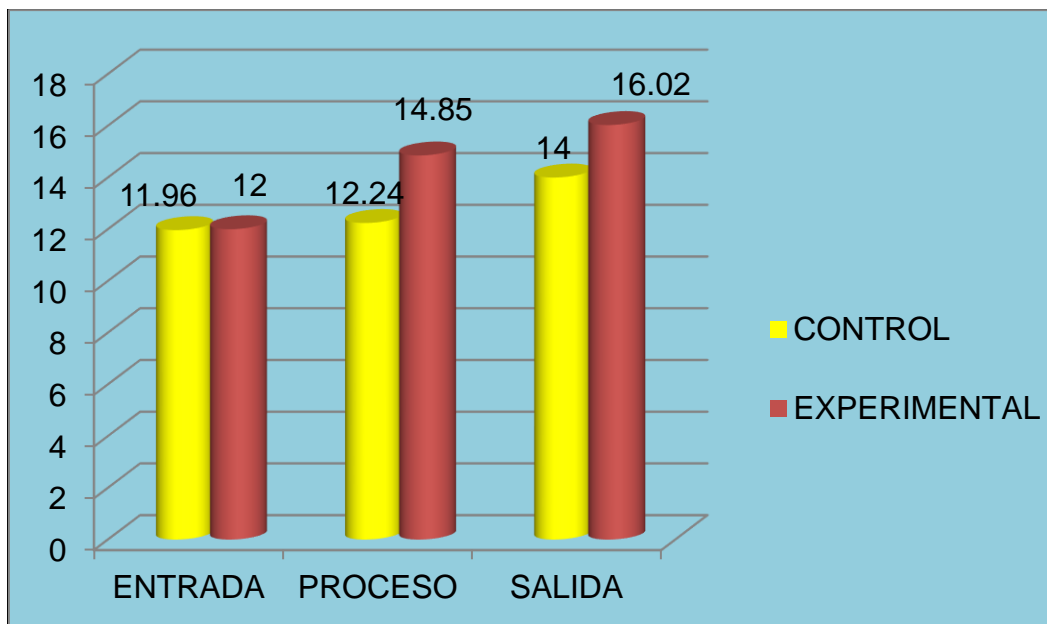

Figure 3. The arithmetic mean of mathematics performance of the experimental and control groups.

Interpretation: According to figure 3, in the entry test both groups obtain similar means, the control group with 11.96 and the experimental group with 12. In the process test there is already a difference between the arithmetic mean of the control group with respect to the experimental group. Since the control group presents a mean of 12.24 and the experimental group a mean of 14.85. In the exit test there is also this difference between the arithmetic means of both groups. Where the control group has a mean of 14 and the experimental group a mean of 16.02 in high school students.

4. Discussion

The review of theoretical approaches has allowed us to conclude that the cooperative classroom is based on the postulates of at least the following theories: Vygotsky's Sociocultural Theory. Piaget's Genetic Theory and its development through the Geneva School of Social Psychology, the Johnson brothers' Theory of Positive Interdependence, Ausubel's Meaningful Learning, Rogers' Humanistic Psychology and Gardner's Theory of Multiple Intelligences.

Theoretically, we agree with Johnson and Holubec (1999), when they point out that cooperative learning is the didactic use of small groups in which students work together to maximize their own learning and that of others. Cooperation is about working together to achieve common goals. It is clear that, in a cooperative situation, individuals seek to achieve results that are beneficial to themselves and to the other members of the group.

From the results and in accordance with Slavin (1999), we have verified that the group as a small community requires a set of rules for its optimal functioning, thus we have: positive interdependence, face-to-face interaction, individual responsibility, heterogeneous groups, individual and group evaluations and reflections, and development of social and group skills.

In view of the results obtained, we can affirm that there is a significant relationship between the application of the cooperative method and the learning of mathematics, which necessarily affects the achievement of a better academic performance of the selected students, given that the results of the statistics are positive, globally and in its different components, highlighting the total score.

The results obtained allow us to infer the existence of a significant relationship between the cooperative method in the teaching-learning of mathematics and the academic performance of the students of the VI cycle of the educational institution "Saúl Cantoral Huamani" of the district of San Juan de Lurigancho.

According to Pearson's correlation coefficient r=0.465 we can conclude that the degree of correlation between the variables cooperative method and academic performance according to Sampieri's table is medium positive correlation, according to the correlation indexes.

Finally, we can point out that there is a fundamental difference between group work and cooperative work. As Pujolás (2004) summarizes, it is not only a matter of doing the same thing together, but also of doing each one doing something in the service of a "community" that pursues common goals,

in this case better learning of mathematics.

5.   Conclusiones

1. In view of the general results, we can point out that we have verified the existence of a significant relationship between the cooperative method in the teaching-learning of mathematics and the academic performance of the students of the VI cycle of the educational institution Saul Cantoral Huamani of the district of San Juan de Lurigancho, results that allow us to infer the benefits of the cooperative method in learning and better academic performance in the experimental group.
2. In relation to the level of development of the essential components of cooperative learning in the students of the VI cycle of the educational institution Saul Cantoral Huamani of the district of San Juan de Lurigancho, it is significant.
3. According to the results obtained in the Kolmogorov-Smirnov test, the control group has a value of p=0.343, this result is greater than 0.05, therefore, the distribution of the data is normal. In the experimental group the value of p=0.277 being greater than 0.05, therefore, it has a normal distribution.
4. Likewise, it can be inferred with a significance level of 0.05 that, the performance of the experimental group in the exit test is higher than the academic performance of the control group in the exit test. Therefore, the level of development of the essential components of cooperative learning in the students of the VI cycle of the educational institution "Saúl Cantoral Huamani" of the district of San Juan de Lurigancho, is significant.
5. From the results obtained we can infer with a significance level of 0.05 that the output test is higher than the input test in the experimental group. Therefore, the level of academic achievement of the students of the VI cycle of the educational institution "Saúl Cantoral Huamani" of the district of San Juan de Lurigancho, after applying the cooperative method is significant.

6.   References

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