Journal of Physical Education & Health, 2018, vol. 7 (12), 37-47

MATHEMATICS AND PHYSICAL MOTOR EXPRESSION: A STUDY OF PRE-SCHOOL CHILDREN AT THE LEVEL OF TASKS TIME EXECUTION

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Abstract

This investigation intends to examine whether there is a correlation between the speed of execution of mathematical tasks successfully resolved and the execution speed of the physical motor control tasks. The specific objectives defined are: knowing if there is a correlation between the times obtained in the activity of Mathematics and times in the activity of Motor Expression; Verify if there is a correlation between the times obtained in the activity of Mathematics and times in the group activity; Verify if there is a correlation between the times obtained in Motor Expression activity and the times obtained in the group activity. The methodology adopted for the realization of this study falls mainly on a positive paradigm, assuming a correlational nature typology. The study was conducted with a group of 22 children. These children performed three timed activities, individually, one for each domain and for the group task. The data analysis was conducted using the statistical program SPSS (version 20). After analysis and processing of data we have obtained positive correlation for all tests, however with very different correlation coefficients. We had a correlation coefficient of $r = 0.051$ between the activity of Mathematics and the activity of Motor Expression, revealing a tiny positive correlation. The test between the activity of Mathematics and Group Activity originated the correlation index $r = 0.749$; revealing a moderate positive correlation. In the test between the activity of Motor Expression and Grupo Activity, we had a correlation coefficient $r = 0.191$, which indicates a weak positive correlation. It was still observable that these data change when we focus only on the results of children aged 5 years old. In the first a correlation index $r = 0.315$ was obtained, changing from tiny to weak positive; the second got an index $r = 0.843$, changing from moderate to strong positive; the third got an index $r = 0.678$, and therefore the positive correlation moderate.

Key words: *Mathematics, Motor Expression, simple classification, multiple classification, Preschool Education*

Introduction

Over many years in school, we as students have been faced with several children and young people who consider that Mathematics entails various difficulties, and who frequently question its usefulness and importance on a regular day basis. These difficulties and doubts sometimes lead these children and young people to fail to develop any interest for this area of knowledge. The same sometimes happens with the area of Motor Expression and Physical Education, when some children and young people believe that they have no capability for games or sports. Sometimes, in these classes it is not so much a lack of enthusiasm that disturbs these children or young people, but the shame of exposing themselves to those colleagues who have certain attitudes and behaviours. For this reason and the interest of both these areas, we decided to study them in Preschool Education: a step where they develop the main bases of knowledge and the first motor skills.

Mathematics in Preschool Education

Moreira and Oliveira [25] consider that Mathematics today has more influence in society: the importance given to the fact that people require mathematical skills that help in making several decisions concerning their daily activities in a sustainable and informed way. Moreira and Oliveira [25] suggest that mathematics is a matter of thinking, involving the understanding, recognition and the use of relations in different contexts, thus considering that children and young people must have access to information that favours the understanding of mathematics as a way of thinking and as a human activity. The teaching of mathematics is fundamental at pre-school age, where the child, from a very early age, is faced with situations that lead to developing mathematical concepts in a natural and spontaneous way. The mathematical experiences that children have at this stage are essential for their mathematical growth, because in kindergarten children begin to build and develop feelings related to mathematics and about themselves; feelings that may influence future attitudes and decisions [23].

Motor expression in Preschool Education

Physical motor expression appears within the area of expression and communication, termed the field of motor expression. Pre-school education should provide moments of exercise of global and precise motricity, allowing the children to use and know their own body. According to Rigal [28], what emerges in the activity of a child is the driveability. The child is an active individual by nature, in constant movement and interaction with their environment. Physical activity and motor actions are aspects of most moments of daily life. Under these conditions, it is normal that a large part of his time is spent in motor activities generally and/or more precisely, during the pre-school stage. Gallahue [17] seems to agree with Rigal [28] revealing that movement is the centre of the active life of children and an important facet in all aspects of human development, be it in the motor field, cognitive or affective. For this author, "to deny children the opportunity to gather the many benefits of a vigorous and regular physical activity is to deny them the opportunity to experience the joy of efficient movement, the effects of motion and a healthy life as active persons being competent and confident" (p. 49). Rigal [28] considers that, along with morphological development, motor development is the most evident aspect in the child's behavioural changes associated with their motor coordination. "In fact, as it grows, the child will acquire and dominate motor behaviours increasing its complexity, and at the age of four, demonstrates a qualitative motor control very similar to adults, even if your income is very low" [28, p. 143]. Ferreira [16] affirms that through physical activities it is possible to work, improve and educate movements, as well as develop the physical well-being, both mental and social.

Mathematics and Motor Expression

Along with the child's development, the role of motor activity is essential not only in the coordination of activities of its own sensorial intelligence, but also in the development of other aspects of intelligence, intervening at all levels of development of cognitive functions [28]. Also Papalia, Olds and Feldmand [26] consider that all aspects of the child's development, physical, cognitive, emotional and social are connected. In education, this may be a condition of quality improvement, leading to the overall formation of a human being, Fazenda [15]. Rigal [28] affirms that the child may be encouraged to perform counting, comparison of quantities, or to identify digits and geometric shapes; starting the learning of mathematical content while practicing a physical activity. The interdisciplinary nature of these two areas provides the opportunity for the child to develop their psychomotricity and the ability to establish mathematical concepts present in their daily lives. Smole [35] considers that physical activities are a way for children to learn general concepts and mathematical concepts, adding that "there is no place in mathematics for the student's 'body', especially in the school playground, which are the genesis of all representations, of all the concepts, preconcepts and concepts that later will bring the possibility of a child learning the beauty of mathematics as a science" (p. 121). Motor activity, especially through manipulation, facilitates access to schemes and representative operating systems and is therefore the starting point for concrete ideas and the support of the acquisition of many concepts. Even though the role of motor activity in favour of school learning is not demonstrated with clarity, there is no doubt that it favours the global development of the child allowing them a greater diversity of experiences. Precise and general motor activities can improve basic motor skills, facilitate the perceptive-motor integration and allow motor skills to be a starting point of cognitive functions. For Rigal [28], the fact that perceptive/motor and cognitive functions often are correlated, raises the hypothesis that the improvement of the first can produce an improvement in the second. "Only if a motor activity involves an important part of cognitive abilities can we expect an improvement of these" (p. 23). The same author considers that the motor activity is a starting point for the concrete and inevitable acquisition of physical concepts as perceptive elements associated with the forms of discrimination or in the acquisition of motor control of graphic movement. If the perceptive and intellectual development favoured by motor action determines in large part success at school, we can infer the existence of a relationship between both. Also Ferreira [16] affirms that the interdisciplinarity of Motor Expression and Mathematics meets "The needs of the child to live, participate and understand a world that requires different knowledge and skills" (p. 41). The learning of concepts or basic skills through the psychomotor education corroborates the idea that the motor activity motivates the child and strengthens their gains. Motor activities usually raise a greater interest in the child, who considers them more pleasant, especially, because immediate feedback on the success or failure of the execution of an instruction is transmitted. Sicilia also [33] affirms that physical education will have a prominent place in pre-school education in all educative action, constituting the basis of preparation for multiple learning, which is more attractive to children. In short, Meur and Staes [23] consider that "the motor function, the intellectual development and the affective development are closely linked in children: The psychomotricity highlights the relationship existing between the drivability, the mind and the affectivity and facilitates the child's overall approach by developing a technique" (p. 5). Moreira and Oliveira [25] have stated that research in mathematics education at the level of pre-school education was still scarce, "being so important that educators with their educational experience and consequent collaborative work, along with readings and appropriate training, seek inspiration and make necessary changes in the environment of learning of mathematics" (p. 26). After some time dedicated to research, we were able to assume that there are few studies on the relationship of the two areas that we intend to study. As we have seen, there are already some studies on the relationship of sport with cognitive activity and school performance. In 1927, Bills, referenced by Costa [12], conducted a study which found that the increase of muscular tension constituted an element facilitator in the performance of several psychological tasks, as the subject in such conditions revealed greater accuracy in solving simple maths problems. The same author refers to Grupta, Sharma and Jaspal (1974), who conducted studies on the effects of aerobic exercise, noting that, immediately after 2 and 5 minutes of exercises, the performance of the subjects in simple arithmetic tasks significantly increased and decreased after 10 and 15 minutes.

The Concept of Classification

The logical-mathematical structures appear together in actions of classification and serialization [28]. In accordance with the GGOPS (1997), the classification shall constitute the basis for: forming groups of objects according to established criteria (colour, shape, size, etc.) and recognizing the similarities and differences between these objects that allow one to distinguish those which belong to a specific set; serialize and sort, recognize the properties that allow the appropriate categorisation of objects according to their qualities (height, length, thickness, lightness, speed, duration, etc.).

Sorting is a process that takes on special importance in Preschool Education because it contributes to the promotion of numerical and geometric skills, as well as for the development of capacities of observation and organization. The ability to reason systematically begins concurrently, and it is important that children have time to do so. The games based on properties of objects are useful for the development of capacity, and the educator can gradually introduce, classifications that contain multiple attributes [25]. According to these authors, the child knows how to sort when it can include an object in a set given certain properties. For this reason, it implies that the child cannot identify properties in the objects around them, and noticing that, sometimes, it is possible to classify in several ways, according to the properties. Through the application of a factsheet belonging to the training program of Mathematics in our school, the classification is one of the pre-numerical concepts, i.e., a concept defined as a pre-requisite for the understanding and consolidation of the concept of numbers. This mathematical concept is the grouping of objects, i.e., the ability to count as equal elements of a set. We can speak of simple classification or multiple classification, the first being related to the identification of only one attribute and the second to more than one attribute. There are many activities that children can accomplish, as suggested by Moreira and Oliveira [25, p. 42]: "to recognize some object properties, compare properties of different objects, select a classification criterion or discover the criterion used in a classification, sort objects taking into account a criterion or discover the criterion used in sorting". In short, it is important that the child has the possibility of making the classification of objects, things and events, in kindergarten. This activity should be rich, varied and continuous, because it is here, and in the creation of spaces of reflection upon it, that the child may disregard the numerical concepts [4].

Materials - The Logical Blocks

With respect to mathematics, many attempts to address it through a playful environment have been achieved with the use of games built specifically for this purpose. Based on Piaget Rigal [28] affirms that "knowledge is not simply a copy of reality, but rather the result of an assimilation characterized by the action of the subject on the objects or their properties" (p. 64). Therefore, that access to knowledge has its origin in action, manipulation and experimentation, which constitutes the basis of the first forms of representation. The child builds their knowledge from the actions they perform on the objects to determine their characteristics. i.e. the activities of manipulation facilitate the exploration of the world and their understanding. This manipulation, according to the same author, can be: random; guided or self-guided. The first characterizes the behaviour of the child when, without a plan, without anticipations to guide their steps, they manipulate randomly. This can be supplemented with an exploratory manipulation, in which the child first observes the objects and then selects some to perform an action according to a certain intention. In guided manipulation, the child performs an action planned by an adult, with defined objectives for future purchases. It is important that the child perceives what was asked, discovers relevant ways for resolving the situation, analyses their action and evaluates its results. These experiences allow extraction of information about the objects through reflection and abstraction. Finally, self-guided and experimental manipulation attempts to verify through the action if what is produced from a mental hypothesis is correct or not" [28, p. 69]. In accordance with the GGOPS (1997), the use of ludic and didactic materials gives the child opportunities to solve logical problems, quantitative and spatial. These are a resource for the child to relate with the space and can support learning and the development of mathematical concepts. Considering Moreira and Oliveira [25], they suggest that the manipulation of physical objects "can allow the creation of learning environments conducive to the development of thought processes" (p. 42), being often used by children to demonstrate their reasoning.

METHODS

Objectives and description

This study was intended to understand whether there is a correlation between both the activities carried out, the level of execution time of physical tasks and tasks related to the simple mathematics content and multiple classification. The main objective of our study is: To examine whether there is a correlation between the speed of execution of mathematical tasks successfully resolved and the speed of execution of tasks in the motor domain. The research took place in a kindergarten.

Table 1 - Characteristics of the study subjects.

Characteristic		Number of Children	%
Gender	Male	9	40.91
	Female	13	59.09
Age	4 years	9	40.91
	5 years	13	59.09

Tasks Performed

Initially we thought it important and relevant to make a diagnostic evaluation to see if children had consolidated the concepts of simple and multiple classification. For this were applied the following tasks:

a) Classification of geometric figures - activity in large group:

This activity was performed in a large group and each child classified a geometric figure (randomly chosen) according to its shape, its colour and its size, placing it in a table previously constructed for the purpose. Generally, all the children managed to sort their figure without hesitation, only two children failed in placing the figure in the table; however they orally classified it correctly.

b) Classification of geometric figures - individual activity:

Here the activity was distinct according to the age of the child, i.e. there was a table of classification for children of 4 years and another different one for children of 5 years. The task of the children of 4 years presupposed the packing of geometric figures and their collage in a table, classifying it according to its shape and its colour. The task of the children of 5 years presupposed the completion of a double entry table with crosses classifying the geometric figures according to shape, colour and size. In relation to these activities, we conclude that, in its generality, the entire group understood and correctly classified the geometric figures, except for some children who needed more support and monitoring. After the analysis of these results, we considered it important to confirm the responses of children and realize that these consciously classified figures. Then, we decided to ask the children about their answers, to corroborate if these concepts had been assimilated or not, reaching the conclusion that they were. After concluding that the theme of simple and multiple classification was not unknown to the children, we were able to attend the activities and perform the data collection to test the correlation. We held an activity in each area and an activity where we combined the tasks of both areas. The three activities were carried out by each child individually and were timed, as follows:

A) Mathematics Activity: consisted of a "route" of four sorting tasks. We had, in a table, four sets of logical blocks of which children were to choose the pieces according to the classification requested in a drawing. In the first case, the children were to only choose the form "circle". In the second box, they were to collect all blue parts. In the third box, they had to choose the yellow rectangular pieces. In the last box, they sought the quadrangular, red parts of small size.

B) Activity of Motor Expression: consisted of a journey involving four physical tasks: jumping in a sack over approximately 2 metres; crawling beneath a table; running along approximately 5 meters; jumping 5 arches.

C) Group Activity: consisted of a path of eight tasks, alternating two areas, i.e., children performed the first task of Mathematics and the first task of motor expression, the second of Mathematics and the second task of motor expression, and so on: 1) simple classification according to form; 2) Bag race; 3) simple classification according to colour; 4) crawling beneath a table.

Collection and processing of data

Data collection was previously defined during a meeting with the parents of the children to explain how the study was developed, and they were requested to authorize the participation of their children by written informed consent. The anonymity of all subjects studied was also assured, the conservation of privacy and the confidentiality of all data and the protection of the rights, interests and sensitivities of children. Among these techniques we also used field notes and direct observation. The observation was the basis for all data collection, we observed the behaviours of children during the realization of the activities, ensuring that these were carried out successfully. During and after the activities, field notes were recorded: registration of diagnostic evaluation of knowledge of children according to simple and multiple classification; registration of the timing of the activities in both areas. Audio-visual recordings were also performed, photographs and videos, as evidence that they could be used for data confirmation. The statistical purposes were assessed using the SPSS (version 20) to a descriptive analysis, calculating the correlation coefficients between the results of Mathematics and Motor Expression, the results of Mathematics and group activity and the results of Motor Expression and group activity.

Results

The maximum and minimum values represent the values of the child who took more time in the implementation and the child that took less time, respectively, the amplitude, the mean and standard deviation for each set of data relating to each activity. The total number of subjects who carried out these activities corresponds to 22 children, represented by numbers from 1 to 22 in the graphic displayed according to their ages. These data were obtained using SPSS (version 20).

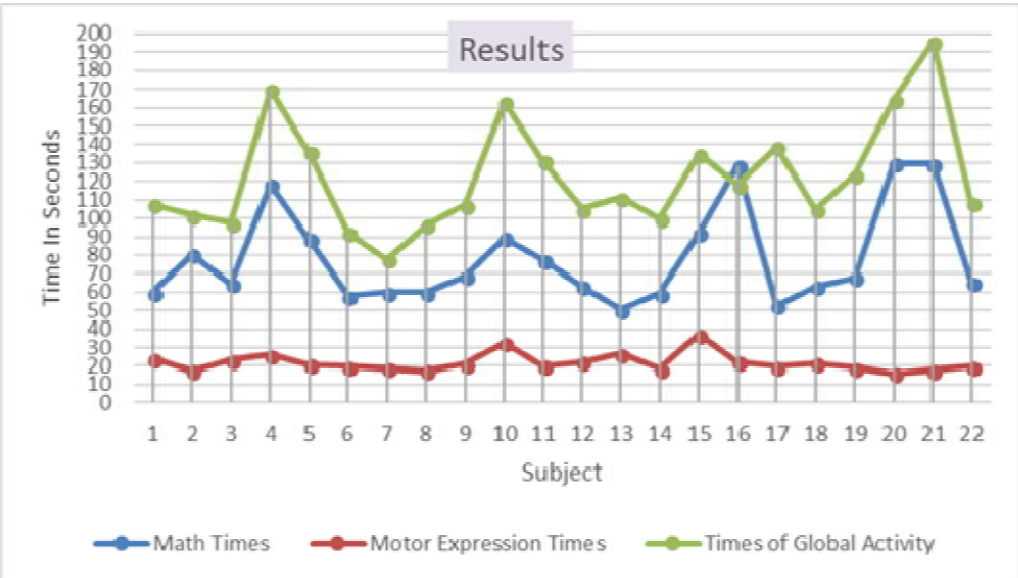

Figure 1. Results of the activities.

Figure 1 shows us the execution times recorded during the implementation of three timed activities. In the blue line, the results were obtained in mathematics. For this activity, the maximum value obtained was 129.75 seconds and the minimum value was 50.16 seconds, there is therefore an amplitude of 1 minute and 20 seconds, with a mean value of 8.57 seconds and standard deviation of 25.26 seconds. The red line refers to execution times recorded during the Motor Expression task. For this activity, the maximum value obtained was 37.16 seconds and the minimum value was 15.82 seconds, giving us a difference of 21.34 seconds, with a mean value of 21.92 seconds and standard deviation with 4.93 seconds. The green line represents the execution times recorded during the realization of the two previous activities combined. Here we have a maximum value of 195.65 seconds, a minimum value of 77.59 seconds and, therefore, an amplitude around 2 minutes. A mean value of 122.04 seconds and standard deviation of 28.84 seconds. We can also see that the child (21) that took more time in the implementation of the activity of Mathematics and of group activity was faster in the execution of the activity of Motor Expression. Another highlight goes to child number 13, who was the fastest in the execution of the activity of mathematics, but among the four who took more time in carrying out the activity of motor expression. For the correlation test the linear correlation coefficients defined by Santos were used [30]: **Correlation I:** results between Mathematics and Motor Expression. Correlation; II: results between Mathematics and group activity. **Correlation III:** results between motor expression and group activity. The following graphics represent clouds of points that give us the first tool to determine the possible existence of a link between these variables. Everyone is represented by a point that corresponds to a value for the first variable and a value for the second variable, the population being represented by a set of points [29].

Correlation I: there is a positive correlation fraction with a value r = 0.051

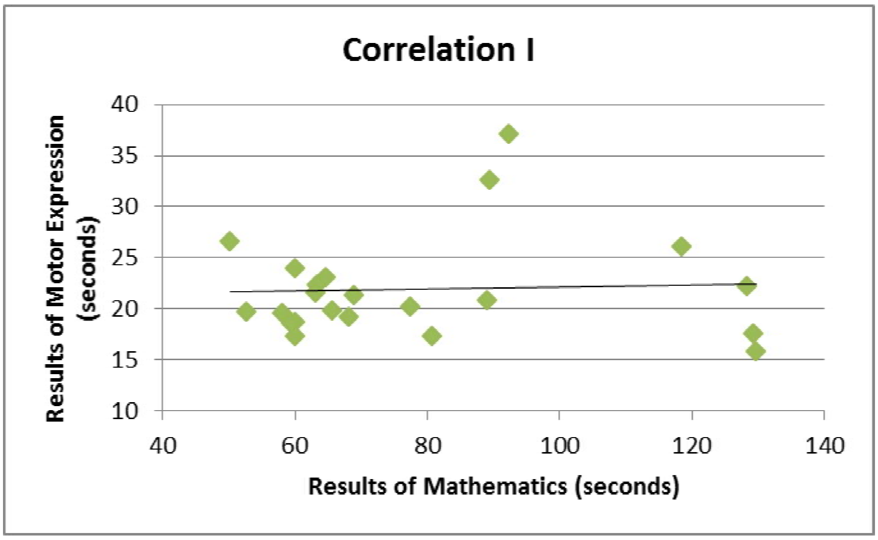

Figure 2. Correlation between the results of mathematical activity and Motor Expression

Correlation II: there is a moderate positive correlation with a value r = 0.749

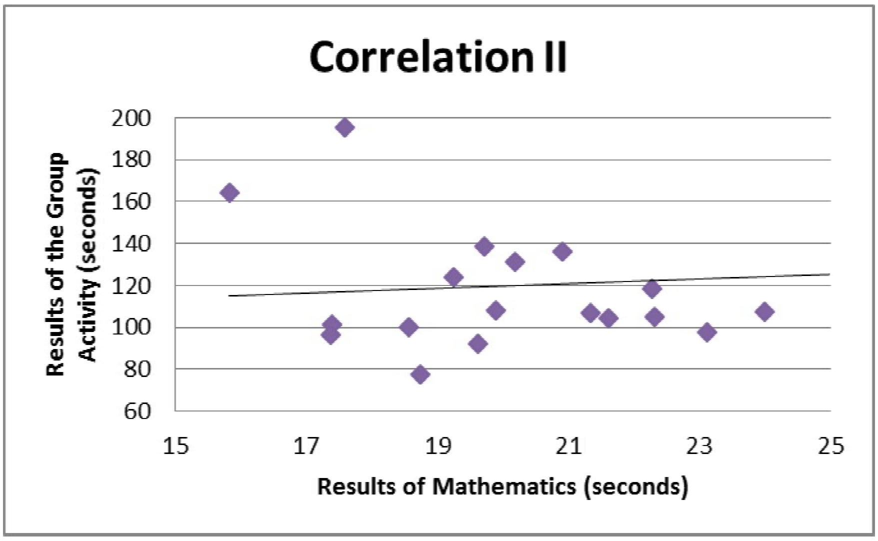

Figure 3. Correlation between the results of the mathematical activity and group activity

Correlation III: there is a weak positive correlation with a value r = 0.191

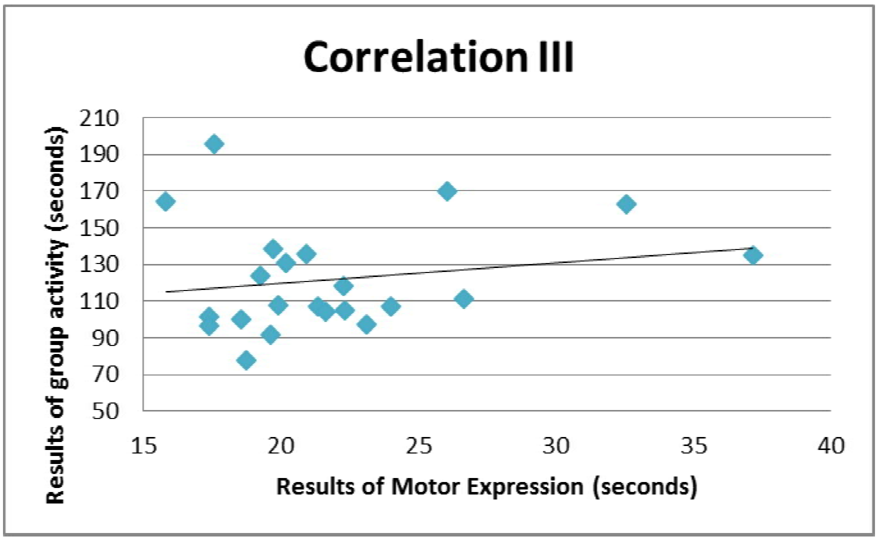

Figure 4. Correlation between the results of the Motor Expression activity and group activity

By isolating the data relating only to the group of children with five years, we get more significant values. Once the index of the Correlation I takes the value of r = 0.315, i.e., there is a weak positive correlation. The index of the Correlation II corresponds to r = 0.843, being therefore a strong positive correlation. The correlation III has an index of r = 0.678, i.e., a moderate positive correlation. We did not find any study like this, to assess the correlation between activities in the areas already mentioned, which does not allow any kind of comparison. However, our data meet the citation of Knapp [18, p. 103], which says that "it is noted that the correlation between the intelligence, measured with the help of classical tests of intelligence, and the performances of motor skills is positive, but that is usually weak", since the correlations found are between a positive correlation and the moderate correlation positive. These numbers alter significantly when we isolate the data of five year-old children, as we can see by observing the following table.

Table 2. Correlation indices

Correlation	General Index	Type of Correlation	Index data from children of 5 years	Type of Correlation
I	R=0.051	Weak positive	R=0.315	Weak positive
II	R=0.749	Positive Moderate	R=0.843	Strong positive
III	R=0.191	Weak positive	R=0.678	Positive Moderate

We can affirm, through the correlation index between the mathematical activity and group activity, that in a general way, the children who achieved the best results in the activity of Mathematics were those who also reached the best results in the group activity, regardless of whether they had the best results in the motor expression activity. The factor that most determined the success in the group activity was the speed of execution of the Mathematics tasks and not so much of the tasks of motor expression, remembering the case of subject 21, which serves as an example for this statement. This was the subject who obtained the highest execution time in the activity of Mathematics and in group activity, but who is between those who took less time in the implementation of the motor expression activity.

Conlusions

We have observed the existence of a positive correlation between these activities, and that the correlation whose value was r = 0.749 was statistically more significant, was found in the test between mathematical activity and group activity. However, these values change when we restricted the results relating only to the children of five years old, assuming a value of r= 0.843 which indicates a strong positive correlation. It is also noted that there is a weak positive correlation, r = 0.051 between the times achieved in the activity of Mathematics and the times in motor expression. It appears that there is a moderate positive correlation, r = 0.749 between the times achieved in the activity of Mathematics and the group activity times, and even a weak positive correlation, r = 0.191 between the times achieved in the activity of Motor Expression and the times in the group activity.

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Received: December 2018
Accepted: February 2019
Published: April 2019

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