Collaborative work as a learning strategy to teach mathematics incorporating robotics using led godt education system and fischertechnik in seventh graders at the school Isidro Caballero Delgado in Floridablanca Santander Colombia

N A Rico-Bautista¹, D W Rico-Bautista², and Y C Medina-Cárdenas²
¹ Universidad Industrial de Santander, Bucaramanga, Colombia
² Universidad Francisco de Paula Santander, Seccional Ocaña, Colombia

E-mail: ing.nolfer.rico@gmail.com, dwricob@ufpso.edu.co

Abstract. This article describes the impact of collaborative work to teach Mathematics in Seventh graders (70 students) at the school Isidro Caballero Delgado, Ocaña, Colombia. Led godt education system and fischertechnik allowed a great interaction and participation and provided the tools to incorporate robotics in the classroom. Moreover, these tools are used as a learning strategy to achieve understanding and analysis in the solving problems teaching math. Students became more critical and responsible facing daily solutions and a better understanding of basic problems of geometry, math and statistics. Students also learnt about and improved interpersonal abilities and improved social interaction. It also allowed making learning effective creating a better environment to improve the acquisition of mathematical concepts.

1. Introduction
In Colombia in the Department of Santander, it is located the school Isidro Caballero Delgado in the neighborhood called Zapamanga in the municipality of Floridablanca, Colombia. It is determined that factors such as Economical and Social backgrounds, the continuous displacement of the students’ parents, the few possibilities to access to education and the drugs problems are problems students face daily and influenced definitely in the Educational process of these students. Nowadays, the different methodologies and teaching strategies vary in any Educational level and they must be adapted to the social, technological and cultural changes in order to give a positive answer to the students’ necessities and expectations talking about their learning.

To be able to apply new tools and strategies in the Teaching process has relegated the physical environment and the role of the teacher in the classroom. The traditional education system has been relegated to a dynamic and effective system. The implementation of didactic resources, technology and collaborative work has created an interaction learning environment which allows a significant learning process [1]. Through different researches, the use of robotics present affordances for mathematical thinking and let on a great support for the teachers in graders [2]. For this reason, the implementation of this tool has been taken into account as a way to promote collaborative work in mathematical classes in order to make teaching and learning more effective [3]. Taking into account the different difficulties mentioned previously, the use of this tool in the classroom besides other significant strategies allow an active participation of the students and the opportunity to access to higher educational levels to students who are vulnerable and growing up in marginalization contexts. Moreover, the impact of information
and communication technologies (ICT) in classroom has showed the benefits of their use which promotes not only the equity and the inclusion in education but also the active participation of school Isidro Caballero Delgado students’ [4]. With the purpose of achieve the students social and educational necessities, these tools have implemented in daily teachers’ activities inside the classroom.

“Proyecto educativo institucional (PEI)” [5], proposes: “To offer an education of quality with high level of efficiency in the contribution of leading to the formation of citizens, the school recognizes the different learning steps and the inclusion of the public policies in education, taking into account the students’ feelings and their necessities which are important as the scientific knowledge as well.”

In order to achieve a significant learning process, a strategic and academic planning is established for the school considering factors such as motivation, perception, interpretation, knowledge, conservation, divulgation, realization and feedback. Moreover, the implementation of punctual strategies focused on collaborative work, discussions and the evaluation performed not only by the teacher but also the students using tools such as self and peer assessment [6], allows an improvement of the whole learning process talking about seventh graders and the student’s school in the future.

For the development of this research is used as a basis the doctoral research “design of a pedagogical strategy based on robotics to teach math in seventh graders. Case: Isidro Caballero Delgado School in Floridablanca, Colombia, through the led godt education system (LEGO®) education- and fischertechnik. This Doctoral research explains firstly the topics to develop, the context and the explanation of the LEGO® education or fischertechnik prototypes used and some recommendations and conclusions that came out. Also, it gives details about who are the participants of the project, the implementation period, and the equipments used to achieve the objectives of the research taking into account the leading questions proposed at the beginning such as: ¿The use of robotics improves the exchange of information and experiences between students? ¿Students work in an organized way from the beginning to the end of each activity? The responsibilities of each student are accomplished in order to achieve the collaborative group goals and to build up the prototype given by the teacher? The students analyze in critical way the mathematical problem and give solutions? With the use of the robotics students develop cognitive knowledge and collaborative skills? [7].

2. Methodology
For the development of each session is important to know the guidelines of the institution regards to its PEI [5], and the mathematics curricular work planning [6] which are the direction established for the organization of the thematic areas in each school grade through the present year. In this documents are found all the topics and goal for the mathematics area and the conceptual bases to guarantee the problems resolutions regardless to a mathematical thinking in order to give to the students the possibility to interact and express their ideas and reasons with the objective to link the real world with the mathematical world.

The next step in to identify the target population, in this case seventh graders, which are divided in groups. Two of them are taken as experimental work and three of them are taken as control groups for the present academic year 2019, in order to establish the impact of the collaborative work strategy [3] and the implementation of the robotics [1] in the classroom in areas such as geometry, statistics and math.

It is important to point out that for the development of collaborative work, some characteristics and elements must be taken into account [8]. The implementation of this kind of strategies are linked to other learning strategies with the purpose to reinforce the academic process like problem based learning either by virtual or face to face course [9-11], the projects- based learning [12], task based learning [13], case studies [14], lucid activities and educational games [15], different technological and pedagogical tools which are very important to strengthen the collaborative work using the robotics in the mathematical learning process. To identify central themes to work in math subject [6] is essential to set up a math workshop taking into account the real world problems students have to face with the purpose to identify the element in the context which can help them to support their explanation. In this way, LEGO® education or fischertechnik is used to help students to build up a prototype according to the theme
proposed allowing students to develop a significant learning process inside a critical thinking through some elements [17,18], as shown in Figure 1.

![Collaborative Work Elements](image)

**Figure 1.** Collaborative work elements.

It is imperative to take advantage of the situations given in the collaborative learning environment [7,8] and the its impact in students learning process. Through a careful design of the workshops and activities, the specific roles given to the students and the teacher and the tools used it can be assured the successful of the learning process. Talking about the role of the teachers, it is clear to point out the importance to define their guidelines work and the importance of their pedagogical and didactical abilities in order to guarantee the correct students interpretation and the significant learning process [19-21]. To apply different kind of activities and prototypes according to the topics presented make the students overcome the challenges proposed in each session. Moreover, students can feel more committed and motivated to participate in the workshops, and encouraged to be responsible in their own learning process. This leads on the reinforcement of the cognitive dimension and the reinforcement of abilities such as mathematical and scientific competences, communication [6] and research skills. For the math teachers is an enrichment experience and a way to be more dynamic and active in their classes, allowing a more interactive learning environment and the acquisition of competences mentioned in the guideless of PEI in order to assure an improvement in the academic students’ performance.

A math course planning has been established for the seventh graders of the school which covers three areas, geometry, statistics and mathematics. Moreover, it was determined the skills and competences students must improve in each of these areas and the different topics they must learn through the school year. The achievement of the goals is measured through some indicators for each one of the areas mentioned previously. For math students will learn integers and arithmetical operations on rational numbers. For geometry students will its elements and shapes. Concerning to statistics students will learn how to present information using graphs.

There are two stages to develop the academic process, the planning and the development of each session:

In the planning session you will find firstly, teachers identify the topics in each area according to established program for the school year; a real situation is designed to work on it; the collaborative groups are established; roles and responsibilities in each group are set up: It must be a leader, a secretary, a time keeper, a helper and a recorder, these roles change in every session; the complementary material and data are searched if it’s necessary; the workshop is designed according to the topic and goals established; the prototype is chosen using any of the LEGO® education or fischertechnik references according to the topic to develop [16], in each session. If it is necessary teacher must build step by step and give the stock as shown in Figure 2; goals and guidelines are set up for each session and the presentation of each class is given and data is printed such as workshops, stocks of every prototype, roles and responsibilities for each student.

During the session teacher gives a brief presentation and explanation of the topic giving suggestions and key words to the students in order to build up the prototype chosen; students are organized in the classroom, materials and pieces to build up the prototype are given, as it is shown in Figure 3; the workshop or the activity is done for a deeper study of the topic, cognitive assessment is developed by the students; students interact in order to determine what they have learnt in the session; the prototype
is dismantled once the feedback is done and stock is taken of every piece in each of the collaborative groups [22].

![Figure 2. A prototype assembled step by step.](image1)

![Figure 3. Assembly of a prototype by the students.](image2)

3. Results

Using Robotics to teach math in seventh graders or as a way to go deeper in math topics, it is possible to identify many interesting situations such as:

- Students with learning disabilities show interest and motivation and they can interact with their parents in an easy way.
- Taking into account economical situation of the students, the opportunity to use this kind of equipment and materials is given since they don’t have the chance to deal with it at home.
- To develop the math topic through the assembly of a prototype allows the active participation of the students and the improvement of their critical and analytical skills in the solving math problems.
- To connect the prototype with the math topic to develop encourages the participation of the student in a critical and analytical way.
- The use of LEGO® education prototypes opened an interaction of the students and a way to develop creativity and problem solving and mathematical thinking. Students also learn to negotiate roles and responsibilities to accomplish the goals as a team.
- Using pieces of LEGO® education and through the construction of the prototypes, students will acquire skills to manipulate amounts. It allows reinforcing mathematical, geometry and statistics topics.
- Students develop planning skills in order to accomplish the time established for the assembly of the prototype.
- Students focus on the understanding of the topic through the assembly of the prototype and observation and analysis are promoted.
- 80.95% of the students showed interest to work in a collaborative groups and the opportunity to interact with their partners in the classroom.
- Regardless to their graders, it is revealed as it is shown in Figure 4 a progressive increase in the last period with a 61.5% of the students with grades between 80/100 y 90/100
4. Conclusiones
Taking into account the school social and economical context and the students necessities, it is underlined a change in the attitude of the students towards math subject from the point of view of students’ parents. Moreover, they are involved in their academic process and social factors such as drugs and gangs have been moved away from the students’ environment since they feel more motivated to accomplish their academic goals.

Although the monitoring of grades showed a lower level of satisfaction of the students, it is determined a gratifying attitude towards the implementation of new strategies in the classroom. It is important to define a monitoring of homework and workshops done for the purpose of connect these learning strategies to the prototype and topic to develop at the math classes.

The grades performance during the development of the work shows a positive acceptance of the educational community including parents. Moreover, it is determined the development of cognitive and social skills of the students bringing mathematical concepts to life. Problem solving and mathematical thinking are developed. Students are engaged in meaningful academic situations where creativity and communication skills are fostered.

Teachers involved in this process participate in an active way and they can update their learning and teaching strategies through the use of equipment and tools through the practical use of LEGO® education or fischertechnik references. It allows to innovate their classes and the prototypes with the purpose of connect math topics with real life concepts. It is a way to challenge students and to guarantee the acquisition of the knowledge in a meaningful and innovative context.

Teachers must keep up with the best practices and learning strategies to support their work at classroom and to generate interdisciplinary knowledge in order to identify factors can affect the learning process in each session.

The continuous personal formation and professional development of teachers are important. Reflecting about the pedagogical practice must be take into account the influence of ICT as a way to innovate the activities proposed for the class and in this way guarantee the quality of education given to the students with necessities such as mentioned previously.

This experience allows the possibility to apply this strategy in other schools and moreover, to subjects such as biology, science and PE. Moreover, the implementation of new tools and learning techniques according to the topic developed gives the opportunity to reinforce students’ cognitive skills as a future professional.

Therefore, this project gives the teacher the opportunity to reflect about his/her teaching practices and let them come up with innovative ways of teaching. They are encouraged to build their capacities for doing research and keep up to date with new advances about the teaching process.

Finally, as a future work, these results can be used as a starting point to new researches in which the benefits and the advantages to use LEGO® education or fischertechnik references can allow a rethinking.
about new curriculums in which innovative ways of teaching can improve the future of education in our country.

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