ISSN:2603-5820

MLS EDUCATIONAL RESEARCH

January - June, 2019
VOL. 3 NUM. 1

http://mlsjournals.com/Educational-Research-Journal

MLS - EDUCATIONAL RESEARCH

Vol. 3 ● Núm. 1 ● Junio – June - Junho 2019

ISSN: 2603-5820

http://www.mlsjournals.com/Educational-Research-Journal

EQUIPO EDITORIAL / EDITORIAL TEAM /EQUIPA EDITORIAL

Portada: Adornos florales en Semana Santa (Tarma - Perú).
MLSER es una publicación científica que se edita dos veces al año, meses de junio y diciembre.

SUMARIO • SUMMARY • RESUMO

Editorial

Professorship training and Information and Communication Technologies (ICT) are recurring research topics within the current educational outlook. MLSER is nurtured by the collaboration of authors from different countries, with this characteristic clearly evident in each one. This is to say that we are currently in a trend running through the world's educational systems, revealing how education depends ever more on innovation and change.

This is seen in the first of these articles which implements a methodological strategy based on a guided inquiry on the suitability of practices within a physics laboratory, highlighting how technological advancements require the development of a scientific thinking with which students will be able to access and transform their environment. Its main conclusion is that the developed strategy is innovative for students by proposing guideline and didactic elements for the teaching of science which will bring them closer to current technological and scientific developments.

There is no doubt that the professorships' training should favor inclusive and quality education since it will enable the use of innovative techniques and methodologies applied to difficulties in learning. This topic is addressed in the following article under a Brazilian context and does so within a cross-sectional study and interviews as a way of collecting data. The results show the existing preoccupation by the professorship about the quality of education and how they search for information from other professors and training through continuous education and post degrees.

The third article addresses the professorships' training in ICT, applied in this case to the training of cabin boys in Electromechanical Technology from the Non-Commissioned Officer Naval School in Barranquilla, Colombia. The research is carried out from the perspective of the teachers, the technology program chief, the cabin boys, the Statistics Department and the Telematic Department. The result highlights proper ICT training and the existence of permanent training for the professorship, meaning an unequivocal sensibility toward the same.

The following work is based on the ICT and Digital line but within the field of Mathematics, aimed at specifying the level of digital empowerment and the development of mathematical skills in the professor's induction training within this subject. It follows a qualitative methodology, likewise evaluating the implications of the professor's use of digital resources. Most of the professors during their induction training already display considerable digital empowerment, which is fundamental when learning mathematics and for developing skills in reasoning, problem solving, modeling and mathematical communication during the math professor's induction training.

The following article shows a notable change in topic, a characteristic feature of an open journal like the MLSER, which accepts any educational research topic that may be of interest. In this case, it highlights the organizational education system of Senegal, and how, due to the second World War, school policies were dominated by assimilation

ideologies which they have currently inherited to a great extent. To change this panorama, it is important to analyze and research the educational orientation laws and the messages in their textbooks within educational programs and official instructions.

The MLSER concludes with a case study on the symphony bands from Caldas (Colombia) which confirms the relationship between musical aptitude and school performance. A quantitative approach was used for this which revealed the positive correlations between all of the variables evaluating musical aptitude.

Antonio Pantoja Vallejo
Editor Jefe / Editor in chief / Editor Chefe

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ISSN: 2603-5820

How to cite this article:

Ortiz Viviescas, C. I., & Suárez-Ortega, M. (2019). Guided Indagation as a Methodology Strategy for the Development of Scientific Competences in Middle Education Students. *MLS Educational Research, 3*(1), 7-24. Doi: 10.29314/mlser.v3i1.175

GUIDED INDAGATION AS A METHODOLOGICAL STRATEGY FOR THE DEVELOPMENT OF SCIENTIFIC COMPETENCES IN MIDDLE EDUCATION STUDENTS

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Abstract. Technological advances require the development of scientific thinking in which students can access and transform their environment. This tends to teach an updated, contextualized and motivating science which awakens interest in students and that emphasizes in the development of scientific competences. Under this premise, the objective of this article is to present the results obtained when implementing a methodological strategy based on a guided inquiry, on the adjustment of physics laboratory practices. The strategy was carried out in three schools of Bogotá (Colombia) in a research consisting of 145 students from secondary education, monitoring the interactions of students employing the follow-up process in the interaction whit laboratory practices model, and analyzing the progress of their performances inherent to the competences suggested in the research. From a mixed methodology, analytical descriptive, were implemented *ad hoc* designed input and output tests, which establish the level of appropriation of competencies, before and after the implementation of the methodological strategy. The results obtained show the effectiveness of the strategy within the educational contexts considered. It is concluded that the strategy presents an innovative and relevant character, since it proposes guiding and didactic elements for the teaching of science, bringing students closer to the new technological and scientific developments of today

Keywords: guided inquiry, methodological strategy, scientific competences, laboratory practices, secondary education.

LA INDAGACIÓN GUIADA COMO ESTRATEGIA METODOLÓGICA PARA EL DESARROLLO DE COMPETENCIAS CIENTÍFICAS EN ESTUDIANTES DE EDUCACIÓN MEDIA

Resumen. Los avances tecnológicos requieren del desarrollo del pensamiento científico con el cual los estudiantes puedan acceder y transformar su entorno. Esto propende por la enseñanza de una ciencia actualizada, contextualizada y motivadora que despierte el interés en los estudiantes y que privilegie el desarrollo de competencias científicas. Bajo esta premisa, el objetivo del presente artículo es presentar los resultados obtenidos al implementar una estrategia metodológica basada en la indagación guiada, en la adecuación de prácticas de laboratorio de física. La estrategia se implementó en tres colegios de Bogotá (Colombia), en una muestra conformada por 145 estudiantes de educación media, efectuando el seguimiento de las interacciones de los estudiantes con el modelo de prácticas de laboratorio propuesto, y analizando los progresos de sus desempeños inherentes a las competencias sugeridas en la investigación. Desde una metodología mixta, de corte descriptivo analítico, se implementaron pruebas de entrada y salida diseñadas *ad hoc*, que establecieron el nivel de apropiación de las competencias, antes y después de la implementación de la estrategia metodológica. Los resultados obtenidos dan cuenta de la efectividad de la estrategia al interior de los contextos educativos considerados. Se concluye que la estrategia presenta un carácter innovador y relevante, al proponer elementos orientadores y didácticos para la enseñanza de las ciencias, acercando a los estudiantes hacia los nuevos desarrollos tecnológicos y científicos actuales.

Palabras clave: indagación guiada, estrategia metodológica, competencias científicas, prácticas de laboratorio, educación media.

Introduction

Worldwide, educational research has established that the number of young people interested in pursuing scientific careers has fallen sharply in recent decades (Pedrinaci, Caamaño, Cañal, & de Pro, 2012). The lower enrollment rates in these careers have led to growing concern (Daza-Caicedo, et al., 2011) due to the impact that science and technology have on the economic and social development of countries.

For this reason, studies have been carried out to identify the factors that directly influence the students' lack of motivation. Among them, the study carried out by Sjøberg and Schereiner (2010) stands out. Its results show that adolescents' low intention to choose a profession related to science, technology, engineering and mathematics is a product of the difficulties involved in learning science and the low incidence of science education in critical thinking.

Rocard, et al. (2008) identified that one of the reasons why young people do not develop an interest in science is the presentation of overloaded and obsolete programs, an abstract approach to knowledge without the support of observation or experimentation, as well as ignoring the direct relationship between current events and their social implications.

For its part, the Organization for Economic Cooperation and Development (OECD) through the Program for International Student Assessment, known as the PISA test, especially in its 2006 test, whose focus was on science, as well as on student performance measurement and knowledge measurement based on the concept of scientific literacy, included questions to investigate students' attitudes towards science and technology from three particular areas: interest in science, support for scientific

research, sense of responsibility over resources and the environment. All this considering that these aspects are related to performance, career choice and lifelong learning for the OECD (OCDE, 2006). In this study it was observed that, although young people highly value the contributions made by science, which contribute significantly to the knowledge of the world, only 21% think that they would pursue a scientific career (Gutiérrez, 2008). In the 2015 test, the vast majority of students expressed a high interest in scientific subjects and acknowledged their role in the world, but only 25% said they wanted to pursue a career in science. It was also found that time spent learning science and how it is taught are closely related to students' interest in scientific careers. It was also observed that students with better results in this field stated that their science teachers explain or expose scientific ideas more frequently, and adapt their teaching to their needs (OCDE, 2016).

At the national level, Colombia has been conducting several perception surveys on science and technology. Specifically, in 2009, the Colombian Observatory of Science and Technology (OCyT), together with the District Secretary of Education (SED), conducted a study (Daza-Caicedo, et al., 2011) with 6,428 high school students in 28 schools in Bogotá, 13 in the public sector and 15 in the private sector. It describes students' perceptions of the scientific and engineering professions, the career opportunities they offer, the image they have of science and scientists, and the different assessments students make about how science subjects contribute to their lives (Daza-Caicedo, et al., 2011). Concerning the last two points, it should be noted that one of the factors most highly valued is the difficulty and tedium that scientific subjects can bring. Therefore, it is considered decisive in the lack of motivation towards choosing scientific careers.

On the other hand, the lack of an adequate scientific literacy that allows students to pursue scientific careers is evidenced by lower performance in international (PISA) and national assessments (Saber 11). Specifically, PISA tests show that the competences assessed in sciences include cognitive processes of special meaning and relevance for their teaching (Bybee, 2004). In this regard, specifically in 2006, of 57 participating countries, only 38.59% achieved a score above the average established by the OECD (500); Colombia ranked 53rd. In 2015, of 70 countries assessed, only 42.85% scored above the OECD average (493); Colombia ranked 57th (OECD, 2007; OECD, 2016). These percentages indicate that the level of scientific literacy worldwide does not even reach 50% of the participating countries.

At the national level, the Colombian Institute for the Assessment of Education (ICFES) is the body responsible for evaluating, through standardized tests, the education received by Colombians at different educational levels. Specifically, the SABER 11 test evaluates the appropriation of competences in students who have completed secondary education. Thus, four performance levels are established in each one of the areas. Level 4 is the highest, where the student employs concepts, laws or theories in solving problems through procedures, skills, knowledge and the specific language of science. In level 1 performance (the lowest), students barely recognize explicit information and demonstrate the insufficient development of inquiry competence. According to the results obtained in science in the Saber 11 tests, applied in 2015 and 2016, it is observed that the students of calendar A schools obtain results that place them at level 2, while the results of the students of calendar B schools place them on levels 2 and 3 (ICFES, 2017).

In order to strengthen the acquisition of scientific competences, the incorporation of inquiry processes in science teaching promotes the implementation of practices in students, where theoretical knowledge is used along with scientific skills and attitudes; thus promoting the development of this type of competences (Crujeiras and Jiménez, 2015). Thus, "the educational process in sciences by inquiry allows the student to assess scientific curiosity and the capacity for analysis as a learning source, and to use the everyday environment as a close element in science didactics, ideal for fostering significant learning" (Torres, 2010, p. 138). All this, within an ideal scenario such as laboratories (Högström, Ottander, and Benckert, 2010), where the practices developed there lead students to spaces for the development of scientific knowledge (conceptual, procedural and attitudinal) and relating it to culture, technology and society. In this regard, Séré (2003) points out that practical work leads to an epistemological awareness in students, who understand the varied relationships between theory and experience in experimentation. In addition, a greater impact is achieved when the action is interdisciplinary.

Therefore, this study's purpose was oriented towards the implementation of a methodological strategy that not only stimulates a more dynamic interaction of students in science classes, awakens curiosity and generates a true appropriation of scientific knowledge, but also promotes the development of scientific competences specifically with middle school students, adopting for this purpose a research methodology applied to laboratory practices.

Method

Specifically, this study aims to determine to what extent guided inquiry as a methodological strategy promotes the development of competences in secondary school students.

Design

In consistency, participatory action research is applied (Álvarez-Gayou, 2003), hand in hand with the sociocritical paradigm (Arnal, Del Rincón, and Latorre, 1992). The design was conceived from a mixed perspective, adopting a descriptive and interpretative approach, and incorporating triangulation.

Participants

The population is represented by students and middle school teachers from three (3) formal education institutions located in the city of Bogotá: Colegio Hunzá, Colegio San Simón and Colegio Abraham Lincoln. These institutions broadly represent the characteristics of the city's schools, by taking into account aspects involved in the educational context, present in each of the participating institutions. These schools are located in different localities and socioeconomic strata, have different academic calendars, some belong to the public or private sector of education and present different results throughout their participation in SABER 11 tests, as described in Table 1.

Table 1
Institutional characterization of the population under study.

Parameters / School	**Hunzá**	**San Simón**	**Abraham Lincoln**
Type of institution	Public	Private	Private
Academic calendar	A	A	B
Stratification	1-2	3-4	5-6
SABER 11 test category (2016)	B	A+	A+
SABER 11 test place (2016)	764	278	26

The sample (Table 2) is made up of students from one of the tenth and eleventh grade groups of the three educational institutions, according to accessibility and availability criteria for participation in the study.

Table 2
Selected sample

School/ Grades	**Hunzá**		**San Simón**		**Abraham Lincoln**	
	Grade	**No. of students**	**Grade**	**No. of students**	**Grade**	**No. of students**
10th	1001	36	1001	23	10A	16
11th	1101	35	1101	15	11A	20
Total		71		38		36

Instruments:

Different instruments were used to implement the methodological strategy:

1. An *entrance exam* that allowed to investigate the level of appropriation of the scientific competencies that would be strengthened with the implementation of the methodological strategy. The design of this exam was divided into two parts. The first one included questions with only one answer, where the appropriation of three of the competencies proposed in the research was investigated: *use of particular codes of science (CU), procedural and experimental (PE)* and *reflexive and critical thinking of science (RCT)*. For this purpose, a set of 50 questions taken from standardized tests applied at the international level (PISA) and national level (Saber 11) in the last 5 years was formed, which showed a relationship with the proposed competencies and allowed to guide the way they should be elaborated. The items were selected based on the analysis of key material available in web pages[1], provided by entities with relevance in the matter. After a rigorous study, 15 questions were selected and adapted to validate

[1] PISA exam e-mail addresses: http://educalab.es/inee/evaluaciones-internacionales/preguntas-liberadas-pisa-piaac/preguntas-pisa-ciencias/fisica;http://educalab.es/inee/evaluaciones-internacionales/preguntas-liberadas-pisa-piaac/pisa-por-ordenador; http://www.mecd.gob.es/dctm/ievaluacion/internacional/ciencias-en-pisa-para-web.pdf?documentId=0901e72b8072f577; www.oei.es/evaluacioneducativa/tipo.pdf
Direcciones electrónicas pruebas Saber 11: http://Cuadernillo%20de%20 preguntas-Saber%2011-%20Ciencias%20naturales.pdf; http://Guia%20de%20orientacion%20saber%2011-2017-1%20(2).pdf; https://orientacion.universia.net.co/imgs2011/imagenes/cuadernill-2016_11_03_145738.pdf

the level of appropriation of each of the competences proposed in the research (5 for each competence). For the selection and wording of the questions proposed in the test, criteria of relevance, clarity, coherence, complexity, relevance were mainly taken into account.

For the validation of this instrument, a *theoretical validity* was implemented based on the review of the literature presented in the theoretical framework of the research and a *content validity* conducted through the method of individual aggregates, where judges formed by external peers (3) reviewed the questions presented in the exam. *The selected* judges[2] reviewed the proposed exam from a rubric with the categories that were taken into account in the design. In order to complement the validation process of the exam, a pilot group was considered, made up of 10 students from Abraham Lincoln High School (5 10B-students and 5 11-B students) and 10 students from Hunza High School (5 1102-students and 5 1002-students). On the basis of the observations made by the students, the time allotted to the test and the editing of one of the proposed graphs were adjusted.

The second part of the test presented a Likert type questionnaire that investigated the perceptions that students had about group work (fourth proposed competence) assigning to the proposed items scores between 1 and 5, being 1 the lowest score and 5 the highest according to their perceptions. For the reliability of this instrument, an initial questionnaire was applied to the pilot group and after carrying out a refinement process, a Cronbach alpha of .92 was obtained, proposing a total of 5 items for this part of the test.

2. A *laboratory program sheet* was also used, from which the proposed practices in each educational institution were organized, specifying themes, material, types of laboratory to be implemented and the spaces in which each practice would be carried out according to the schedule of the different groups.

3. Likewise, *the progress section of the laboratory practices* was designed to record the progress or difficulties detected in the students when interacting with the proposed methodology. Through this section, assessments were assigned to the performances involved in each competition.

4. Finally, a *leaving test* was used, implemented to establish the impact of the methodological strategy based on the advances in the scientific competencies that were sought to be developed in the research. The procedure adopted for the elaboration and validation of this instrument was the same as that adopted for the entrance test.

Procedure

In the design phase of the implementation, a previous diagnosis was used to establish the appropriation of the approach by competencies in the institutions under study, carried out through interviews with rectors and teachers, the study of institutional documents (Institutional Education Project, IEP (in Spanish, PEI), documents in the area of natural sciences and curricula), and the application of a sociodemographic survey that made it possible to identify socioeconomic aspects, family and students' interest in science.

[2] *Juries: Head teacher at the Research Center and teacher of Knowledge Theory at Abraham Lincoln School; Physics teacher at Abraham Lincoln School; University Teacher and PhD in Education.*

Subsequently, according to the literature review, it was decided to establish the competencies that would be strengthened in the research, each with their respective performances: Use of particular codes of science (CU), Procedural - Experimental (PE), Reflective and Critical Thinking of Science (RCT), and Teamwork (TW) [3].

In this design phase, a model of laboratory practices was proposed under the research methodology (Benarroch, 2015¸ Caamaño, 2012), which considers the implementation of experimental practices through a series of phases: 1) Focusing phase; 2) Exploration phase; 3) Verification and contrast phase; 4) Results socialization phase; and, 5) Application phase. The process includes the exploration of previous ideas on some subjects, the formulation of hypotheses, the approach of procedures, the confrontation of predictions on the obtained results approached in a logical and argumentative way. Subsequently the knowledge is exposed and disseminated in order to be applied in new situations in which it is transferable.

Concretely and to carry out this design, in a *first phase* the entrance test was applied in each one of the groups of the three educational institutions. Once this information was collected, the results were tabulated and coded for analysis.

In a *second phase*, in a meeting with the tenured teachers, the results of the *entrance exam* obtained in each grade were socialized and analyzed. Likewise, the work plan to be carried out in each grade was carried out through the *laboratory program card* instrument, establishing the laboratory practices that were developed in accordance with the study plan of each subject. Finally, meeting sessions were scheduled with the tenured teachers to provide feedback on the process and aspects of the development of the practices.

The *third*[4] *phase* gave way to the realization of laboratory practices under the new methodology. Once each practice was completed, the approaches presented by the students were reviewed using the *practical laboratory progress rubric* instrument, which assigned a specific evaluation to the performances proposed in the different experimental practices for each of the competencies. Once the interaction of the students with the implemented strategy was finished, an analysis was made of the

3 *Use of particular codes of science (CU)* that refers to the socialization of knowledge, the use of particular communication codes through which the construction of semantic structures is proposed so that they can be interpreted by the members of a community; *Procedural - Experimental (PE)* that emphasizes the contrast of the theoretical with reality through experimentation through the implementation of a series of procedures that involve skills related to material manipulation, assemblies elaboration, appropriate use of instruments and data processing, manipulation of computerized tools and technological material and the accomplishment of some activities that imply the follow-up of instructions by the students, among others; *Reflective and Critical Thinking of Science (RCT)*, emphasizes that the solution of problematic situations involves the integration of knowledge in a proactive and creative way, which requires an adequate development of cognitive processes involving basic thought processes allowing students not only analyze and explain scientific phenomena, but build knowledge from them; and *Teamwork (TW)*, develops the ability to interact with others in a group and individual way, awakening a sense of belonging, responsibility and efficiency when making confrontations of ideas, celebrating agreements and tackling tasks together.

4 These practices were developed by one of the female researchers, who was accompanied, during each class session, by the head teacher of the subject. The teacher presented an attitude of interest and enthusiasm, since the way in which the experimental activities were carried out aroused astonishment and interest in knowledge. In the same way, little by little impressions of each session were collected, which were socialized in the scheduled meeting meetings in order to obtain the necessary feedback to nourish aspects of the implementation.

progress achieved in each competence from the evaluations obtained in the proposed performances in each of the experimental practices.

In a *fourth phase*, the application of the *final test* instrument was carried out, with which, in a first part, the level of appropriation of scientific competences reached after the implementation of the methodological strategy was established again. In the second part, the Likert questionnaire used in the entrance test was implemented to identify any change in the students' appreciations about teamwork.

Finally, in a *fifth phase*, the results of both the entry test and the leaving test were analyzed through an analysis of variance that allowed to establish the impact of the proposal.

Results

On the results obtained in the *entrance test*, the average of the answers given was initially obtained from the situations proposed from each competence obtaining a general average (Tables 3 and 4).

Table 3
Achievement of tenth grade students in the competences assessed on the entrance test

School	**Hunzá**		**San Simón**		**Abraham Lincoln**	
Skill	Correct	Incorrect	Correct	Incorrect	Correct	Incorrect
UC	36.56%	63.44%	53.92%	46.08%	66.26%	33.74%
PE	33.14%	66.86%	47.84%	52.16%	73.78%	26.22%
PRC	33.14%	66.86%	48.68%	51.32%	76.28%	23.72%
Average	34.28%	65.72%	50.14%	49.85%	72.10%	27.89%

Note: UC: Use of Particular Science Codes Competence; PE: Procedural-Experimental Competence; PRC: Reflective and Critical Thinking of Science Competence.

Table 4
Achievement of eleventh grade students in the competencies assessed on the entrance test

School	**Hunzá**		**San Simón**		**Abraham Lincoln**	
Competence	Correct	Incorrect	Correct	Incorrect	Correct	Incorrect
UC	47.68%	52.32%	55.98%	44.02%	76.00%	24.00%
PE	34.62%	65.38%	51.98%	48.02%	70.00%	30.00%
PRC	36.14%	63.86%	49.63%	50.64%	68.00%	32.00%
Average	39.48%	60.52%	52.53%	47.47%	71.33%	28.66%

Note: UC: Use of Particular Science Codes Competence; PE: Procedural-Experimental Competence; PRC: Reflective and Critical Thinking of Science Competence.

From the results obtained in the *entrance test* (Table 3), it can be observed that the students of Abraham Lincoln School presented a higher level of appropriation of the competencies to be strengthened in research in both the tenth and eleventh groups. The above can be attributed, to a certain extent, to the type of training offered by this institution, Baccalaureate (IB) where the methodology of investigation is constantly privileged not only within experimental practices, aspect evidenced in the diagnosis at the beginning of the research. In addition, it was also observed that low results obtained

in every competence, both by the tenth and eleventh grade students of the Hunzá School, were similars, as well as the general level valuations. Something similar was presented in the tenth and eleventh grade students of San Simón School. However, the general average of the results in this last institution was more acceptable, without ceasing to show that there is not an adequate appropriation of the competencies proposed for research[5].

With respect to the second part of the test that investigated the students perceptions in relation to group work (*TE* competence), the assessments from 1 to 5 were grouped into: low score (1 to 2), acceptable score (3) and high score (4 to 5) (Table 5).

Table 5
Perception of teamwork (competence TE) entrance test

School	Grade	Tenth			Eleventh		
	Assessment / Item	Low	Acceptable	High	Low	Acceptable	High
Hunzá	1	11.4%	20.0%	68.6%	7.7%	26.9%	65.4%
	2	5.7%	20.0%	74.3%	3.8%	26.9%	69.2%
	3	8.5%	20.0%	71.5%	11.5%	7.7%	80.8%
	4	11.4%	22.9%	65.7%	15.3%	19.2%	65.4%
	5	2.9%	17.1%	80.0%	3.8%	26.9%	69.2%
San Simón	1	8.3%	4.3%	86.9%	6.7%	13.3%	80.0%
	2	8.7%	26.1%	65.2%	13.3%	20.0%	66.7%
	3	26.0%	4.3%	69.5%	6.7%	13.3%	80.0%
	4	17.3%	34.8%	47.8%	0.0%	20.0%	80.0%
	5	8.7%	21.7%	69.6%	6.7%	6.7%	86.6%
Abraham Lincoln	1	0.0%	6.3%	93.8%	15.0%	10.0%	75.0%
	2	0.0%	6.3%	93.8%	5.0%	5.0%	90.0%
	3	6.3%	12.5%	81.3%	25.0%	10.0%	65.0%
	4	6.2%	12.5%	81.3%	10.0%	20.0%	70.0%
	5	0.0%	0.0%	100.0%	10.0%	20.0%	70.0%

From the results obtained, it was observed that in tenth grades of the Hunzá and San Simón Schools, and in the eleventh grades of Hunzá and Abraham Lincoln, a more rigorous work in relation to the group work dynamics must be done. However, although the students percentage who assigned low and acceptable ratings to the items investigated did not exceed 35 %, when implementing the proposal it was sought that this percentage decrease.

With respect to the progress of the students in each competency for the practices analyzed and, according to Figure 1, it was observed that in Hunza school, specifically for grade 1001, although the initial assessments were not the same in each skill greater progress was presented in the *UC* competency. The skill that had less progress was *PRC*, which is consistent with weaknesses observed within the guides. These are related to the approach of predictions, the presentation of arguments that accounted for the

[5]This is in line with the previous diagnosis carried out in these educational institutions, which showed the low incidence of activities tending to develop scientific skills and the absence of appropriation of research methodologies.

validity of the set of data collected, the appropriate drafting of conclusions and the identification of the objective of the practice.

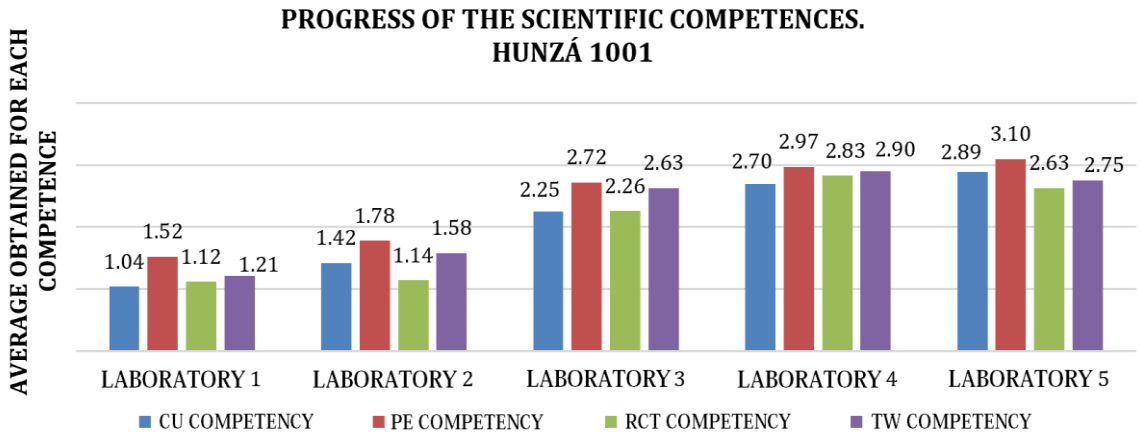

Figure 1. Competences progress in Hunzá School 1101

Note: UC: Use of Particular Science Codes Competence; PE: Procedural-Experimental Competence; PRC: Reflective and Critical Thinking of Science Competence.

In this same institution for grade 1101, according to Figure 2, it was observed that the averages of the competencies were very similar in each laboratory practice. As in grade 1001, there was greater progress in the *UC* competency. The competence that revealed less progress was PE, aspect that was in agreement with weaknesses observed inside the presented guidelines. These are elated to the adequate elaboration of predictions, the proposal of procedures that allow the collection of information to validate a prediction and the adequate organization of information through tables.

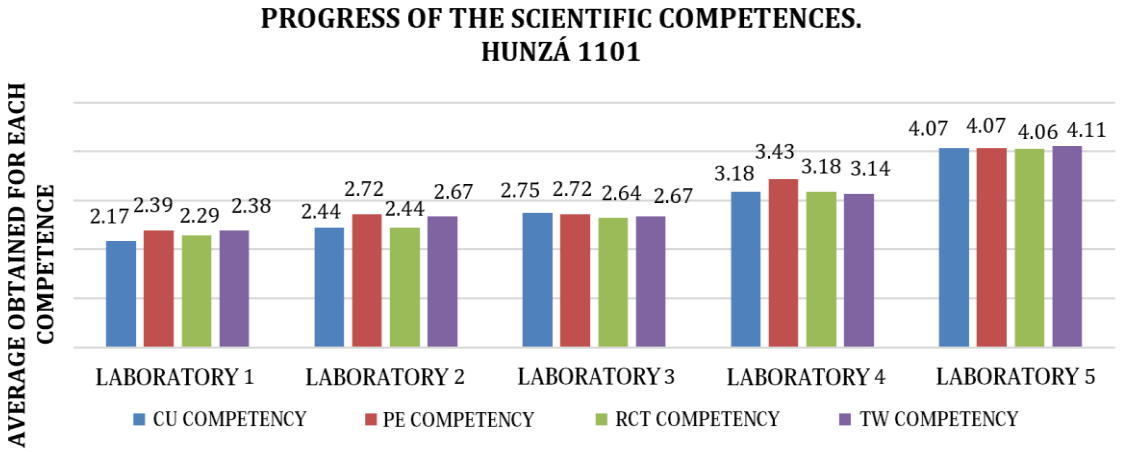

Figure 2. Competences progress in Hunzá School 1101

Note: UC: Use of Particular Science Codes Competence; PE: Procedural-Experimental Competence; PRC: Reflective and Critical Thinking of Science Competence.

In San Simón School, according to the results shown in Figures 3 and 4, it was observed that, although the assessments in each competence were not similar to each other, their progress was greater than that evidenced in each of the Hunzá School grades. Specifically in grade 1001, the proficiency that made the most progress was *PRC*. The competence that showed the least progress was *UC* associated with difficulties specifically related to the use of an adequate scientific language in the explanation of phenomena and the contextualization of practice

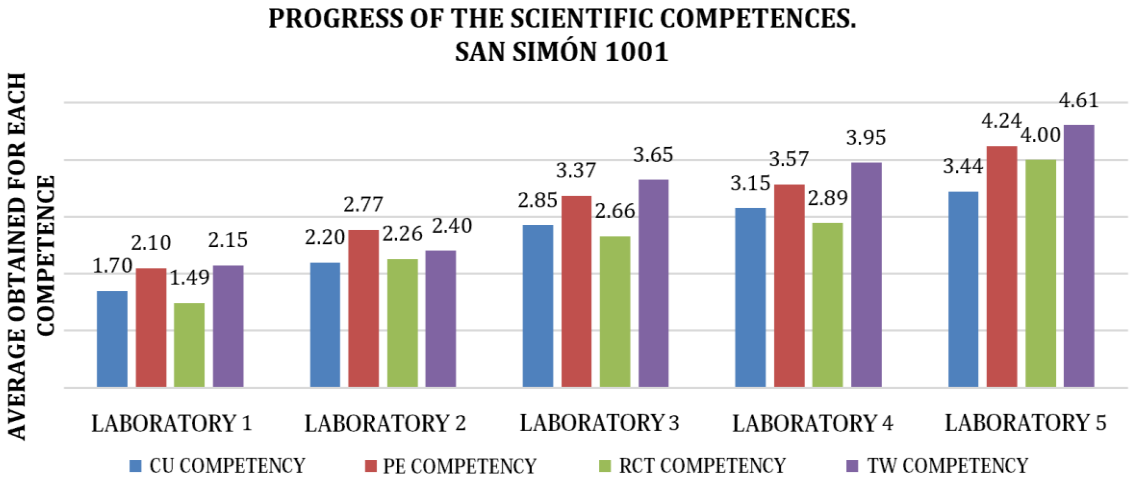

Figure 3. Competences progress in San Simón School 1101

Note: UC: Use of Particular Science Codes Competence; PE: Procedural-Experimental Competence; PRC: Reflective and Critical Thinking of Science Competence.

In grade 1101 of San Simón School, it was seen that as in grade 1001, the competence with the greatest progress was *PRC*. The competence with the least progress was *PE* related to difficulties observed within the guides related to the elaboration of predictions and the proposal of procedures that allow information to be collected to validate a hypothesis.

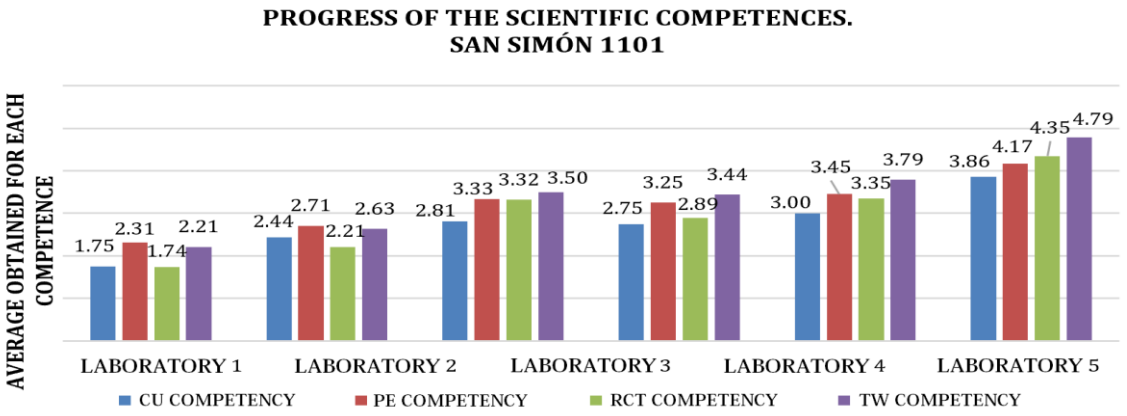

Figure 4. Competences progress in San Simón School 1101

Note: UC: Use of Particular Science Codes Competence; PE: Procedural-Experimental Competence; PRC: Reflective and Critical Thinking of Science Competence.

Besides that, Abraham Lincoln School was the educational institution where there was the least progress in the competences, although it should be noted that the ratings assigned in each of them were the highest.

As the Figure 5 shown, there was a greater progress in the *TE* competence, specially in grade 10A; while the competence with less progress was *UC* related to difficulties observed within the guidelines, specifically with the elaboration of some arguments.

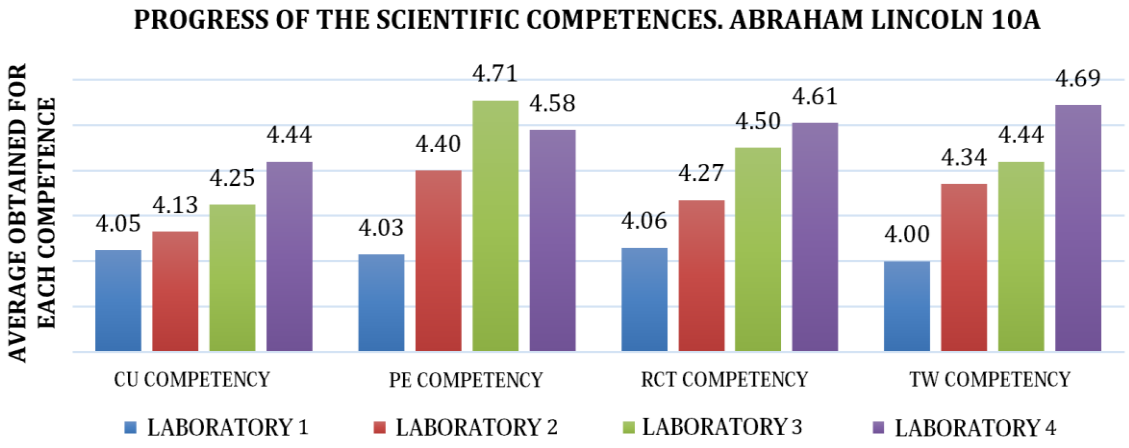

Figure 5. Competences progress in Abraham Lincoln School 1101

Note: UC: Use of Particular Science Codes Competence; PE: Procedural-Experimental Competence; PRC: Reflective and Critical Thinking of Science Competence.

At grade 11A, there is greater progress in PRC competence, and similarly, the one that made the least progress was UC, also associated with difficulties observed inside the guides, in relation to what concerns the arguments elaboration (Figure 6).

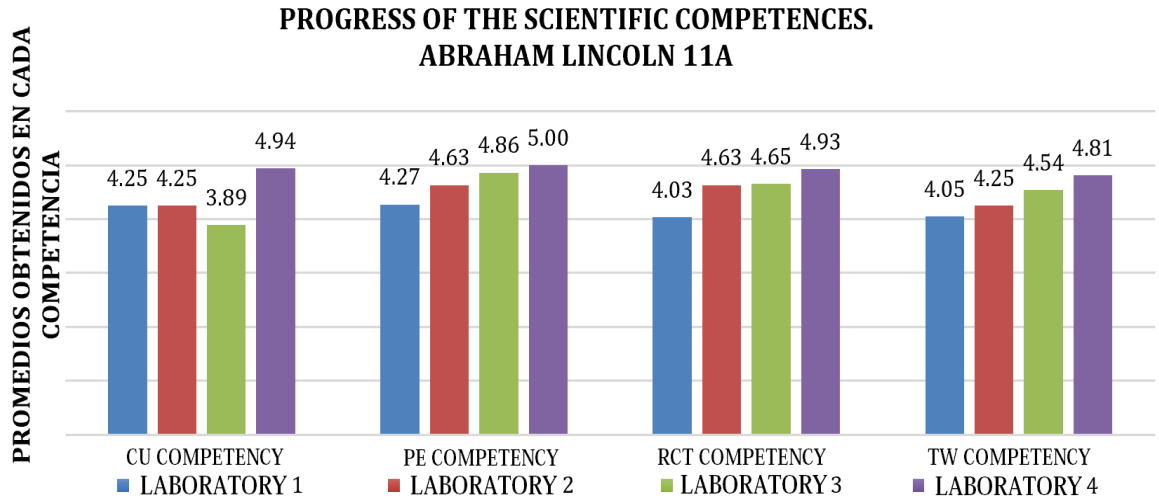

Figure 6. Competences progress in Abraham Lincoln School 1101

Note: UC: Use of Particular Science Codes Competence; PE: Procedural-Experimental Competence; PRC: Reflective and Critical Thinking of Science Competence.

Finally, feedback on the weaknesses and strengths in student productions before initiating a new practice made it possible for more significant advances to be made in the performances within the new practices.

With regard to the tabulation of the results obtained in the *exit test*, similar to the *entrance test*, the average of the answers given from the situations proposed in each competence was obtained (Tables 6 and 7).

Table 6
Assessment of 10th grade students in the competences assessed on the exit test

School	**Hunzá**		**San Simón**		**Abraham Lincoln**	
Competence	Correct	Incorrect	Correct	Incorrect	Correct	Incorrect
UC	65.15%	34.85%	69.57%	30.43%	72.5%	27.4%
PE	56.0%	44.0%	59.13%	40.87%	82.5%	17.5%
PRC	37.14%	62.86%	55.65%	44.35%	76.25%	23.75%
Average	52.76%	47.24%	61.45%	38.55%	77.08%	22.92%

Table 7
Assessment of 11th grade students in the competencies assessed in the exit test

School	**Hunzá**		**San Simón**		**Abraham Lincoln**	
Competence	Correct	Incorrect	Correct	Incorrect	Correct	Incorrect
UC	71.54%	28.46%	76.0%	24.0%	87.0%	13.0%
PE	53.08%	46.92%	68.0%	32.0%	82.0%	18.0%
PRC	40.0%	60.0%	54.67%	45.33%	73.0%	27.0%
Average	54.87%	45.13%	66.22%	33.78%	80.7%	19.3%

Examining the results obtained in the *exit test*, again Abraham Lincoln students present the highest scores despite the fact that, as mentioned, their progress in the competencies during the interaction with the methodological strategy was not as significant as with the other two schools.

It was also observed that the results obtained by Hunzá students in both grades show a significant increase. The performance in relation to the *UC* competence, whose valuation is higher, stands out, which is in line with the progress evidenced during the interaction with the methodological strategy.

On the other hand, although the students of the San Simón school also showed a significant increase in the results, it should be noted that, in particular, those competencies that showed significant progress during the interaction with the new methodological strategy were those that obtained the lowest results in the exit test, which could be attributed to the high level of complexity of the questions proposed in this competition, since, as can be observed, in all grades of the educational institutions, the PRC competition was where the lowest scores were presented, with the exception of grade 10A of Abraham Lincoln School. This indicates that it is definitely difficult for students to perform advanced mental processes where a higher level of analysis and deduction is required. Finally, it should be noted that the highest rated competence was *UC* in all grades of the three educational institutions.

From the results obtained in the first part of the entrance and *exit* tests, the statistical analysis T Studen[6] was carried out, which allowed a hypothesis test to be carried out and with it to establish the impact of the proposed methodology.

In this way, the hypotheses that were sought to be tested were:

H_o:

- The average of the results obtained in the entrance test is greater than or equal to the average of the results obtained in the exit test.

H_a:

- The average of the results obtained in the *exit* test is higher than the average of the results obtained in the entrance test.

To carry out this statistical analysis, the SPSS computer program was used, with which a normality test was initially performed through the nonparametric Kolmogorov-Smirnov test.

Finally, in order to establish whether the Null Hypothesis (HO) or the Alternate Hypothesis (Ha) was adopted, the respective P-value for each of the degrees was determined with the same SPSS computer program, as described in Table 8. For this purpose, a significance level of 5 %, i.e. $\alpha = .05$, was defined, thus establishing a confidence level of 95 %.

Table 8
Calculation of the P-value

	Tenth	**Eleventh**
	P-value	**P-value**
Hunzá	.0006	.0007
San Simón	.0040	.0080
Abraham Lincoln	.261	.086

Note: For $P < \alpha=0.05$ the null hypothesis is rejected and the alternate hypothesis is accepted.

Thus, it was observed that the P-value achieved for the Hunzá and San Simón school grades indicates that the implementation of the proposed methodology was feasible for the strengthening of scientific competencies. Not so in the Abraham Lincoln High School grades, this could be related to the fact that this group, having a background in inquiry methodologies, did not show a significant change in the final test results.

However, returning to the second part of the *exit test*, which gives an account of the students' appraisals of group work, again applying the questionnaire proposed in the entry test and grouping the appraisals given by the students from 1 to 5 in: low appraisal (1 to 2), acceptable appraisal (3) and high appraisal (4 to 5), the data obtained were recorded in Table 9.

[6] This statistical analysis was used because there were quantitative variables (entry and exit test results) from the same group (in each grade), which were measured before and after.

Table 9
Perception of teamwork (competence TE) output test

School	Degree	Tenth			Eleventh		
	Assessment / Item	Low	Acceptable	High	Low	Acceptable	High
Hunzá	1	0.0%	11.4%	88.6%	0.0%	3.8%	96.1%
	2	2.9%	14.9%	82.9%	0.0%	19.2%	80.7%
	3	5.7%	14.3%	80.0%	0.0%	3.8%	96.1%
	4	5.7%	14.3%	80.0%	0.0%	19.2%	80.7%
	5	5.7%	5.7%	88.6%	0.0%	7.7%	92.3%
San Simón	1	0.0%	8.7%	91.3%	0.0%	13.3%	86.6%
	2	4.3%	17.4%	78.3%	0.0%	0.0%	100.0%
	3	0.0%	13.0%	86.9%	6.7%	0.0%	93.3%
	4	8.7%	21.7%	69.6%	0.0%	26.7%	73.3%
	5	0.0%	21.7%	78.3%	0.0%	0.0%	100.0%
Abraham Lincoln	1	0.0%	6.3%	93.8%	0.0%	15.0%	85.0%
	2	0.0%	0.0%	100.0%	10.0%	5.0%	85.0%
	3	0.0%	12.5%	87.6%	5.0%	15.0%	80.0%
	4	0.0%	6.3%	93.8%	10.0%	15.0%	75.0%
	5	0.0%	6.3%	93.8%	15.0%	0.0%	75.0%

When analyzing the results obtained in the *exit test*, it was found that the percentage of students who assigned low and acceptable scores to each of the items decreased significantly, which evidences a higher score compared to the dynamics given within a group work.

Discussion and conclusions

In relation to the objective proposed in the present study, after having implemented the methodology of guided inquiry in physics laboratory practices, it was evident that there was a significant progress in the appropriation of the scientific competencies proposed within the research in the middle school students of the three educational institutions under study. This was evidenced by a significant increase in the overall results of the *exit-level test* where Hunzá 10th grade students had an increase of up to 15% and 11th grade students had an increase of 18%. In addition, tenth grade students at St. Simon's showed an increase of 13% and eleventh grade students showed an increase of 11%. The tenth and eleventh grade students at Abraham Lincoln High School, although showing a lower proportion increase, 9 % and 5.9 % respectively, continued to have the highest performances, which is largely due to the competency training presented by students from lower grades.

Regarding the results obtained by the students in each competition in the *exit test*, it is also concluded that, in the three educational institutions, the competence that obtained the highest result was the *UC* competence and, worryingly, the competence that obtained the least result was that of *PRC*, which implies that within science classes there must be more exhaustive and rigorous work to motivate the development of cognitive processes in students, strengthening mental processes such as seriation, discrimination, classification, analysis and synthesis, findings that are in line with the study of Torres, Mora, Garzón and Ceballos (2013). On the contrary, these results are not in line with the progress made by the students when interacting with the laboratory practices.

Regarding the experimental work in the classroom, it can be concluded that the methodology implemented led to the adaptation of practices that were striking and interesting, both for students and for teachers who teach physics in each of the grades in the different educational institutions. In this way, the students interacted with different types of practices (virtual, guided, among others), designed with all kinds of resources. This aspect supported the initial motivation to apply the methodology strategy in different educational contexts, showing results that give a significant scope to the proposal in the field of education, since it provides both teachers and students with tools for the appropriation of scientific competencies in the different science subjects in a dynamic and striking way under different contexts.

Thus, it is expected that the research developed will have a positive impact on science teachers who state that not having the necessary resources or time constitutes a limitation for the implementation of experimental practices. This study also identifies the need for educational reflection, showing that the development of scientific skills should not only focus on solving problems with pencil and paper or the application of written tests inside the classroom, but should also promote spaces that denote a special interest for students such as laboratories (Guerrero, 2011), implementing within them, methodologies that enhance scientific curiosity and appropriate the skills necessary to develop critical thinking and scientific reasoning (Torres, 2010).

Nevertheless, in spite of the excellent results obtained in the research, we found some limitations in the implementation of the proposal, being noteworthy: a) The resistance of some rectors and teachers of educational institutions to which they were invited to participate; and, b) the fear of facing new perspectives in education leaves the teaching enclosed in traditional and daily models, displacing the opportunity to implement new pedagogical alternatives that nourish and strengthen the didactic task.

Finally, although it is recognized that the research methodology is widely used worldwide, in Colombia there are no clearly defined guidelines for its implementation, specifically in laboratory practices in secondary education. In this way, new questions are opened to the possibility of transferring this methodology to other schools, and to the influence of certain variables that can mediate its impact, such as the awareness of schools and teachers about new methodologies and previous experience in actions of educational innovation.

References

Álvarez-Gayou, J. (2003). *Como hacer investigación cualitativa. Fundamentos y metodología.* México: Paidós Educador.

Arnal, J., Del Rincón, D., & Latorre, A. (1992). *Investigación educativa. Fundamentos y metodologías.* Barcelona: Labor.

Benarroch, A., & Níñez, G. (2015). Aprendizaje de competencias científicas versus aprendizaje de contenidos específicos. Una propuesta de evaluación. *Enseñanza de las ciencias, 33*(2), 9-27. doi: 10.5565/rev/ensciencias.1578

Bybee, R. (2004). *Scientific Inquiry and Science Teaching. En: Flick, L. y Lederman N. (eds.), Scientific inquiry and nature of science: Implications for teaching, learning, and teacher education.* Dordrecht, The Netherlands: Kluwer Academic Publishers,.

Caamaño, A. (2012). ¿Cómo introducir la indagación en el aula? Los trabajos prácticos investigativos. *Alambique Didáctica de las ciencias Experimentales*(70), 83-91.

Crujeiras, B., & Jiménez, M. (2015). Análisis de la competencia científica de alumnado de secundaria: respuestas y justificaciones a ítems de PISA. *Eureka, 13*(2), 385-401. Retrieved from https://revistas.uca.es/index.php/eureka/article/view/2931

Daza-Caicedo, S., Guerrero, J., Osorio, C., Hernández, Y., Celis, J., Rozo, C., & Escobar, M. (2011). *Entre datos y relatos: percepciones de jóvenes estudiantes sobre la ciencia.* Bogotá: Observatorio Colombiano de Ciencia y Tecnología.

Guerrero, J. (2011). Resultados globales de la encuesta de percepción a jóvenes escolarizados sobre la ciencia, la tecnología, la profesión científica y la enseñanza de las ciencias en Bogotá. En S. Daza-Caicedo, J. Guerrero, C. Osorio, Y. Hernández, J. Celis, C. Rozo, & M. Escobar, *Entre datos y relatos. Percepciones de jóvenes escolarizados sobre la ciencia y la tecnología* (págs. 17-74). Bogotá: Observatorio Colombiano de Ciencia y Tecnología.

Gutiérrez, A. (2008). La evaluación de las competencias científicas en PISA: perfiles en los estudiantes iberoamericanos. *Alambique, 57*, 23-31. Retrieved from https://didacticaciencias.files.wordpress.com/2010/04/gutierrez_2008.pdf

Högström, P., Ottander, C., & Benckert, S. (2010). Lab work and learning in secondary school chemistry: the importance of teacher and student interaction. *Research in Science Education, 40*, 505-523. Retrieved from https://link.springer.com/article/10.1007/s11165-009-9131-3

ICFES. (2017). *Saber 11° 2017-2.* Bogotá: Instituto para el Fomento de la Educación Superior.

OCDE. (2006). *PISA 2006. Marco de la evaluación. Conocimientos y habilidades en Ciencias, Matemáticas y Lectura.* OCDE.

OCDE. (2016). *PISA 2015. Resultados Clave.* OCDE.

OECD. (2007). *PISA 2006 Science Competencies for Tomorrow´s World* (Vol. 1). OECD Publishing.

Pedrinaci, E., Caamaño, A., Cañal, P., & de Pro, A. (2012). *Once ideas clave. El desarrollo de la competencia científica.* Barcelona: Graó.

Rocard, M., Csermely, P., Jorde, D., Lenzen, D., Walwerg-Henriksson, H., & Hemmo, V. (2008). Enseñanza de las ciencias ahora: una nueva pedagogía para el futuro de Europa. *Alambique. Didáctica de las ciencias experimentales*(55), 104-120.

Séré, M. G. (2003). La enseñanza en el laboratorio. ¿Qué podemos aprender en términos de conocimiento práctico y de actitudes hacia la ciencia? *Enseñanza de las Ciencias, 20*(3), 357-368. Retrieved from https://core.ac.uk/download/pdf/38990709.pdf

Sjøberg, S., & Schereiner, C. (2004). *The ROSE project. An overview and key findings.* Retrieved from https://roseproject.no/network/countries/norway/eng/nor-Sjoberg-Schreiner-overview-2010.pdf

Torres, Á., Mora, E., Garzón, F., & Ceballos, N. (2013). Desarrollo de competencias científicas a través de la aplicación de estrategias didácticas alternativas. Un enfoque a través de la enseñanza de las ciencias naturales. *Tendencias. Revista*

de la Facultad de Ciencias Económicas y Administrativas. Universidad de Nariño, *XIV*(1), 187-215. Retrieved from https://dialnet.unirioja.es/servlet/articulo?codigo=4453237

Torres, M. (2010). La enseñanza tradicional de las ciencias versus las nuevas tendencias educativas. *Revista electrónica Educare*, *XIN*(1), 131-142. Retrieved from https://dialnet.unirioja.es/servlet/articulo?codigo=4780946

Date received: 29/10/2019
Date reviewed: 28/11/2019
Date accepted: 27/02/2019

MLS - EDUCATIONAL RESEARCH
http://mlsjournals.com/Educational-Research-Journal
ISSN: 2603-5820

How to cite this article:

Yavorski, R. & Santos_Campos, M.A. (2019). Teacher Training: Teacher Training and the Influence on Student Learning. *MLS Educational Research, 3* (1), 25-42. Doi: 10.29314/mlser.v3i1.123

TEACHER TRAINING: TEACHER TRAINING AND THE INFLUENCE ON STUDENT LEARNING

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Abstract. The learning process needs professionals prepared to face all the challenges of education, therefore the education professional, training becomes basic item is important for inclusive education and quality. The difficulties presented by the students can be exceeded from the use of innovative techniques, motivating students in the search for knowledge. Objective: observe whether the knowledge of the teacher influence on the methodologies used for learning difficulties. Methodology: cross-sectional study of interview to identify the current situation with teachers in primary education institutions investigated. The semistructure interview was composed by open and closed questions allowing the teacher discourse freely on the proposed theme, with the purpose of clarifying it. Results: it was observed that in all classrooms of the institutions surveyed, there are students who present learning problems, that most teachers are postgraduates and seek to know new methodologies for help the students about learning. Conclusion: it is concluded that teachers they care, with the effectiveness and quality of education and the importance in working innovative techniques looking to solve learning problems and behaviour. For this seek information with other professionals, in the process of extension and post-graduates.

Keywords: Elementary school, post-graduates, learning.

FORMAÇÃO DOCENTE: A FORMAÇÃO DO PROFESSOR E A INFLUÊNCIA SOBRE A APRENDIZAGEM DO ALUNO

Resumo. O processo de aprendizagem necessita de profissionais preparados para enfrentar todos os desafios da educação, sendo assim, a formação deste profissional torna-se item básico e importante para a consecução de umaeducação inclusiva e de qualidade. As dificuldades apresentadas pelos alunos podem ser ultrapassadas a partir da utilização de técnicas inovadoras, que motivem os alunos na busca de conhecimento. Objetivo observar se o conhecimento prévio do professor influencia nas metodologias utilizadas para as dificuldades de aprendizagem. Metodologia: estudo transversal composto de entrevistas para analisar a situação atual junto aos professores em instituições de ensino fundamental investigadas da

cidade de Sarandi, Paraná, Brasil. A entrevista semiestruturada foi composta por perguntas abertas e fechadas permitindo ao professor discorrer livremente sobre o tema proposto, com o objetivo de esclarecer. Resultados: observou-se que em todas as salas de aula, das instituições pesquisadas, existem alunos que apresentam problemas de aprendizagem, que grande parte dos professores são pós-graduados e buscam conhecer novas metodologias para auxiliar os alunos quanto à aprendizagem. Conclusão: conclui-se que os professores se preocupam, com a efetividade e qualidadeda educação e da importância em trabalhar técnicas inovadoras buscando solucionar os problemas de aprendizagem e comportamento dos alunos. Para isso, procuram informações com outros profissionais, em cursos de extensão e pós-graduação.

Palavras-chave: Ensino Fundamental, pós-graduação, aprendizagem.

FORMACIÓN DOCENTE: LA FORMACIÓN DEL PROFESOR Y LA INFLUENCIA SOBRE EL APRENDIZAJE DE LOS ALUMNOS

Resumen. El éxito en el proceso de aprendizaje requiere medios adecuados para afrontar los desafíos de la educación, asimismo, la formación del profesional de la educación es un componente básico e importante para una educación inclusiva y de calidad. Las dificultades presentadas por los alumnos pueden ser exitosas a partir de la utilización de técnicas innovadoras, que les motiven en la búsqueda del conocimiento. Objetivo. Observar si el conocimiento previo del profesor ejerce influencia en las metodologías aplicadas para las dificultades de aprendizaje. Metodología. Estudio transversal que pretende analizar la efectividad de las prácticas pedagógicas utilizadas en las instituciones de enseñanza primaria de la ciudad Sarandi, Paraná, Brasil en alumnos con dificultades de aprendizaje. Se compuso de entrevista con preguntas abiertas y cerradas posibilitando al profesor opinar libremente sobre el tema propuesto para su aclaración. Resultado. Se observó que en todas las clases de las instituciones investigadas, existen alumnos con problemas de aprendizaje y que casi todos los profesores son postgraduados y buscan conocer nuevas metodologías que auxilien sus alumnos en las dificultades presentadas durante el proceso de enseñanza-aprendizaje. Conclusión. Concluyese que los profesores investigados si se preocupan por la efectividad y cualidad de la educación a la par de la importancia del uso de técnicas innovadoras que solventen los problemas de aprendizaje y comportamientos de sus alumnos. Por ello, buscan obtener información y más formación por parte de otros profesionales en curso de extensión y postgrado.

Palabras-clave: Enseñanza primaria, postgrado, aprendizaje.

Introduction

Education has always been a much-discussed topic in the world. First, there was a discussion about the quality of the education received by the general population. Over the years, it became apparent that there was a need to better prepare education professionals to put the quality of education into practice. This created a demand of professionals with technical knowledge in the educational areas to improve the work in the different education levels in general.

As a fundamental right, education is a commitment for all, so as to promote the personal, intellectual, social, economic and cultural growth of each student enrolled in school regardless of the level of education, whether primary, secondary or higher. It is within this scenario that one becomes a citizen. According to UNESCO (1998), scientific and technological training is necessary so that students become part of society and, above all, are able to face the challenges of everyday life.

According to Dos Santos (2008, p. 6), the challenge that teachers face is diversity, cultural pluralism. This is why there is a need to think about the subject in order to begin the conceptual and practical transformation of the school, so as to guarantee education for all and effective learning that ensures student permanence and their academic success. This is why it is necessary to reflect on the theme and the possible social transformation in the school by means of pedagogical practices that encourage the enrollment, permanence and success of each student who goes to school.

In the search to develop the physical, cognitive and social capacity of the students, the school plays the key role of training citizens. Therefore, education must happen collectively. It also must contemplate the differences that make up the school, such as: ethnicity, race, gender, class, sex, among others; while teachers must be able to adapt to them (Dos Santos, 2008, p. 9).

To this end, the pedagogical task must take into account that different individuals have different learning rhythms, in the same age group, and each one's potential (Simón, n.d.).

As a result, the national government began to develop policies so that teacher training was of high quality, believing that it would reflect on student development. Thus, for Gatti (2009, p. 90), cited by Brejo (2015, p. 217-218):

> [...] the trainer's training becomes central in the formal educational processes, leading to the preservation of a civilization that has better life opportunities and the co-participation of all. For this reason, understanding and discussing teachers' training, working conditions and careers, and consequently the configuration of their professional identity becomes important when understanding and discussing a country's or region's educational quality.

Investment in teacher training is fundamental and necessary, as is the need to carry out work committed to the students' particularities. In their training, teachers undergo various transformations, perfecting their identity, their culture and the history they are helping to build, so that the knowledge they acquire will guide their educational-pedagogical relationships. They will also recognize that children are unique beings and pedagogical practices must respect their differences by promoting interaction, socialization and the individual and collective construction of new knowledge (Brejo, 2015, p. 219).

The Brazilian educational legislation foresees that an adequate training, so that teachers respond to the children's learning needs, is a higher-level degree, which offers essential subsidies to teach specific contents to children, and still articulates teaching and research activities. In other words, teachers need to be prepared to handle countless situations, from the simplest to the most complex, seeking to solve them (Brejo, 2015): 220).

Therefore, research and reflection help to develop topics that assist teachers when designing classes that focus on student learning and the individual's overall development. In order to develop effective teaching-learning activities, pedagogical work needs to consider the knowledge and specific skills of teachers, developing in it the activities of the didactic field (Silva, Giordani, Menotti, n.d., p. 3-4)

The fact of having knowledge or certain abilities is not enough to ensure the competency of an education professional, but their thoughts, behaviors and stances

when facing a problem characterize them. An educator does not only teach, but also learns gradually more when doing so, therefore becoming as well subject to the process of learning (Cades, 2015, p.15).

In consequence, the development of a pedagogy professional takes place at the moment said professional come into contact with reality, that is to say, their research is governed by the school reality/necessity; it extrapolates observation enabling the intervention along with the authors of the process of learning. Said interventions are designed and articulated with the moment lived in each school, and mainly with the moment the individual lives inside the school (Francisco, Schneider, 2010, p. 12-13).

It is important to analyze the teacher's training and initial education, making them aware that their training is not over when they graduate. On the contrary, training is a permanent process with the aim of preparing the teacher for professional experiences in which effective changes take place, where the teachers provide their past experiences, knowledge and aspirations for the future to the training process, aspects that will influence learning (Rêgo, 2006, p. 76).

The dynamics developed in the classroom must allow changes and challenges that can motivate the student to understand and tackle the issue raised. The teacher must pay attention to the creation of new knowledge with the classroom's contributions, systematizing and organizing said knowledge (Rêgo, 2006, p. 88). School, as well as the professionals working in it, provide features that depend on the times they lived in. Currently, teaching and learning have these features:

According to the authors (p. 13-14):

> Counselors, nowadays, are characterized by a much wider task, in the sense of their pedagogical dimension. They function as mediators, along with the other educators, operating with all the school's protagonists in order to recover a more efficient action and an education that trains students as citizens, especially considering the development of subjectivity. There has been a shift from the former emphasis on individual counseling to the current reinforcement of the collective approach, keeping in sight that the ensemble is composed by individuals that must think and act based on contextual questions, involving contradictions and conflicts, as well as successful achievements. The aim is to change reality and transform it into something fair and humane.

Working with students is not an easy task. Working with them in the classroom means to take action, in the sense of understanding the students' behaviors and rely on theoretical bases to know how to proceed in front of certain situations (Francisco, Schneider, 2010, p. 15).

In addition, school context requires the teacher to provide all their knowledge, to share wisdom and challenges with other teachers and specialists in order to solve the student's difficulties so they do not drop out of school. The teacher that is concerned about education and that develops good pedagogical practices makes an important difference in their student's future lives (Ferreira, 2008, p. 28; Brejo, 2015: 221).

According to Brejo (2015, p. 221-222), pedagogical practice, when guided by ethics, understands and respects the students' diversities in all their development, considering them the center of the educational process, no matter what their racial, religious or economical situations are. If the goal is to transform the school

environment, we must consider it a continuous job. According to Libâneo and Pimenta (1999), transforming the school into a space for cultural, scientific and technological development requires a collective effort by the school itself, that is to say, teachers, civil servants, principals and the students' parents, in addition to social groups involved. They must endeavor to tackle challenges, mainly in the area of public policies, where teachers are the essential professionals in the construction of the school. This is why it is important to invest in professional training and personnel appreciation.

However, training a thoughtful teacher also requires a change in the quality of the job and schools. In countries where this reform settled in, there has been an investment in teacher training and development, as well as in institutions. Teachers started acquiring dignity in their jobs and their teaching careers with the increase in their salaries; in our country these reforms do not take place, since the discussed goal is to change training, not working conditions (Pimenta, 2013, p.106).

Currently, structured education has been shaken by conflicts between educators and students, which results in unhappy teachers and students with little knowledge on the different subjects. Since the decade of the 90s until these days, the issues with education are getting much worse, with a low learning index, which is bad for a developing country (Kubata, Fróes, Fontanezi, s.f., p.4).

Methodology

Type of Research

A transversal study using ad hoc questionnaire for data collection and bibliographic theoretical foundation search. It enabled a collected data discussion, propitiating the researcher to cover the wide phenomena in order to characterize the current state of the problem and to make a subject's history in the city's primary schools.

In accordance with the set objectives, the bibliographic search and publications' survey began, selecting the most appropriate materials on the subject. After the selection, a reading began and a summary of the work was made, focusing on the most relevant aspects in order to compose the research theoretical reference.

From the nature's point of view, the research is classified as basic. The researcher is motivated by intellectual curiosity. The data was collected through interviews with teachers, which, according to Minayo (2001, p.52-55), enable the researcher to look for information contained in their discourse, it is not a neutral conversation, but aimed to collect information regarding the set out problems experienced by them.

The interview was conducted with teachers of students with learning problems in 2nd, 3rd and 4th grade of primary school in the city of Sarandi, combining open and closed questions, enabling the interviewee to discuss the proposed topic freely. They were carried out in February 2018, with approximately 30 minutes of duration. Its guiding axes were: a) teachers' training, b) students' difficulties, and c) the pedagogical work carried out by the teachers towards the students' difficulties.

Research Space

Characterization of the Municipality where the research is carried out

The research took place in the city of Sarandi, which is located in the northeast of Paraná, southern Brazil. It is part of Microregion 9, Association of the Municipalities of Northern Paranaense.

Reseacrh location

The municipal schools selected through the Municipal Education Ministry with the purpose of showing the reality of 10 teachers from two public primary schools in the city of Sarandi (PR), and for being the primary schools that received the best evaluations by the Ministry. One of the schools is located in the central area of the municipality and the other in the peripheral region.

Municipal School A - Kindergarten and Primary Education up to the 5th year.

Municipal School B - Kindergarten and Primary Education up to the 5th year.

The researched schools seek to guarantee the democratic principle of equality of conditions for school access and permanence; free access to the public network; primary education with different education forms' quality, prohibiting any form of discrimination and segregation.

Philosophy and didactic-pedagogical principles of the Ministry of Education and Culture aimed at schools.

The Ministry of Education and Culture understands school as part of the community, so a current historical context analysis is necessary in order to understand educational issues. With the economy's growing globalization process, leading to international competitiveness and production patterns, consumption and work organization changes, the worker's profile is causing new professions emergence while others are dismissed. There is a trend towards the intellectualization of the production process demanding the workers of a greater knowledge, use of ICT (information and communication techniques), computing and other communication means, cognitive skills and reasoning flexibility.

For facing all these transformations and challenges, it is necessary to invest in education by raising the population's scientific, cultural and technical level, in the sense of making the quality basic schooling universalization possible and improving the opportunities and population's working conditions.

As this is a new historical moment, the school institution needs to reorganize and rethink its pedagogical proposal and its role within society, reflecting on what citizens want to form and what society we want for all. The definition of man, society and education does not only refer to education professionals, but to the whole community where they work.

In this line of thought, the school must contribute to forming people with a critical conscience, prepared to play the leading class role in the future based on scientific knowledge.

The sample comprised 10 primary school teachers trained in Pedagogy and working in the 2nd, 3rd and 4th years of primary education in schools A and B of the municipality of Sarandi. The studied institutions teaching staff is formed by teachers with a degree in Pedagogy. Teachers work in two shifts, while in each day 4 (four) hours are invested as non-teaching hours, in which pedagogical activities are planned.

Nowadays, the teacher's professional activity requires continuous training, and the educator who invests in self-knowledge will be better prepared to understand the students' requirements. The training's objective is to deepen theoretical and practical aspects that guarantee the work's specificity and systematization, since a consistent theoretical foundation will enable evaluating underway actions and those that will be planned, intensifying the professional's knowledge.

Results

After data collection and analysis of interviews with teachers, responses were organized according to the relevance of the topic of study in tables which were discussed descriptively. Partial research data are presented.

Professional performance

Professional training of teachers in the primary education institutions investigated.

All formation, initial or superior, provides humans with the necessary knowledge so that they come to propose important changes and social transformations, being possible to be both a formal and informal education. In formal education, the teacher presents specific contents and adequate methodologies in the sense of training people capable of developing critical vision and creativity (Yavorski, 2014, p. 63).

With the development of discussions on the quality of education in the country, the need was perceived for a better preparation of education professionals, which led school institutions to require from their professionals, in addition to a degree in Pedagogy, a postgraduate degree, that is, a specialization that would prepare them and help them work with students who present varied levels of learning and learning difficulties.

The school, in general, plays a fundamental role in the development of students' learning abilities, this being the main focus of the institutions. For dos Santos (2008, p. 9), education must be done collectively, taking into account the individual differences of each student, where the teacher must be able to work. Therefore, education professionals need to be aware that the construction of knowledge occurs heterogeneously and at each individual's pace. According to Brejo (2015), pedagogical practice needs special attention to enable teachers to face daily challenges. This provides the possibility of improving and raising the level and quality of education offered in educational institutions in general.

Table 1 presents the academic training of the teachers of the institutions participating in the research

Table 1
Academic training of teachers from the institutions researched

Teacher	Degree	Post Degree	Post Degree in progress
T1	x		
T2	x		
T3		x	

T4			x
T5			x
T6			x
T7			x
T8		x	
T9			x
T10	x		
TOTAL	**3**	**2**	**5**

The educational institutions surveyed admit professionals with a degree in Pedagogy to teach classes from the 1st to the 5th year of primary education. Teachers are responsible for teaching most of the subjects related to the grade they teach, with the exception of the subjects of arts, physical education and foreign language (English).

It is observed that, among the teachers interviewed, seven (7) declare to have postgraduate degrees in several different courses such as Psychopedagogy, Inclusive Special Education, History, Globalization, School Management; five (5) have specific postgraduate degrees in Learning; three (3) only a degree; and two (2) postgraduate degrees in other areas.

Of the teachers who claim to have postgraduate degrees, all have more than one postgraduate degree. Of the graduate teachers, one level 1 (T1) teacher has stated: "I have difficulty working with students with learning difficulties." Interviewer: "What do you do when you detect a student who has learning difficulties? Do you turn to a professional?" T1: "In the municipality there is no one to turn to, the psychologists of the department do not guide the teachers and normally only deal with behavioral problems. I usually talk to other teachers who have more experience with these students, who helps me a lot is the T3 teacher who is specialized in Psychopedagogy."

Thus, it can be concluded that for 9 teachers the postgraduate course becomes important for them to have tools that help in the work with students who have learning difficulties as well as behavioral difficulties. The data suggest that the teachers interviewed are currently oriented towards solving students' problems; there is a concern for the quality of teaching.

Thus, for Gatti (2009, p. 90) cited by Brejo (2015):

> [...] the formation of the teacher becomes central in the formal educational processes, in the direction of the preservation of a civilization that contains better possibilities of life and co-participation for all. Therefore, understanding and discussing the formation, working conditions and career of teachers, and, consequently, the configuration of their professional identity becomes important for the understanding and discussion of the educational quality of a country or region (p. 217-218).

Teacher training is thus directly related to the quality of education in a country. With the opening and expansion of educational opportunities, new challenges arose for the Brazilian public school, having an alteration in the general sense of the school. The incorporation of population sectors that did not have access to school brings new

experiences for the educational institution along with tensions, contradictions and differences present in every society (Gusmão, 2010).

Teacher's time in primary education

Concerning the teacher's time in primary education, it can be verified that four (4) teachers from the participating institutions have been working in the schools for more than 10 years, but we also find recently graduated teachers. Table 2 presents the teaching time of the participating teachers.

Table 2
Teacher's time in primary education

Years taught	**Number of teachers**
0 to 5 years	2
6 to 10 years	1
11 to 20 years	4
More than 20 years	2
Not mentioned	1
Total	10

The teacher level 2 (T2), with more than 20 years of experience in Primary Education, declares: *"In the several years that I work, I notice that nothing has changed in the classroom. What differentiates the students of the past from those of today is that the actual ones do not want to study; they are lazy."* In view of the teacher's statement, it is observed that she does not perceive the students' difficulties as problems related to the methodology applied or the behavioral difficulties, but rather to the lack of will of the student.

In light of the educational policies, teachers and schools are important elements for the social, cultural and economic development of nations. Therefore, these are the responsible for the students failures and their lack of preparation at the end of their studies. The training of education professionals came to be seen as theoretical and detached from the school and society demand (Oliveira, 2009, p. 38). Teacher P2, due to lack of knowledge, represents and reproduces the above-mentioned theory.

Regarding the teacher learning, it is important that the teacher learns to be a teacher, and this happens in:

- Learning in the teacher-student relationship;
- Learning in the teacher-teacher relationship;
- Learning through pedagogical practice (Pivetta, Isaia, 2008, p. 251).

The premises described above are linked to the teacher's daily life and are developed in a dynamic process, being built collectively. The T2 seems to ignore that the teacher's task is complex and involves domains of knowledge that can be acquired in exchange and interaction, as well as the capacity for initiative that the teacher needs in the face of existing diversities in society.

The exchange of information with the student makes it possible for the teacher to learn about the difficulties encountered by the students and, therefore, he or she can try to solve them with research and interaction with other teachers. The valorization of the student establishes an affective and flexible relationship, which will help in the understanding of the student and later in the development of the teaching-learning process.

Teacher level 10: *"I have already taught in many classes, but this is the most difficult of them all. Sometimes I don't know what to do for the students to learn. I have a student who has repeated a course several times and can't read or write."*

The teaching work needs critical reflection, where the teacher needs constant self-evaluation to make sure that the content taught is correct and appropriate for the student. Through the practice of self-evaluation, the teacher becomes able to create theories about his/her practice and constantly reorganize him/herself. Reflection allows the teacher to innovate pedagogical practice by improving what is not good (Rodrigues, Costa, 2015, p. 1-3).

Number of students with learning difficulties per teacher

Education is a complex process, but it occurs collectively, providing subsidies for the individual to develop individually. However, some individuals fail to adequately accompany the education process as a dynamic and subjective phenomenon (Yavorski, 2014, p. 15).

The issues of learning difficulties are described in the NCPs (National Curricular Parameters), which show the importance of the constructive participation of the pupil and the intervention of the teacher for the learning of contents necessary for the full development of the individual. The development of the student's full capacity occurs through the knowledge construction. The traditional teaching done through expository classes or reading of texts happens to have a different direction. It is possible to work with knowledge in a dynamic and instigating way, that is, the teacher plans learning situations that allow the student to solve problems dynamically on the most diverse issues (Ychoski, 2014, p. 19).

The NCPs were created as devices to organize the education curriculum to make effective the objectives of democratic education, through the objectives proposed for Primary Education, and starting from the school the creation of conditions for good learning (Brazil, 1997). Basic education must be focused on acquisition and effective learning outcomes. Active and participatory approaches are valuable in ensuring learning and enabling the development of student potentialities (UNESCO, 1998, p. 4).

Table 3
Number of students with learning difficulties for each teacher

Teacher	Number of Students
T1	1
T2	4
T3	2
T4	8
T5	2
T6	6
T7	2
T8	4
T9	6
T10	4
Total 10	39

Table 3 shows the number of students with learning difficulties indicated by the teachers; of these 39 indicated students, 7 did not agree to participate in the research, leaving a total of 32 participating students. Teachers T4, T6 and T9 have the highest number of students with learning difficulties. T4 has 8 students and T6 and T9 have 6 students each. T4 has a postgraduate degree, but it is not related to learning problems. The following question was asked about the data:

"Are you prepared to work with children with learning difficulties?"

Of the 10 teachers who answered the question, 9 find it difficult to work with students who have some kind of difficulty in the learning process, including postgraduate teachers. Only one teacher considers that students with difficulties cannot learn due to lack of intelligence and there is no way to help.

T1: "Even if I get help from other teachers with more experience, I feel that I need to do a specialization, which helps to solve the students' problems. *Sometimes I don't know what to do to make it easier for them to understand the content. I think Psychopedagogy is a postgraduate course that helps a lot with slow students".*

For this teacher, specialization is important, because it can bring information that helps in the work in the classroom with the students. Alternative work proposals may be the answer to transform the reality experienced today by schools with so many problems. In order to be able to create and intervene in educational processes, the education professional would need initial academic training and continuous quality training. In order to fulfill the role of educator it is necessary to transmit knowledge safely and for this it is necessary to study (Martins, 2003).

T2: *"These students are a hopeless case. In the time I teach, I have never seen a student with a learning disability develop. They are really "dumb", it runs in their families, their parents can't read or write, and their children don't want to learn. It's no use, you'll see when you start working with them, they're not interested. Those teachers who say you do this or that, they don't know anything, all chatter."*

The T2 teacher does not seem to respond to the learning needs of children, that is, the teacher needs to be prepared to handle innumerable situations, from the simplest to the most complex, seeking to solve them (Brejo, 2015, p. 220). In the teacher's speech, it seems that she has no concern for these facts, with the need for learning. The teacher in the classroom also needs to exercise the function of researcher, through research, the teacher builds classes where the focus is the student's learning and its integral development (Silva, Giordani, Menotti, n.d., p. 3-4).

The knowledge factor is not sufficient to guarantee the professional competence of the educator, however, what characterizes it are its actions in the face of problems. Competence is not in teaching, but in learning more and more in teaching, becoming also subject of the learning process (Cades, 2015, p. 15).

Licensed teacher, level 3 (T3): *"I have many students with learning difficulties, it is a pity, we see that they have a great desire to learn, but as I do not have specialization in the area, I find some difficulties".* Interviewer: *"Don't you have support from specialized professionals?"* T3: *"No, the professionals who come from the secretariat don't know how to handle it, they always pass by the room and observe and say that everything is in order. And we do what we can to help the students".*

In addition to courses that help teachers work with students with learning difficulties, it is necessary to open a space for teachers to discuss the methodologies used by systematizing a way of working with students with difficulties.

Teacher level 4, graduate with specialization (T4): *"I have a specialization in Psychopedagogy, that's what helps me, but I keep thinking about my classmates, who don't have the knowledge I have, it's very difficult to work with students who have difficulties. Sometimes I get lost without knowing what to do with some students, but as I know the way, I investigate until I find a solution. I also seek to converse with other teachers who specialized in the area so that together we can try to find solutions for our students".*

Teacher level 5, graduate with specialization (T5): *"I usually use what I learned in the major and, when I can't solve, I talk to the supervisor and other colleagues, but I always try to study the cases and follow the students in everything."*

Four of the teachers interviewed believe that it is important to be privy to learning disabilities, and they feel that they need more information to do a better job. Sometimes these teachers consider themselves unprepared to face certain difficulties presented by students. The teacher with specific training in learning considers that in some cases they encounter difficulties in solving the problem presented by the student and needs to resort to other professionals to reflect together and try to find a solution to the problems presented.

Only one teacher demonstrated disinterest in postgraduate studies, as he considers that students are not capable of learning. For Libâneo (2006) quoted by Martins (2003, p. 8) the problem of education is in:

> Poorly organized and managed schools, poor teacher training, poor student performance. Professional training research has an open wound, which is the imbalance between the definition of legal devices and the daily reality of schools. We all know that our school suffers from many shortcomings and chronic problems - the poverty of families, the low salary of teachers, the social devaluation of the teaching profession, the precarious physical and

> material conditions of schools, grade repetition, the age-to-school year gap, the learning difficulties of students, factors that contribute to the decline in the quality of teaching. There are other incidences of the socio-cultural context of the school such as the intensification of urbanization which, together with other factors, causes the widening of social and cultural diversity within the school; the impact of the media on school life and on student learning; the changes in the internal processes of student learning; The fragility of forms of school organization and management in the midst of abrupt changes in curricular organization, such as cycles and the integration of people with special needs; the difficulty of teachers in adapting to these changes, underscored by the lack of mastery of the contents and methodologies of the disciplines; the shock in the face of problems linked to violence, the use of drugs, the early sexuality of students, and the control of the class.

According to Martins (2003, p. 8-9.), it is not the legal reformulation of pedagogy courses that will bring the solution to all school problems, but rather:

> a greater sensitivity to the demands and training requirements coming from the school will be able to favor a better professional training, because this is what it is all about. Part of the confusion in the legislation and the difficulties in obtaining consensus on curricula derive from the lack of realism in capturing the needs and demands of schools and teachers. I believe that we are not knowing how to subordinate teacher training policies to school and student learning policies, and one of the reasons for this is the distancing of some segments of educators from the concrete issues that involve the functioning of the school and the work of teachers.

Thus, it is important that the teacher knows the reality of the student and the context in which the school is inserted to achieve changes in all areas. We need to provide options so that students continue to be motivated to learn by relating pedagogical work to a broader social context. The teacher in the classroom must be a researcher and should be concerned about looking for elements that can facilitate student learning.

Interviewer: "What techniques do you, as a teacher, use to solve learning difficulties?"

Graduate specialized teacher (T6): "*What helps me is the postgraduate course I did in Psychopedagogy, when I perceive that students are having difficulty, I use the techniques I learned in the postgraduate course. The best thing was to be able to apply all the techniques with the students, then there wouldn't be any struggling student, but time doesn't allow me to, there is a lot of content to teach. I think it is very important to have a professional who guides the teachers in new techniques to solve the difficulties presented by the students*".

The teacher perceives the importance of a differentiated curriculum that helps the student in his difficulties and the exchange of information and knowledge in the sense of understanding the function of the school, which is to guarantee knowledge to the student. The teacher, reflecting on his task, becomes capable of creating, developing educational attitudes that can improve the quality of teaching, and thus value the professional of education.

With difficulties found in the class, the teacher is obliged to dominate practices and knowledge different from those under their purview. Action in basic education requires knowledge, review, reflection-action and creativity by the teacher, so that initial and continuous formation need to provide the teacher with tools which help him in the daily matters. The teacher´s critical reflection about his work will allow the development of attitudes which improve the teaching process (Bonato, 2010).

Graduate teacher with 7-level specialization (T7): *"I use the plan sent by the Secretary of Education, there is no due course to make extra activities in the sense of solving the students´ difficulties. I have a non-literate student; I use with him a literacy little book in which I explain the exercise so that he does it at home; afterwards, I correct it. I do this activity 3 (three) times per week. This in the only different technique I use in my lessons."*

Even using the material given by the Secretary of Education, the teacher has the need of using other methodologies with some students, thus demonstrating the importance of teaching which considers the individual differences of each person. 20% of teachers cited the plans sent by the Secretary of Education, 10% follows exactly the Secretary´s orientations, and 10% uses differentiated techniques without being known by the Secretary´s technicians.

Licensed teacher, level 8 (T8): *"The Secretary sends the education plans ready and we must follow them to the letter. I do not like this because I cannot use different techniques. Everything is printed, which limits the student a lot. I do not have postgraduate in learning problems, but I detect that the students have difficulties which must be worked in a differentiated way. I talk to my colleagues to try to solve the difficulties I find in the content transmission.*

80% of teachers use collective readings, text production, dramatization, poetry and songs in an attempt to motivate the student to learn. In 1990, the World Conference of Education for All was celebrated in Thailand with the aim of guiding reforms in education, fighting against illiteracy and for the fulfillment of the basic learning needs. According to UNESCO, education opportunities must be oriented to the learning basic needs, being reading, writing, speaking, calculus and problem solving necessary for human survival, dignity and quality of life. Thus, education must provide the basis and foundations to form and boost learning and permanent development of the human being (Oliveira, 2009, p. 38).

The teachers cited seem to be aware of the four pillars of education listed in the UNESCO conferences which are: learn to know, learn to do, learn to live together and learn to be. When the learn to do is evident, the professional qualification is important and must be wide so that the professional has competence and aptitude to face several differentiated situations and work as a team, but also learn to do, in the field of the several social or work experiences offered to the individuals, and learn to live together, developing the understanding of the other and the perception of differences (Oliveira, 2009, p. 39).

Conclusion

The research concludes that the teachers are concerned about the fact that their students have learning difficulties and search to reflect on their actions discussing with other professionals the methodology applied.

We can infer that the teacher, throughout his professional practice, looks for developing himself and to upgrade to improve his professional career. The difficulties found by the teachers in class change the school and the professional of education´s conception, and the teacher has the need of rethinking his teaching-pedagogical practices at school. It was observed that the teacher´s working conditions and the differences found at school make him search new methodologies to help his students to develop knowledge, even when following a plan made by professionals who are not in the school and do not know the reality of school life. The municipality where the research was carried out is very diversified in economic and cultural terms; thus, teachers need to know the reality of each student to fulfill their needs. The contents applied must be oriented to the students' reality and not to abstraction.

A great need by the teachers to find something new to solve the students´ learning problems which end up compromising the general class development was observed. All the teachers were responsive to new ideas and they were concerned about their students with specific difficulties.

In some cases, we can see professionals who are not as committed to problem solving. They instead blame and throw responsibility of a student's lack of learning onto others.

Schools still employ mechanical teaching-learning processes that do not enable the student to express their opinion. Knowledge is presented as "ready" for the student to reproduce it, without making much sense to them at times.

In conclusion, it is important for the teacher to take up the role of knowledge mediator and not one merely of ownership. The different realities and values of each one should be taken into consideration so as to innovate in their practice in this way (Silva, Giordani, Menotti, s.f., p. 3-4).

Acknowledgement

I wish to give thanks to the educational institutions and their teachers for collaborating in this study by providing the data necessary for this research.

I would also like to thank my advisor and co-author for the technical-didactic support.

Bibliographic references

Amaral, J.J.F. (2007). *Como fazer uma Pesquisa Bibliográfica*. Fortaleza.

Barbosa, E.F.(1999). Instrumentos de coleta de dados em pesquisa. SEE-MG/CEFET-MG. Retrieved from http://www2.unifap.br/midias/files/2012/03/coleta_dados.pdf

Bonato, E.M. (2010). Formação docente e as influências das reformas educacionais na educação brasileira. In *Simpósio Nacional de Educação*. XXI Semana de Pedagogia. Infância, Sociedade e Educação, 13 a 15 de outubro, Anfiteatro Campus de Cascavel. Cascavel-Paraná.

Brejo, J.A. (2015). Políticas públicas para a educação infantil: do contexto latino-americano à realidade brasileira. Perspectivas em Políticas Públicas. *Belo*

Horizonte, *7*(15), 181-229. Retrieved from http://revista.uemg.br/index.php/revistappp/article/view/866

Cades, M. (2015). As atitudes do professor que qualificam o trabalho pedagógico. *Ver. Saberes, Rolim de Moura*, *3*(2), 14-26.

Dos Santos, I.A. (2008). Diversidade na educação: uma prática a ser construída na Educação Básica. Panamá: Cornélio Procópio. Retrieved from http://www.diaadiaeducacao.pr.gov.br/portals/pde/arquivos/2346-6.pdf

Ferreira, I.M. da C. (2008). *Dificuldades específicas de aprendizagem dislexia*. Porto: Escola Superior de Educação Paula Frassinetti.

Francisco, D.A., Schneider, (org.). (2010). *Ações, reflexões e desafios na formação do pedagogo na contemporaneidade* (pp 100). Novo Hamburgo: Feevale.

Gusmão, J.B.B. de. (2010). *Qualidade da educação no Brasil: consenso e diversidade de significados*. (pp 180). Brasil: Faculdade de Educação da Universidade de São Paulo.

Kubata, L., Fróes, R. de C., Fontanezi, R.M.M. (s/d). A postura do professor em sala de aula: atitudes que promovem bons comportamentos e alto rendimento educacional. Revista Electrónica de Salas *3*(1), 1-26. Retrieved from http://periodicos.unifacef.com.br/index.php/rel/article/view/421/404

Libâneo, J.C., Pimenta, S.G. (1999). Formação de profissionais da educação: visão crítica e perspectiva de mudança. *Educação & Sociedade*, *20(68)*, 239-277. doi: 10.1590/S0101-73301999000300013

Marconi, M. de A., Lakatos, E.M. (2003). *Fundamentos da metodologia científica*. (5 ed.). São Paulo: Atlas.

Martins, S. da S. (2003). *A prática pedagógica dos educadores no espaço escolar: reflexões voltadas ao aluno trabalhador* (p. 71-99), Panamá: Editora UFPR.

Minayo, M.C.S. (2001). *Pesquisa social: teoria, método e criatividade*. (18 ed.). Petrópolis: Vozes.

Oliveira, A.S. (2009). *Quando o professor se torna aluno: tensões, desafios e potencialidades da formação em serviço* (pp 186). São Paulo: Faculdade de Educação da Universidade de São Paulo.

Pimenta, S.G. (2013). Políticas públicas, diretrizes e necessidades da educação básica e formação de professores. In Libâneo, J.C., Suanno, M.V.R., Limonta, S.V. (orgs.). *Qualidade da escola pública: políticas educacionais, didática e formação de professores* (pp. 91-106). Goiânia: CEPED,

Pivetta, H.M.F., Isaia, S.M. de A. (2008). Aprender a ser professor: o desenrolar de um ofício. *Educação, Porto Alegre*, *31*(3), p.250-257. Retrieved from http://revistaseletronicas.pucrs.br/ojs/index.php/faced/article/view/4479

Rêgo, M.C.F.D. (2006). *A formação docente no fazer e refazer da prática pedagógica*. Tese de doutorado em Educação da Universidade Federal do Rio Grande do Norteatal

Rodrigues, J.B., Costa, M.S.F.P.M. (2015). A prática pedagógica e suas vertentes. In *VI Encontro Mineiro sobre Investigação na Escola. II Seminário Institucional*

PIBID – Programa Institucional de Bolsa de Iniciação à Docência. 01 a 03 de outubro. Uberaba.

Silva, E.L., Giordani, E.M., Menotti, C.R. (s/d). As tendências pedagógicas e a utilização dos materiais didáticos no processo de ensino e aprendizagem. Santa Catarina: Universidade Federal de Santa Maria.

Simão, A.L. (s/d). Ensino Fundamental de nove anos: o trabalho da professora do 1º ano. São Paulo: Pontifícia Universidade Católica de São Paulo.

UNESCO. (1998). Declaração Mundial sobre Educação para todos: satisfação das necessidades básicas de aprendizagem. Jomtien.

Yavorski, R. (2014). *Analise de Temas Ambientais desenvolvidos por professores do Ensino Fundamental de 1º ao 5º ano de Maringá*. Uniara, Araraquara: Centro Universitário de Araraquara.

Date received: 19/06/2018
Date reviewed: 09/09/2018
Date accepted: 18/03/2019

MLS - EDUCATIONAL RESEARCH
http://mlsjournals.com/Educational-Research-Journal
ISSN: 2603-5820

How to cite this article:

Angulo Cétarez, M. J. (2019). Teacher's Preparation in ICT and its Valuation in the Formation of Cabin Boys in Electromechanical Technology from the Non-Commissioned Officer Naval School of Barranquilla. *MLS Educational Research*, *3*(1), 43-58. Doi: 10.29314/mlser.v3i1.123

TEACHER'S PREPARATION IN ICT AND ITS VALUATION IN THE FORMATION OF CABIN BOYS IN ELECTROMECHANICAL TECHNOLOGY FROM THE NON-COMMISSIONED OFFICER NAVAL SCHOOL OF BARRANQUILLA

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Abstract. A teacher's preparation is demanding, not only requiring the appropriation of a specific knowledge of teaching, but the development of communication skills for the management of ICT (Information and Communication Technologies) as well. A continuous interaction with cabin boys (newly admitted students who last two years in the Non-Commissioned Officer Naval School) should be sought at the work site and wherever they are. This article, as a result of research in the Electromechanical Technology of the Non-Commissioned Officer Naval School of Barranquilla, presents the teachers' preparation and how they perceive it within their teaching activities. The 24 teachers in technology have been used as a population, of which 12 teach in subjects directly related to the use of ICTs, and so comprising this study and therefore representing the sample. Information was taken from the teachers, technology program manager, cabin boys, the Statistics Department and the Telematics Department. The results show teachers with good levels of ICT training and a favorable perception in their use. A tendency to stay permanently updated is observed; however, there are some specific cases that prove otherwise. It is recommended to continue monitoring these processes by applying it to the other technologies and training schools of the National Navy.

Keywords: E-learning, cabin boy, ICT, West point**.**

PREPARACIÓN DEL PROFESORADO EN TIC Y SU VALORACIÓN EN LA FORMACIÓN DE LOS GRUMETES DE LA TECNOLOGÍA ELECTROMECÁNICA DE LA ESCUELA NAVAL DE SUBOFICIALES DE BARRANQUILLA

Resumen. La preparación del docente es exigente y no sólo basta con apropiarse de un conocimiento específico de enseñanza, sino que requiere del desarrollo de habilidades comunicativas para el manejo de las TIC (Tecnologías de la Información y la Comunicación). Se debe buscar una interacción continua con los grumetes (estudiantes recién ingresados que duran dos años en la Escuela Naval de Suboficiales) tanto

en el sitio de trabajo como en cualquier lugar donde se encuentren. Este artículo, como resultado de una investigación en la tecnología Electromecánica de la Escuela Naval de Suboficiales de Barranquilla, expone la preparación de los docentes en TIC y cómo éstos las perciben en las actividades de enseñanza. Se ha tomado como población a los 24 docentes de la tecnología, de los cuales 12 desarrollan materias que están directamente relacionadas en el uso de las TIC, siendo así involucrados en este estudio y por lo tanto representan la muestra. Se recopiló información de los docentes, jefe de programa de la tecnología, grumetes, Departamento de Estadística y Departamento de Telemática. Los resultados muestran a los docentes con buenos niveles de formación en TIC, con una percepción favorable en su uso. Se observa una tendencia a su actualización permanente; sin embargo, existen algunos casos puntuales que demuestran lo contrario. Se recomienda continuar con el seguimiento a estos procesos aplicándolos en las otras tecnologías y escuelas de formación de la Armada Nacional.

Palabras clave: E-learning, grumete, TIC, West point.

Introduction

The NONS[1] is located in the city of Barranquilla. It is near the Caribbean Sea and behind its facilities is Colombia's most important waterway: The Magdalena River, which flows into the Caribbean Sea through the Bocas de Ceniza. This institution trains and prepares both militarily and technologically the men and women who serve as non-commissioned naval officers in the naval or land units of the National Navy.

Nowadays, there is no previous study on the use of ICT in the teaching process of Electromechanical technology nor the impact they have on it. For this reason, it is necessary to know how to use and incorporate them. We have the continuous collaboration of teachers (this research's object of study) and the academic program directors. Both are needed for preparing talented people in the use of new information and communication technologies. In addition, there is a need for people characterized by their enthusiasm, willingness, motivation and interest in promoting innovations so that can cabin boys benefit from the instruction received. This led to the following question: What is the status for the use of ICT in the in NONS's Electromechanical technology teaching process?

When trying to answer this question, an analysis was initially carried out on the ICT state of the art at the global, national and regional levels. As a result of this study, we discovered that by using them in the pedagogical activity, the teacher's work in higher education institutions is made easier due to the student's motivation to research a previously discussed topic from class or to prepare the lessons to be received in advance. This helps in structuring meaningful learning.

Pedagogical processes benefit from the management of technological resources, from class preparation to didactic evaluations. These are supported by software specifically designed for this purpose. This enables the implementation of training with quality standards where the student manages to achieve meaningful learning in accordance with the current demands of society. Citizens, therefore, have characteristics for knowing, doing and acting, with innovative skills that they recognize in their environment, adapting to it and seeking to solve situations that come their way on a daily basis. As a result, they are able to create new products that meet human needs (Unesco, 2008).

[1] Non-Commissioned Officer Naval School

The structure we work with in Spain is based on a quality education focused on the student, i.e., with up-to-date information received in a way that effectively addresses current challenges. On the other hand, the teacher is constantly preparing the topics discussed in the classroom and updating their knowledge through courses or masters, which not only include research in their field of knowledge but also in ICT. In other words, the technological means in training are handled with prudence; and through their use, they provide truthful and precise knowledge (European Commission, 2018).

Nowadays, ICT have reached a peak and experienced a great boost thanks to their impact on the different social communities. So much so that they are used in every activity of the human being, promoting a rise in the demand of worker training, which in this case corresponds to teachers and students (Marqués-Graells, 2012). Indeed, there exists a requirement for a digital literacy that provides the proper training needed to access information and communication anytime and anywhere, thus, leaving time and space barriers behind.

The impact of ICT is evinced by the society and development model that humanity has passed through (Fourçans, 2013). It is manifested in the teaching process, since they 'enable the integration of more novel experiences that are connected to the expectations and experiences of XXI century students' (Unesco, 2013, pg. 67).

Educational programs that catch the students' attention due to their user friendliness and dynamic structure provide a way of improving the teaching process, enabling teachers to have a versatile tool available to be used when developing lessons according to the topic being addressed and the development point of the pedagogical activity. In addition, 'animations provide further simplicity in the design - and, subsequently, in the cognitive load; they are superior to static media in terms of learning efficiency' (Holzinger, Kickmeier, & Albert, 2008, pg. 287).

Having the information at hand, sorted by analysis necessities with assessment models and tools that are efficient and pertinent to the conditions for developing academic actions, means that the provided training can prove to enable improvement proposals for both teachers and students (Jaime & Lizcano, 2015). Mobile learning is based on information reception and delivery in different contexts with the aid of technology, adding a channel to support the other real-time training resources (Ramos, Herrera, & Ramírez, 2010).

The benefits of virtual learning, such as the optionality of the student's presence in the classroom (Pantoja-Vallejo & Zwierewicz, 2008), and the fact that the use of ICT means that the advantage level can be measured by social prestige, coexistence and user satisfaction (Opati, 2013), provide those students with access to technologies and their respective tools with an interactive learning developed within a dynamic environment (Imbernón, Silva, & Guzmán, 2011).

There are difficulties present in educational institutions because 'in schools, changing lesson planning is slower than adapting to computers in the classroom' (Livingstone, 2012, pg. 10). However, research by the ITU[2] reflects the current ICT global infrastructure progress state considering the indicators proposed by them (ITU, 2017).

Some of the institutions and organizations highlighted their support to the use of ICT are the United Nations Task Force during the forum on Promoting an Enabling

[2] International Telecommunication Union

Environment for Digital Development, held in Berlin in 2004, which communicates the key role of ICTs within organizations. The WHO (World Health Organization) also promotes their implementation in the field of health sciences, as well as the WIPO (World Intellectual Property Organization), which promotes those activities related to e-commerce on the Internet in order to streamline commercial transactions.

In addition, the ICAO (International Civil Aviation Organization) has designed a plan to ensure compatibility between its applications and aviation security components worldwide. The FAO (Food and Agriculture Organization of the United Nations) also carries out projects aimed at converging new and traditional technologies in order to work on alternative crops. Similarly, the UNCTAD (United Nations Conference on Trade and Development) collaborates with developing countries in implementing national ICT policies to promote online-business, exports and competitiveness.

Meanwhile, the International Trade Centre (*Centro de Comercio Internacional*) administers the e-trade bridge program in 30 countries managing auctions of different items via the Internet. Similarly, the WMO (World Meteorological Organization) is working on the development of an ICT system for the exchange of information regarding weather conditions, water resources and climate types.

The World Bank supports governments in implementing competition policies and regulation for the ICT sector. In addition to the above, the OECD (Organization for Economic Cooperation and Development) reviews the efforts of member countries from this community to strengthen access to information.

CERN (European Organization for Nuclear Research) manages the ICT project with the collection and exchange of scientific data in the management of nuclear energy. Lastly, UNESCO and ITU, at the World Summit on the Information Society in Geneva 2003 and then in Tunis 2005, seek the integral development of the individual, with the development of ICT skills being one of their priorities through the Ceibal plan created in 2007 which aims to give equal opportunities to everyone through access to technology.

In military education, e-learning and simulation technologies provide solid tools for the preparation of military members, without forgetting that "achieving the development of competencies for the handling of information in virtual learning environments, the guidance of the teachers and the peers themselves is of great importance" (Alba & Orrego, 2013, pg. 114). The U.S. Army, through West Point, is the main driving force behind the development, use of e-learning and simulation technologies, investing billions of dollars in these programs.

Major investments in new educational technologies have enabled American cadets to remain motivated in studying in ways not done before. For this, behaviorist approaches are used with better control and management of the knowledge imparted to the subjects (Juhary, 2010).

The U.S. regiment built its twelve principles of knowledge management including policies ranging from the incentivized incorporation of knowledge with media such as podcasts, videos and simulations, to mandatory training (Byrne & Bannister, 2013). The military operations of networks, information technology and ICT are intertwined at the micro and macro organizational levels of the armed forces, emphasizing that the processes of use of force, support and generation of results are focused on their systems (Mattila & Parkinson, 2017).

The motivation to carry out academic activities in Latin societies stands out along with the student's concentration when immersed in a world where ICT are used, due to the animated dynamic and interactive possibilities of these tools. (Sunkel, 2010) This means that the way in which information is presented to cabin boys influences their learning disposition. In Colombia, five skills were specified for teachers to properly manage ICT: technological, communicative, pedagogical, managerial and research (MEN, 2013), with full knowledge in technological tools, from their functioning, validity and regulations perspective.

The reason for its use, and the way it will be implemented in the classroom, must be clear. This is to say, there must be prior planning that includes the communication method to be used for these processes to enable new knowledge to be integrated into the student's previous experience. The teaching function in NONS is therefore framed within a continuous and integral pedagogical formative process, which sizes the management of disciplinary, interdisciplinary and transdisciplinary knowledge through ICT and other means that enable the student's social and academic transformation (ENSB, 2016).

NONS professors have been working in modeling by using algorithms that enable naval objects, machines and tools to be visualized, facilitating the instructions given to the cabin boys in the machinery and equipment parts used in the Colombian Navy (Álvarez, 2014). AR[3] provides the details in handling plans, ships and airplane analysis, enabling the cabin boys to become more involved in their preparation, and therefore, receive significant learning foundations which, in this situation, are hard to achieve without the technology's help.

Method

The proposed objective of this research is performing an ICT diagnosis for the use of the teaching process in the NONS's Electromechanical technology.

Participants

The population is made up of 24 NONS Electromechanical technology teachers with different undergraduate and postgraduate academic training. They are also composed of 2 completely differentiated groups: 14 civilian teachers with extensive experience in secondary and higher education formative fields, knowledgeable in different pedagogical strategies to impact the cabin boys' learning; and 10 military personnel (some of them working in Electromechanical Technology and others on support belonging to another technology) with specific knowledge and skills in a work area, and knowledgeable in the diverse needs presented in the different naval and terrestrial units of the Colombian National Navy.

Of these 24 teachers, there are 12 (50% of the study population) whose subjects are directly related to the use of those ICT involved in this study. We also work with the Electromechanical Technology program chiefs, who themselves are two non-commissioned officers with extensive experience and knowledge in the strengths and needs of the Colombian National Navy, first and second year cabin boys with emphasis on Motors, Electrical Controls and Refrigeration who are in permanent contact with

[3] Augmented Reality

teachers, the Head of the Statistics Department who is responsible for handling the notes, the Head of the Telematics Department who is in charge of the institution's hardware and software structure, the librarians who handle information regarding texts, magazines, platform and databases, the Head of the Instructional Assistance Department, other non-commissioned officers who directly or indirectly relate to this technology, and the Academic Dean.

Design

The research method used is quantitative, which relies on deductive statistical tools. This approach presents several useful sequential characteristics applicable to the field of research with which a problem of delimited and concrete study is set out by carrying out specific questions with the proposal of the hypotheses from the researcher's part: the use of ICT improves the teaching process in NONS Electromechanical technology; when ICT tools are available in NONS Electromechanical technology, some of the teacher's academic activities are facilitated, with the incorporation of ICT in NONS Electromechanical technology favoring the teacher's collaborative work. The answers are obtained with their respective demonstration and inferences to other teachers in technology and the institution from a selected sample of the population.

We seek maximum control in order to exclude other possible explanations based on uncertainty and to minimize the error generated during the process. The predictions proposed are based on previous studies and it is clear that the phenomena observed should not be subjective and, therefore, follow a determined and structured pattern.

Data collected are within the standards of validity and reliability required in scientific research work, using deductive reasoning from educational theories, ICT principles and military training requirements that are transformed into hypotheses for subsequent testing (Hernández, Fernández, & Baptista, 2010). The aim is to identify the causal laws present in ICT teaching in NONS Electromechanical Technology, which is shown as a reality external to the individual.

Instruments and Techniques

The survey used is reliable, which means that, when it is applied to the same individual under the same conditions, it generates the same results. In addition, we compile the information handled by the Statistics Department with respect to the evaluations carried out by the cabin boys about the teachers on the subjects taught, the program chiefs who carry out the annual performance evaluation, and the Telematics Department, in whose formats the hardware and software infrastructure of the institution is recorded.

The teacher's preparatory conditions were measured with respect to ICT and the way they perceive them in their academic activities thanks to the survey. The survey was developed in stages from 2013 in the Electronics program and modified and adapted in 2016 to Electromechanical Technology and evaluated by an interdisciplinary group of experts in 2017. Subsequently, thanks to the information provided by the Statistics Department, data was obtained on the assessment periods that the cabin boys carry out on the teachers according to the subjects that they teach, for which a representative sample was taken, and where they were asked to respond to a questionnaire designed for this purpose.

With the annual performance evaluation that the program managers carry out on the teachers, information was obtained referring to the strengths, the aspects to be

improved, achieving the objectives, and overall performance. Lastly, the documents provided by the Telematics Department obtained data on network capacity, computer equipment and the technological tools that teachers have access to, as well as any installed software and databases.

Procedure

The information used for this research was collected through an action defined by stages: firstly, the questionnaire was developed with closed-ended questions aimed at understanding the teachers' training in ICT. Secondly, it was used Likert type questions in order to identify their perception regarding the handling of these technologies. A sample of 12 of the 24 teachers in Electromechanical Technology was subsequently selected according to the subjects taught and the level of involvement in the use of ICT, providing them with a discussion on the importance of their work. The survey, designed in Google Forms, was then delivered to their emails.

A meeting was later held with the non-commissioned officer in charge of data management in the Statistics Department, who consulted its sources and provided all teachers with information on the assessment carried out by the cabin boys. The researcher selected the relevant information from the Electromechanical Technology for further analysis. A meeting was consequently arranged with the program managers to provide the annual performance evaluation data to the technology teachers who provided the information used in this work.

Based on the foregoing, the Head of the Telematics Department compiled information on the databases, hardware and software installed in the institution. Lastly, the collected information was processed, enabling identifying the dependency relationships among variables. So, this led to the verification of the proposed research hypotheses.

Results

The following is an analysis of the results obtained during the research established in the NONS.

The following factors are considered in Table 1 which corresponds to the teachers' evaluation of Electromechanical Technology for the first module for 2017 by the cabin boys: *Knowledge of the discipline, planning of the workshop, learning environment, strategies, methods and skills, motivation, assessment, communication, course management, information and communication technologies, general satisfaction*. We can see that the minimum score achieved over 5.0 was 4.5 in the Damage Control and Thermal Engine subjects and the maximum was 4.9 in the following subjects: Converters, Alternative Engines, and Automation and Principles. Such results indicate that the cabin boys considered that a high level was maintained during the instruction given to them in this module's subjects probably due to the fact that they most likely enjoyed the way in which the academic activities were carried out.

Table 1.
Teacher Evaluation 2017 (1)

No.	Subject	Evaluation
1	Engine Thermodynamics	4.6
2	Converters	4.9
3	Naval History	4.7
4	Alternate Engines	4.9
5	Damage Control	4.5
6	Current Circuit	4.8
7	Automation and Principles	4.9
8	Thermal Engines	4.5
9	Basics of Thermal Engines	4.7

Note: created by the work's author based on the information provided by the NONS Statistics Department (2017).

In Table 2, corresponding to the teachers' evaluation of the Electromechanical Technology of the second module for 2017 by the cabin boys, we can see that the minimum grade achieved over 5.0 was 4.1 in the Design I (AutoCAD) subject and the maximum was 4.7 in the following subjects: Human Rights, Thermal Engines, Electromechanical Engines, and Automation and Principles. This indicates that the cabin boys considered that a high level was maintained during the instruction given to them in this module's subjects probably due to the fact that they enjoyed the way in which the academic activities were carried out.

Table 2
Teacher Evaluation 2017 (2)

No.	Subject	Evaluation
1	Fluid Mechanics	4.4
2	Human Rights	4.7
3	Thermal Engines	4.7
4	Research Methodology	4.5
5	Damage Control	4.6
6	Electromechanical Engines	4.7
7	General Technical English	4.6
8	English III	4.5
9	Automation and Principles	4.7
10	Alternating Current Circuits	4.3
11	Drawing I (AutoCAD)	4.1
12	Ethics and Values	4.6

Note: created by the work's author based on the information provided by the NONS Statistics Department (2017).

The program manager is in charge of assessing the teacher's job performance as related to the Electromechanical program by carrying out this activity during the mid-year and at year's end through the productivity and work pattern factors, which are in turn divided, in the case of productivity, into: *planning, resource use, quality, technical competence, responsibility and opportunity;* in the case of work pattern, it is divided

into: *institutional commitment, information processing, teamwork, interpersonal relations and initiative*.

The objectives between the program manager and the teachers are concerted annually in accordance to the institutional needs, to be worked during the evaluation period. The results show that the teachers obtain between *superior*, 767 up to 883, and *outstanding*, 884 up to 1,000, which indicates their high level of commitment and responsibility with both the institution and the program.

Information was obtained from the Telematics Department regarding the institution's physical resources. There are 20 desktop computers in the English laboratory; 10 desktop computers in the electrical controls laboratory; 1 desktop computer for every 3 teachers in the faculty office; 27 desktop computers in the library; a room with 11 laptops in the PVD[4], 1 Smart TV, and another room with 16 desktop computers, 1 Smart TV; there is also 1 TV for every 2 classrooms.

All of the above equipment has broadband internet access. However, some of them have more restrictions when browsing websites such as those in the faculty office and the English laboratory. There are also places where the use of equipment is shared between the students and the teachers, such as the English laboratories, the electrical control room, the PVD, and the library.

With regard to software, Blackboard[5] is used for all Military Forces of Colombia, which has access to the Digital National Security Archive documentary databases (a collection of more than 140,000 books from different international publishers). The reference for the management of thesis and articles from Latin American universities is also available.

Moreover, the Colombian National System of Open Access to Knowledge (SNAAC, *Sistema Nacional de Acceso Abierto al Conocimiento*) is used and which coordinates information between public and private institutions in Colombia. In addition, the FFMM library catalogue is available along with the ARC library with access to Training Schools.

During their training, marines have at their disposal the ESUP library when enrolling in the ARC Surface School. The ESCAN library is also consulted in the air-sea area, which provides access to naval aviation along with the FAC library when admitted to the Colombian Air Force Training Schools.

The SIBFA catalogue is used for the consultation of physical documents in the libraries of the Armed Forces. Moreover, we work with the online magazine database ProQuest and Power Search; the latter being a tool for locating articles and books on topics such as justice, crime, war and terrorism.

In addition to the above, the Latin American scientific journals SciELO and the Directory of Open Access Journals DOAJ (website for the access to free journals) were consulted for journals. Lastly, with respect to databases we have the GALE CENGAGE Learning, the Chatham House Online Archive database, the Smithsonian Collections Online database, the OECDiLibrary (database for Economic Cooperation and Development), and the database of the Organization of Ibero-American States (OEI,

[4] Punto Vive Digital

[5] Computer platform for the creation of documents and administrating courses which are accessed by the students via the internet

Organizaciones de Estados Iberoamericanos). Some of these sources of information are limited to the exclusive use of military teachers.

With regard to the installed capacity of the cabling, Figure 1 shows the infrastructure of the Academic Department, classrooms and library.

Figure 1. Wiring in the Academic Department.

Note: Adapted from the NONS Telematic Department 2018.

Apart from what has been previously explained, Figure 2 shows how the different dependencies of the NONS are connected via single mode, multi-mode and UTP.

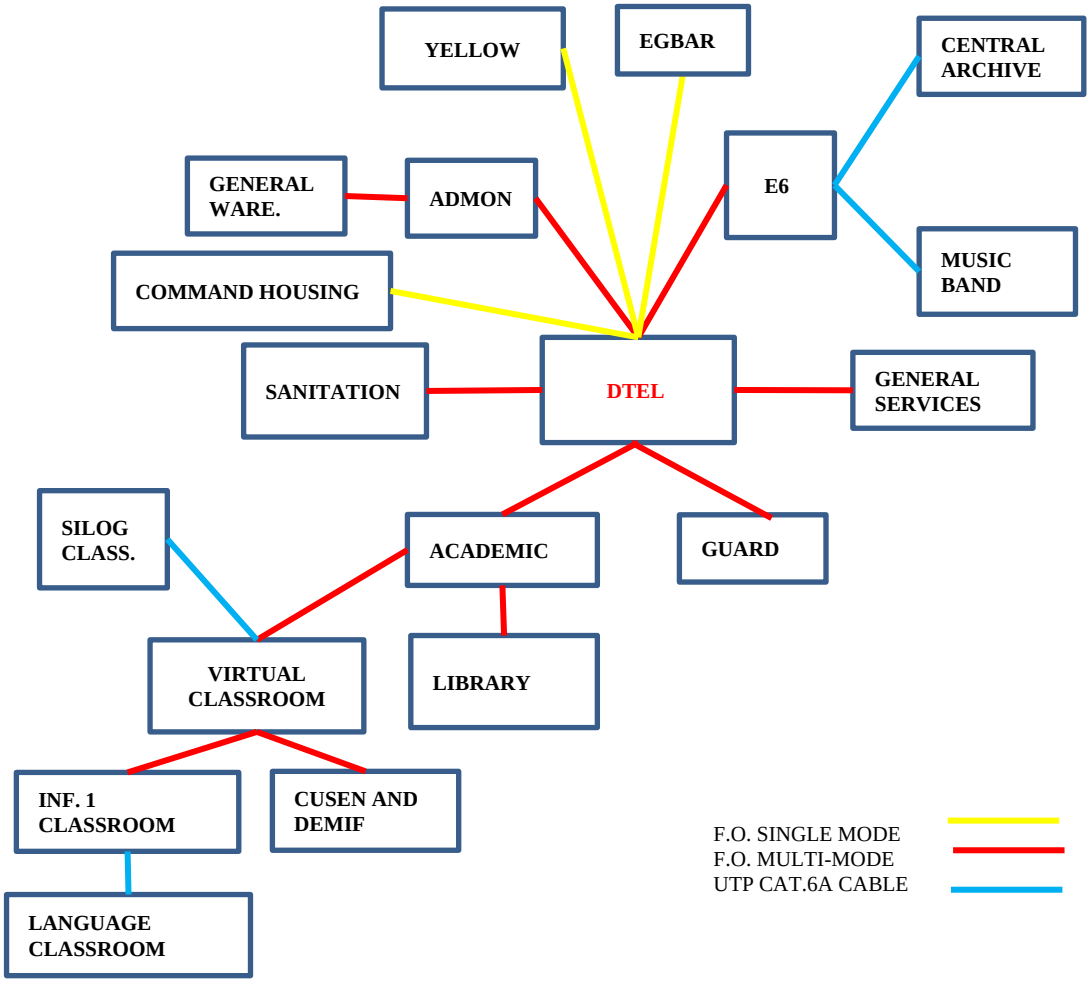

Figure 1. Wiring in the NONS.

Note: Adapted from the NONS Telematic Department 2018.

Discussion and Conclusion

With the use of ICT, NONS teachers develop their academic activities much better planned, initially investing time to prepare the support materials but becoming easier in later implementing them in the subsequent modules with these tools, and so streamlining the educational process. This is to the benefit of cabin boys who receive instruction directly applied to electromechanical systems, visualizing situations where they see the importance of knowledge. The teacher can also devote more time to resolving student concerns or consulting updated information on a specific topic.

In addition, there are obvious difficulties during the research, keeping in mind that, as a military institution, there are restrictions on the handling of information that needs to be requested under justified grounds and with anticipation in order for them to carry out the respective analysis and authorize its disclosure. It is also necessary to consider the priority status in Colombia that lead to joint efforts in improving national security; thus, more time is needed to carry out subsequent work related to ICT, providing increasingly comprehensive responses with their respective recommendations. Economic resource constraints and the non-priority of its implementation likewise affect the broadening of this technology.

In a previous study carried out in IHE[6] in Colombia, the difficulties that arise when implementing these technologies were:

> The oldest teachers...are...restrictive in their use of technological mediations, rejecting and disagreeing with processes that take them away from the traditional paradigm.
>
> ... One aspect to be overcome is the loneliness and absence of people not present during the learning process...
>
> Technological mediations... Are associated with the need for a fast and stable Internet connection (Padilla, Vega, & Diego, 2014, pgs. 286-287).

The aim of this research was to attract the attention of teachers and researchers, motivating them to use computer resources more frequently, implementing them in their work functions according to the training needs of the cabin boys with applications that strengthen their learning. Its purpose is for non-commissioned officers to provide their services in the different regions of the country, in order to achieve a strengthened and strong Colombian National Navy.

One of the objectives was to confirm that collaborative work among teachers is strengthened with the use of ICT, as evidenced by their perception of the benefits of sharing information, programs and other computer tools. Furthermore, in some cases they come into contact via Wi-Fi, through WhatsApp and e-mails when carrying out teamwork such as reviewing the PEI, academic regulations, collecting and analyzing information regarding the report to be sent to the CNA[7] on how the Naval School is doing, or when they need to communicate with the program chief.

Another objective was to identify academic activities that are simplified by the use of ICT. This manifests itself with the benefits of facilitating class preparations with information found through specialized web pages, databases, developing classes using videos, power point or prezi presentations, specialized programs such as Derive, Circuit maker, Solid Works, Solid Cam, Geo gebra, sending data online, evaluations through the Blackboard platform, and feedback on recommendations that can be carried out online.

Lastly, to identify the influence of ICT in teaching, where it was evident that some teachers do not have solid ICT training, and simply handle them by experience or by listening to others; this situation was observed when they were required to help in completing the survey, although they did show interest in improving and resolving this difficulty after speaking with them. There are teachers who can be considered as being at an intermediate stage in the implementation of ICT because they handle the basic Microsoft office package and their academic activities revolve around this resource. Other teachers are at a more advanced level, using specialized software for their courses in Mathematics and Electronic Circuits.

This shows that teachers need better preparation in NONS to take greater advantage of ICT. This stimulates the cabin boy in researching a content and even preparing a topic in advance to be discussed in class. This situation is observed in the classroom and in the library when they consult specialized web pages, where they ask the teacher where to find the information, what web pages they know of, what online

[6] Institutions of Higher Education
[7] National Accreditation Board (*Concejo Nacional de Acreditación*)

texts they know of, motivating the teacher to research and update their knowledge, and so becoming a counselor who knows the information and knows where to find it.

The teacher's role in the management of ICT during their daily activities stands out, reflecting positively in their degree of interest, commitment and support when using these tools. In short, cabin boys are encouraged to apply them in their assigned academic commitments, providing guidelines to follow so that they develop quality work both in their content and in their presentation, as well as being regarded as references for other students who begin their work. This is evident in the work performance evaluations carried out by the Head of the Electromechanical Technology program.

With respect to the way in which the teachers are perceived by the cabin boys, the evaluations carried out highlighted the perception that their teachers are committed to the teaching processes. They follow a sequence on the imparted instructions, clarify doubts and encourage their students in improving their academic performance, encouraging them to consult reliable sources and use ICT in a legal and ethical manner during the analysis and development of their work.

Regarding the ICT infrastructure of NONS, hardware resources were found such as computer equipment with Internet connection in the Electromechanical Technology laboratories, the library, the Punto Vive Digital, the faculty office where educators have access to prepare as well as to develop and evaluate their classes, as well as in the cabin boy shop where documents can me printed, scanned and information consulted, without forgetting the computers of the research center's program managers. The software found were those such as office packages, specialized software, and databases that teachers consult or manage to share information even with other forces in Colombia, along with the Blackboard platform used to communicate with the cabin boys via messages, assigning activities, and evaluating them.

Adding to the list are Smart TVs installed for every two classrooms, used by teachers as well as the cabin boys for videos and presentations. Likewise, most of the cabin boys also have a laptop computer where they carry out many of the activities assigned to them by the teachers.

Although there are online training courses in the use of the Blackboard platform as provided by the Colombian National Navy, the teaching process may be improved with the addition of the system's effective use, since not all teachers currently us it. The use of a greater number of interactive software aimed at handling machines, technology mechanisms, electronic circuits, and refrigeration is also recommended. This drives the consultation of specialized sources such as databases and works on thesis works done by other cabin boys who previously carried out their research, by which they can count with a better vision and propose written solutions either as mock ups or prototypes for specific institutional cases.

We may infer that the Naval School tends to improve its academic processes as enshrined in its institutional accreditation by the CNA with the certification issued by its ICONTEC[8] audit for all its administrative processes. This highlights certain aspects to be improved such as applied and scientific technological research, but it also shows the high quality with the resolutions in recognizing the effectiveness of their academic programs, its organization, functioning and the compliance of its social function. The teachers committed to their activities and conscious of what dominates in the

[8] Colombian Institute of Technical Standards (*Instituto Colombiano de Normas Técnicas*)

application of ICT in education at the global level propose driving its rational and efficient management so as to increase their research level in NONS's Electromechanical Technology.

The recommendations also include the development of other exploratory activities that involve the rest of the NONS's technologies, not only at the cabin boy's levels, but the marines' intermediate capacities. Non-commissioned officers with advanced training can also be included, developed technological specializations from the graduate studies office such as Network Systems, Composite Materials, Integrated Coastal Zone Management, in Maritime Traffic Control, Health Services Administration, in Human Talent Management and Leadership, Security and Information Management. This point suggests considering this place of practice during the proposed studies, specifically for Hydrography and physical Oceanography where the cabin boys carry out part of their APNS[9] studies.

In addition to what has been previously mentioned, future research can analyze the learning processes, how to benefit from the use of these tools, speaking with the cabin boys to obtain clarity on administering these computer resources, with an emphasis on the development and management of specific software as required in each technology, since there are currently few of them. The need also arises to implement research in the naval officer training centers, beginning with the APNS cadets and students from NITS[10] in their different levels of education in this field, keeping in mind that there are restrictions in the management of information due to its military nature and, thus, a greater amount of time is needed to justify such requests with the support of previously carried out studies.

References

Alba, M., & Orrego, C. (2013). Aprender haciendo en la virtualidad. *Ciencia y Poder Aéreo, 8*(1). doi: 10.18667/cienciaypoderaereo.14

Álvarez, H. (2014). Objetos virtuales de aprendizaje en la formación tecnológica. *Escenarios, 12*(1). Retrieved from https://dialnet.unirioja.es/descarga/articulo/4763570.pdf

Byrne, B., & Bannister, F. (2013). *Knowledge Management in Defence*. En B. Janiūnaitė, A. Pundziene & M. Petraite (Eds.), *14th European Conference on Knowledge Management* (pp. 106-116). México: México. Academic Conferences & Publishing International. Retrieved from https://books.google.com.co/books?id=esUTBAAAQBAJ&pg=PT105&lpg=PT105&dq=Knowledge+Management+in+Defence++Barry+Byrne+and+Frank+Bannister+Irish+Defence+Forces+and+Trinity+College+Dublin&source=bl&ots=ArvtBTEBb9&sig=U7Ty8NybtlKRlwQaIMqfaHJRccs&hl=es-419&sa=

ENSB. (2016). *Proyecto educativo institucional.* Barranquilla. Retrieved from http://docplayer.es/54287070-Proyecto-educativo-institucional.html

European Commission. (2018). *Education and training monitor*. Retrieved from https://ec.europa.eu/education/policy/strategic-framework/et-monitor_en

[9] Admiral Padilla Naval School (*Escuela Naval Almirante Padilla*)

[10] Naval Infantry Training School

Fourçans, M. (2013). La adaptación en tiempos de cambio: las TIC en el medio educativo. *Reflexión académica en diseño y comunicación*, 20. Retrieved from https://fido.palermo.edu/servicios_dyc/publicacionesdc/archivos/429_libro.pdf

Holzinger, A., Kickmeier-Rust, M., & Albert, D. (2008). Dynamic media in computer science education; context complexity and learning performance: is less more? *Educational Technology & Society*, *11*(1). Retrieved from https://www.j-ets.net/ets/journals/11_1/20.pdf

Imbernón, F., Silva, P., & Guzmán, C. (2011). Competencias en los procesos de enseñanza-aprendizaje virtual y semipresencial. *Comunicar*, 18(36). doi: 10.3916/C36-2011-03-01

ITU. (2017). *Measuring the information society report.* Geneva, Switzerland: ITU. Retrieved from https://www.itu.int/en/ITU-D/Statistics/Documents/publications/misr2017/MISR2017_Volume1.pdf

Jaime-Vivas, R., & Lizcano-Dallos, A. (2015). Trabajo colaborativo mediado por TIC en el aprendizaje de dinámica de sistemas. *DYNA*, *82*(189). doi: 10.15446/dyna.v82n189.42026

Juhary, J. (2010). *The military academy of Malaysia compared with West Point.* Florida, United States: Dissertation.com. Retrieved from http://www.universal-publishers.com/book.php?method=ISBN&book=159942309X

Livingstone, S. (2012). Critical reflections on the benefits of ICT in education. *Oxford review of education*, *38*(1). doi: 10.1080/03054985.2011.577938

Marqués-Graells, P. (2012). Impacto de las TIC en la educación: funciones y limitaciones. *3 Ciencias. 2*(1). Retrieved from https://dialnet.unirioja.es/servlet/articulo?codigo=4817326

Mattila, J., & Parkinson, S. (2017). *Predicting the architecture of military ICT infrastructure.* En R. Dameri & R. Spinelli (Eds.), *11th European Conference on Information Systems Management*. Genoa: Italy. Academic Conferences & Publishing International. Retrieved from http://www.academia.edu/34644149/Predicting_the_Architecture_of_Military_ICT_Infrastructure

MEN. (Coord.) (2013). *Competencias TIC para el desarrollo profesional docente.* Bogotá, Colombia: Imprenta Nacional. Retrieved from https://www.mineducacion.gov.co/1759/articles-339097_archivo_pdf_competencias_tic.pdf

Opati, O. (2013). *The use of ICT in teaching and learning: the case of college of education and external studies.* Oslo, Noruega: Trykk. Retrieved from https://www.duo.uio.no/bitstream/handle/10852/36807/ICT%40MUK-Onop.pdf?sequence=1&isAllowed=y

Pantoja-Vallejo, A., & Zwierewicz, M. (2008). Procesos de orientación en entornos virtuales de aprendizaje. *REOP*, *19*(3). Retrieved from https://www2.uned.es/reop/pdfs/2008/19-3%20-%20Antonio%20Pantoja%20Vallejo.pdf

Padilla, J., Vega, P., & Rincón , D. (2014). Tendencias y dificultades para el uso de las TIC en educación superior. *Entramado*, *10*(1). Retrieved from http://www.scielo.org.co/pdf/entra/v10n1/v10n1a17.pdf

Ramos, A., Herrera, J., & Ramírez, M. (2010). Desarrollo de habilidades cognitivas con aprendizaje móvil: un estudio de casos. *Comunicar, 17*(34). doi: 10.3916/C34-2010-03-20

Sunkel, G. (2010). TIC para la educación en América Latina. En CEPAL (Ed.), *Congreso Iberoamericano de Educación*. Buenos Aires, Argentina: CEPAL. Retrieved from https://www.oei.es/historico/tic/Sunkel.pdf

Unesco. (2008). *Estándares de competencia en TIC para docentes.* París, Francia:UNESCO. Retrieved from http://www.eduteka.org/EstandaresDocentesUnesco.php

Unesco. (2013). *Enfoques estratégicos sobre las TIC en educación en América Latina y el Caribe.* Santiago, Chile: OREALC. Retrieved from http://www.unesco.org/new/fileadmin/MULTIMEDIA/FIELD/Santiago/images/ticsesp.pdf

Date received: 09/10/2018
Date reviewed: 29/10/2018
Date accepted: 06/02/2019

MLS - EDUCATIONAL RESEARCH
http://mlsjournals.com/Educational-Research-Journal
ISSN: 2603-5820

How to cite this article:

Vilchez Guizado, J. (2017). Digital Empowerment and Development of Mathematical Competences in the Training of the Teacher of Mathematics. *MLS Educational Research, 3*(1), 59-78 Doi: 10.29314/mlser.v3i1.130

DIGITAL EMPOWERMENT AND DEVELOPMENT OF MATHEMATICAL COMPETENCES IN THE TRAINING OF THE TEACHER OF MATHEMATICS

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Abstract. The present work was oriented to reveal the level of digital empowerment and the development of mathematical competences in the initial formation of the mathematics teacher at the Hermilio Valdizán University. The objective of the study was to evaluate the implications of the use of digital resources: mathematical software and interactive pages in the teaching-learning process of the topics of mathematics and the development of reasoning, problem solving and argumentation skills, communication and argumentation. The research was framed in the qualitative methodology based on the techniques of participant observation, in-depth interview and evaluation rubric. The data collected through the interview was subjected to a process of codification, categorization and construction of semantic networks with the help of the Atlas.ti, while the data from the observation process and the rubric are presented and interpreted statistically in (frequencies and percentages). From the most significant findings it can be seen that most of the teachers in initial training have a considerable digital empowerment, expressed in the use of free software, collaboration resources, social networks and interactive pages for the solution of mathematical problems in algebraic form and graph. On the other hand, more than 85% state that their mathematical competences were developed optimally with the use of technology. It is concluded that digital empowerment is fundamental for the learning of mathematics and the development of reasoning skills, problem solving, modeling and mathematical communication during the initial training of the mathematics teacher.

Keywords: Digital Empowerment, mathematical competence, initial teacher training.

EMPODERAMIENTO DIGITAL Y DESARROLLO DE COMPETENCIAS MATEMÁTICAS EN LA FORMACIÓN DEL DOCENTE DE MATEMÁTICA

Resumen. El presente trabajo estuvo orientado a develar el nivel de empoderamiento digital y el desarrollo de competencias matemáticas en la formación inicial del docente de matemática en la Universidad Hermilio Valdizán. El objetivo del estudio fue evaluar las implicaciones del uso de recursos digitales: software matemático y páginas interactivas en el proceso de enseñanza-aprendizaje de los tópicos de la matemática y el desarrollo de las competencias de razonamiento, planteamiento y resolución de problemas, comunicación y argumentación. La investigación estuvo enmarcada en la metodología cualitativa sustentada en las técnicas de observación participante, entrevista en profundidad y rúbrica de

evaluación. Los datos recolectados a través de la entrevista fueron sometidos a un proceso de codificación, categorización y construcción de redes semánticas con ayuda del Atlas.ti, mientras que los datos provenientes del proceso de observación y de la rúbrica se presentan e interpretan estadísticamente en (frecuencias y porcentajes). De los hallazgos más significativos se puede extraer que la mayoría de los docentes en formación inicial tienen un empoderamiento digital considerable, expresado en el uso de software libre, recursos de colaboración, redes sociales y páginas interactivas para la resolución de problemas matemáticos en forma algebraica y gráfica. Por otro lado, más del 85% manifiestan que sus competencias matemáticas fueron desarrolladas de forma óptima con uso de la tecnología. Se concluye que el empoderamiento digital, es fundamental para el aprendizaje de las matemáticas y el desarrollo de las competencias de razonamiento, resolución de problemas, modelación y comunicación matemática durante la formación inicial del docente de matemática.

Palabras clave: Empoderamiento digital, competencia matemática, formación inicial docente.

Introduction

In recent years, the strategic objectives of education have been to improve the quality of education through the diversification of contents and teaching methods, as well as through strategies aimed at promoting experimentation, innovation, dissemination and sharing of information and good practices, forming learning communities and stimulating fluid dialogue on policies to be followed as well as activities to be carried out (UNESCO, 2004). This statement is reinforced by the implementation of digital technologies as a didactic resource aimed at training focused on student learning, within a constructive and interactive environment of didactic processes.

Nowadays, education systems at their different levels and modalities revolve around the use of information and communication technologies (ICTs) to provide students with the tools and knowledge of the era of globalization and knowledge, where the development of mathematical competencies becomes essential: associating real situations with mathematical expressions, use of didactic resources, heuristic and metacognitive strategies, as well as the explanation, justification and verification of concepts and theories, fundamental inputs for knowledge building in a quality educational process. The teaching-learning process receives a significant impact from ICT compared to conventional teaching-learning methods. It also predicts the transformation of the educational process and the way in which teachers and students access knowledge and information (Spanish, 2010).

Therefore, the current educational praxis focuses on the integral formation of students in the different areas of the curriculum being studied, particularly in the area of mathematics, through the development of knowledge, skills and attitudes oriented to innovation and lasting transformation, in line with scientific and technological progress. Under this premise, the use of ICT and the process of learning mathematics cannot be separated. Thus, the use of digital technology as a didactic-pedagogical resource dynamizes the teaching-learning process. These resources, when used appropriately, help teachers to capture students' attention, to motivate, to develop examples, to encourage creativity and to assign tasks. They also support students through interactive activities to solve numerical, algebraic and graphic problems in an autonomous and collaborative way. Interaction in all learning environments allows innovation to help students develop their skills, so that they respond equitably to current and future educational needs; thus consolidating the link between professional training and educational praxis.

The potential of digital resources in teaching and learning processes is one of the current challenges that mathematics education faces; since from these new technological tools benefits are glimpsed offered by calculators, computers, software, Internet, etc., due to the fact that they can store, process and transmit information, thus constituting a fundamental resource for problem solving. However, such didactic processes and their learning are not without difficulties. Among them stand out those associated with representational nature and those linked to a conceptual complexity over those related processes (Hitt, 2003).

Nowadays, the use of digital resources in the teaching and learning process at higher education level is an absolute necessity, since they allow to perform functions that range from information access and exchange, to the creation of simulated environments that facilitate the realization of practices of easy control and preparation by teachers. Moreover, their flexible and open nature means that they can be used in different contexts and learning situations, from information transmission to phenomena simulation or exercises realization, knowledge evaluation or tutoring.

Making a diagnosis regarding the use of digital technology in the teaching-learning process during the subject development and the integration of ICT into the curriculum, in the professional education career of the Universidad Hermilio Valdizán de Huánuco, the following was found. The use of digital technology in the development of academic activities, as a didactic medium and resource, is sporadic and static. In addition, in most cases, teachers use the technological resource only as a visual aid, without encouraging dynamism or interaction in student learning, which leads to a deficient learning, filled with flaws and inconsistencies, mainly due to not knowing how to use digital technology as a didactic resource. As an alternative to the deficiency detected in the use of ICTs by teachers and students during the didactic process, there is an urgent need to promote digital empowerment in educational subjects as a catalyst for the teaching-learning process of the different topics, making ICTs real resources to express meaningful, effective and efficient learning in students.

This is why the proposed innovation is pertinent, since through the project, it was possible to optimize the process of learning mathematics, making use of some digital tools (mathematical software, interactive pages and social networks), as well as integrating them into the current curriculum as transversal content to all curricular areas. This way the student assimilates the benefits of technological resources for learning mathematical concepts and procedures, thus making them a student of the global world in which they live.

The research process consisted of revealing teachers' knowledge and attitudes in initial training regarding the use of digital tools as a means and resource for capacity building in the management of technology resources and as a catalyst for the development of mathematical competencies in higher education students, having the following as a guiding question of the process: What is the influence of the digital empowerment of teachers in initial training on the development of their mathematical skills? The study objective is to identify, describe and analyze the influence of digital empowerment on the development of mathematical competencies in the initial training of teachers in the specialty of mathematics.

Empowerment

Empowerment was initially conceived as the process of searching for the basic opportunities that those marginalized or disadvantaged groups aspire to obtain, either

through direct help or through non-marginalized people who share their own access to these opportunities; it is based on the change in collective mentalities and the capacity that people seek in their aspirations for development, well-being and fulfillment of rights and freedoms, which they count on as human beings. Empowerment attacks any attempt to deny people the development of skills for self-sufficiency, with an emphasis on the elimination of needs, with greater participation in activities at the individual, social, cultural and economic levels, where ICT resources help to promote these activities, in the last two years the concept has shifted towards the inclusion of society as a whole and towards the preparation to live in a digital world, for the development of skills in general.

Empowerment refers to the process by which the strength of individuals and social groups is increased to drive beneficial changes for the group in the situations in which they live. It generally affects the beneficiary, in the development of confidence in their own capacities and actions. It is by changing attitudes individually and collectively that students change the way they act in problem solving. There are different areas in which in recent years there has been greater participation and increased empowerment, within the current educational context there is a strengthening of digital empowerment for the efficient performance of various academic and administrative tasks.

The phenomenon of empowerment analyzes the theoretical distinction between process and result of empowerment, which is not viable in objective and absolute terms or in terms of essence, but useful, in analytical terms, from the perception of the community involved, which must be understood by the external collaborator. It is also proposed to establish a difference between context and level of empowerment, and to analyze the context of the phenomenon at the individual, organizational and community levels of the social aggregate, which brings clarity to its definition. In this way the conception of empowerment acquires centrality as a process in successive contexts that benefit not only individuals but also social collectives (Silva and Martínez, 2004).

Digital Empowerment

Digital technologies offer new possibilities that require new, more collaborative methodologies, with greater possibilities of communication and interaction from anywhere and at any time: they also offer us greater access to information in different formats, as well as the collaborative construction of knowledge. But the use of these new resources also requires new attitudes such as being critical, creative, ethical, flexible and adaptable, responsible, with initiative and autonomy. In short, they require a civic digital attitude and an ability to learn throughout life, progressively accelerated.

To be digitally competent means to be provided with the knowledge, skills and attitudes required to identify, access, manage, analyze, integrate and evaluate digital resources; to build new knowledge based on different media and information sources; and to communicate and collaborate with others in an effective, efficient, critical, creative and ethical way, in the context of specific situations (work, personal and professional development, learning and knowledge socialization). In other words, the student must be able to benefit from digital tools in a meaningful way in various areas of life (Ala-Mutka, 2011; Ferrari, 2012; Vivancos, 2008). The same that leads to the digital empowerment that

> offers different development possibilities that require more collaborative techniques or methodologies, with greater possibilities of communication and interaction from anywhere and at any time, as well as greater access to

> information in different formats and to the collaborative construction of knowledge (Carruyo, 2017, p.21).

Currently, higher education institutions are undergoing important changes with the aim of promoting innovative experiences in teaching-learning processes based on ICT (Coll, 2004; Salinas, 2004), oriented towards the development of the so-called digital competences (sum of skills, knowledge and attitudes, in technological, informational, multimedia and communicative aspects), a key and essential component for successful development in today's society (Severin, 2011).

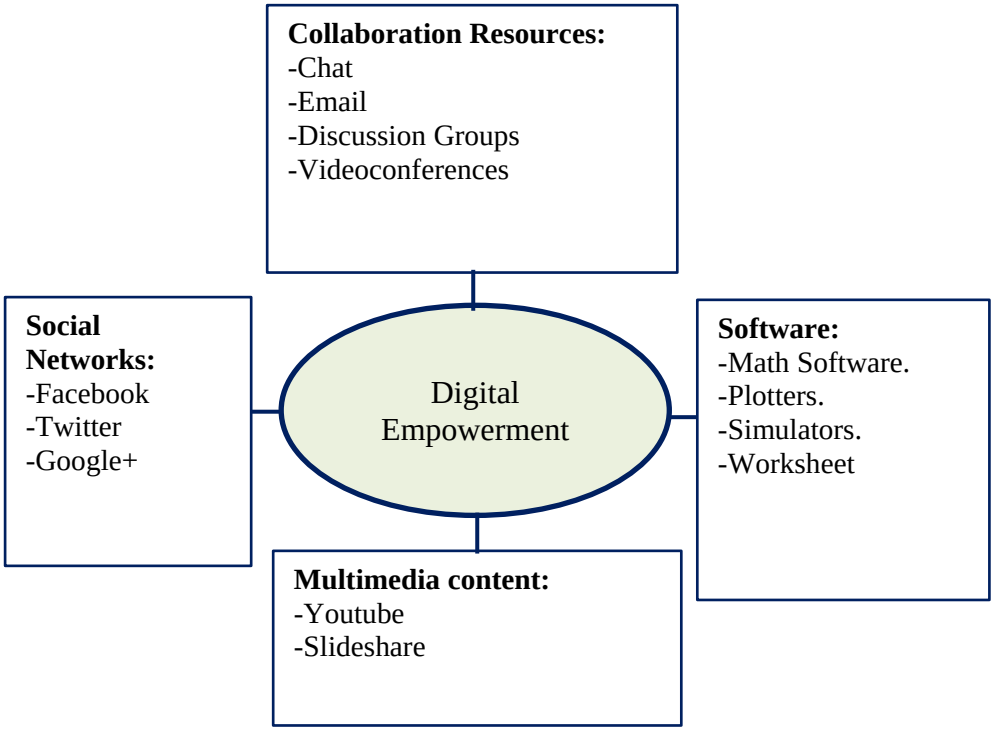

Figure 1. Digital resources most frequently used in the learning of mathematics.

> Digital empowerment means having a foundation of advanced training in digital skills, which encourages individuals to be more efficient and critical, and to have personal and professional skills that go beyond the simple use of technology, in order to search for, capture, manage and process information, to present and disseminate content in the appropriate format, and to communicate and collaborate on the network (Guitert, 2013, p. 98).

In general terms, digital empowerment should be considered as a multidimensional social process in which leadership, communication and self-managed groups replace the mechanistic pyramidal structure with a more horizontal structure (Jiménez, Martelo and Jaimes, 2017). For this reason, being empowered with digital technology currently entails “being digital” as an individual, possessing knowledge of technology, network communication, multimedia languages and how to manage information in the most efficient way using ICT and digital media. It also allows us to decide which software may be the most appropriate to manage the teaching-learning process. In short, we need to know how to integrate digital technologies into the higher education environment to be as efficient and effective as possible, to innovate, create and transform in the personal, social and professional environments of today's society.

Competency-based Approach to Education

Competencies are an approach to education and not a pedagogical model, since they are not intended to be a perfect representation of the entire educational process, determining what the instructional process, the development process, the curricular conception, the didactic conception, and the type of didactic strategies to be implemented should be. On the contrary, competencies are an approach, because they only focus on specific aspects of teaching, learning, and evaluation (Tobón, 2005), as the following:

1. The integration of knowledge, cognitive processes, skills, abilities, values, and attitudes in performance in the face of activities and problems.
2. construction of training programs in accordance with the disciplinary, investigative, professional, social, environmental, and labor requirements of the context; and
3. the orientation of education by means of quality standards and indicators in all its processes, which can be carried out from any of the existing pedagogical models, or also from an integration of them.

Mathematical competence consists of the ability to use, relate, apply, analyze and model mathematical elements such as: geometric elements, numbers, symbols, functions, algebraic expressions with their basic operations, forms of expression and mathematical reasoning, both to produce and interpret different types of information, to expand knowledge about quantitative and spatial aspects of reality, and to solve problems related to daily life and work.

The competencies or general processes, for the area of mathematics, chosen by the PISA project (OECD, 2004, p. 40), cited by Rico (2006, p. 59), are:

> Thinking and reasoning. This competence includes (a) asking questions specific to mathematics (How many are there? How to find it? If so, then?); (b) to know the types of answers mathematics offers to the above questions; (c) to distinguish between different types of formulations (definitions, theorems, conjectures, hypotheses, examples, conditioned statements); and (d) to understand and use mathematical concepts in their extension and limits.
>
> Debating. This competency includes (a) knowing what mathematical tests are and how they differ from other types of mathematical reasoning; (b) following and valuing chains of mathematical arguments of different types; (c) having meaning for heuristics (What can [or not] happen and why?); and (d) creating and expressing mathematical arguments.
>
> Communicating. This competence includes (a) expressing oneself in a variety of ways, on subjects of mathematical content, orally and also in writing; and (b) understanding formulations about these subjects from other people in oral and written form.
>
> Modeling. This competence includes (a) structuring the field or situation to be modeled; (b) translating reality into a mathematical structure; (c) interpreting mathematical models in real terms: working with a mathematical model; (d) reflecting on, analyzing, and offering critique of a model and its results; (e) communicating about a model and its results (including its limitations); and (f) directing and controlling the modeling process.
>
> Raising and solving problems. This competence includes (a) posing, formulating and defining different types of mathematical problems (pure, applied, open-response,

closed); and (b) solving different types of mathematical problems through a variety of pathways.

Representing. This competence includes (a) decoding, interpreting, and distinguishing between different types of representation of mathematical objects and situations, as well as the interrelationships between different representations; and (b) choosing and relating different forms of representation according to the situation and purpose.

Using symbolic, formal and technical language and operations. This competency includes (a) decoding and interpreting symbolic and formal language and understanding its relationships with natural language; (b) translating from natural to symbolic and formal language; (c) handling statements and expressions containing symbols and formulas; and (d) using variables, solving equations, and understanding calculations.

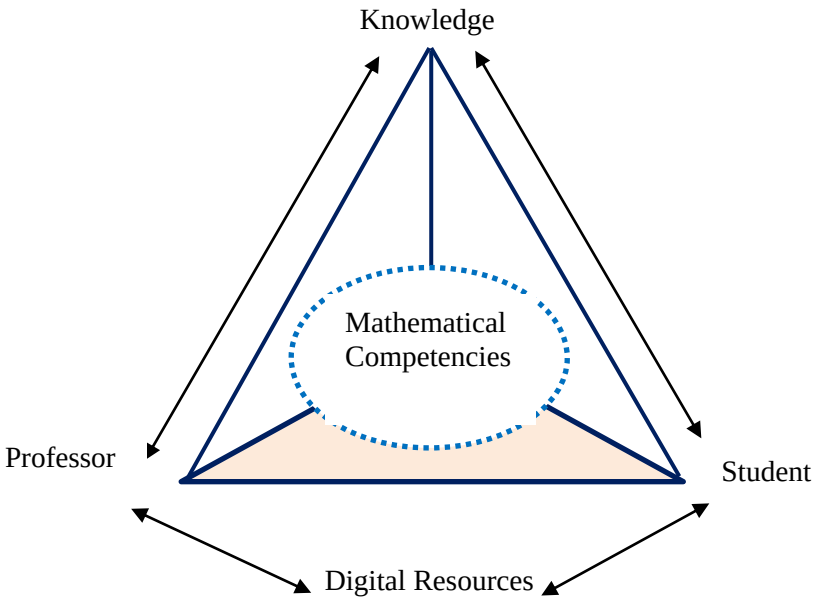

Figure 2. Pedagogical tetrahedron: digital empowerment and mathematical competences.

The development of mathematical competences can be developed efficiently through student-teacher interactions, mediated by digital resources and knowledge. However, a teaching approach with the use of digital resources must be well structured, pursuing individual, group, contextual, social, and technical learning in which the student will be able to learn and understand the issues addressed, since the management of information, time, place, and skills in the management of technological resources are present in the teaching-learning process through experience and practice.

Method

The objective of the study was to describe and analyze the level of digital empowerment of teachers and students during the teaching-learning process of mathematics, based on the development of digital skills through the use of collaborative resources, free software, multimedia content and social networks, and its impact on the development of mathematical skills in the initial training of mathematics teachers.

Methodological process

The study was approached through the qualitative methodology, in its phenomenological variant, to describe and analyze the different events of the studied reality in a conscious, open and objective way, from where the senses and meanings are perceived to understand the reality where the investigation of the use of digital technology as a learning resource took place, within a systemic process, reliable from the criteria of the investigative rigor, which allowed to generate an approximation to the relation between digital empowerment and development of mathematical competences, from which the methodical of this research is presented.

According to Husserl (2005) the end of phenomenology is not so much to describe a singular phenomenon, but rather to discover in it the universally valid essence, and scientifically useful. From this posture the method takes for real everything that is thought in a clear and different way, besides being put in a temporal perspective, in other words, what we see is not the object in itself, but as it is perceived and experienced in the context.

Likewise, Martínez (2009, p.139) considers that the phenomenological method "focuses on the study of experiential realities that are not very communicable, but that are determinant for the understanding of the mental life of each person". Particularly it can be said that the phenomenological method is the most suitable to study, as well as to understand the experiential structure of the people, inasmuch as it focuses its attention on the description and the study of those realities or focused activities.

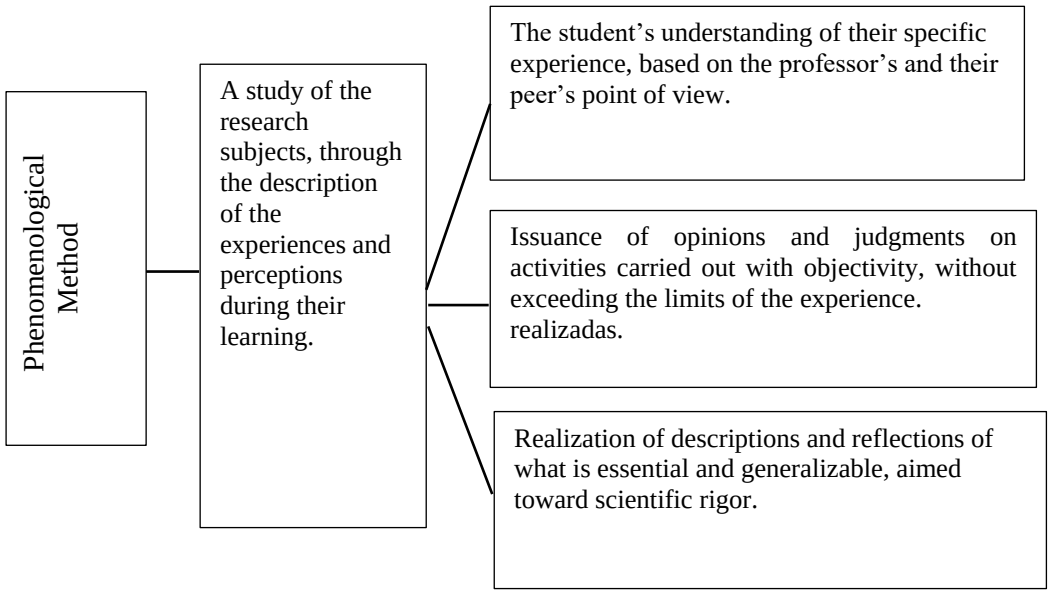

Figure 3. Diagram of the conception of the phenomenological method.

In order to carry out the qualitative study, it is based on the conviction of the traditions, functions, values and norms established in a context. Under this premise, an exposition of the phenomenological process is made in order to respond in a systematic way to the demands of the scientific rigor of the work carried out. In this research journey, the construction of a route related to the use of digital technology was considered important, which accounts for a set of actions and interactions that are developed during the research process. This structure of interactions between the

subjects under study and the researcher, which according to Martínez (2009) is expressed in four stages: previous, descriptive, structural and discussion.

1. *Previous Stage:* Preparation to carry out the study.
2. *Descriptive stage:* Tactics for conducting the study.
3. *Structural or Interpretative Stage:* Intersubjective reflection of the researcher and those researched.
4. *Stage of Discussion of Results and Approach to Knowledge:* Discoveries and Reconstructions from the Reflective Horizon:

This research was characterized by the application of some techniques and instruments used in qualitative research, in order to investigate the senses and meanings given by the actors involved in the study, to the use of digital technology in the development of mathematical skills during university education.

The technique of participating observation (phenomenological) was aimed at capturing aspects of the reality in which the subjects of study (students of mathematics and physics), as well as the appreciation of symbolic elements, such as gestures, expressions, attitudes and other manifestations during the process of gathering information. Furthermore, an in-depth interview was applied, which allowed the discovery of findings through a dialogical exchange, in a cordial and confidential way. It has also the aim of unveiling the structures that allowed to fix the support for the construction of categories of such manifestations.

Design

Phenomenology is based on the description of phenomena as they exist, are experienced, lived and perceived by man (Martínez, 2009). The phenomenology tries to explain the meanings in which we are immersed in our daily life, and not the statistical relations from a series of variables, the predominance of such or such social opinions, or the frequency of some behaviors. The stages of a phenomenological process are shown in Figure 4.

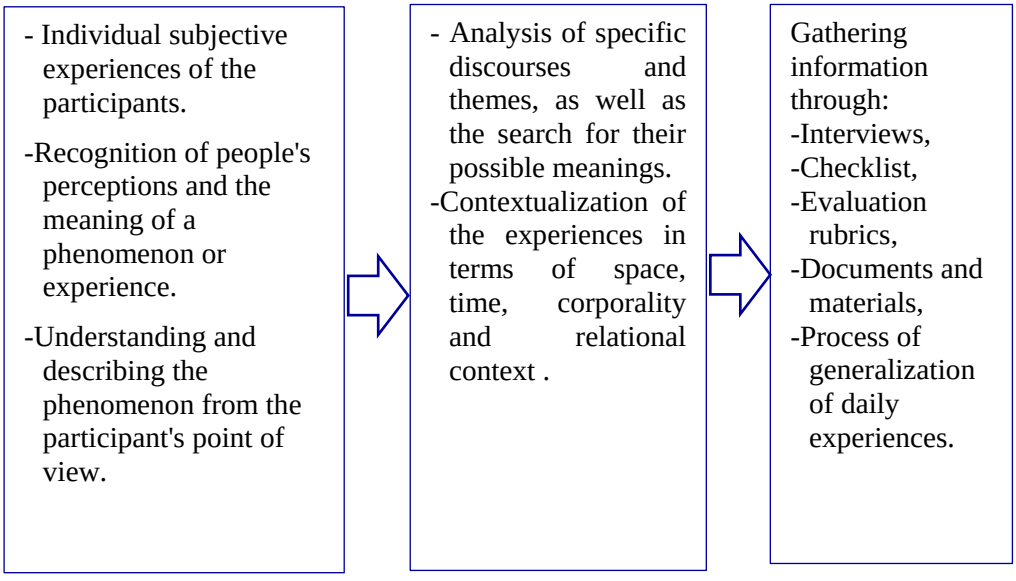

Figure 4. Diagram of the conception of the phenomenological method.

Participants

In order to carry out this research, the population was formed by 26 students of third year from the Degree in Mathematics and Physics of the Faculty of Education Sciences, Universidad Nacional Hermilio Valdizán in the department of Huánuco, Peru. The study population was chosen intentionally, and a homogeneous level of access and use of digital technology and Web resources for different purposes was previously confirmed. These resources were easily routed for the use of these technological resources for didactic and instrumental purposes, in the process of learning mathematics.

Tools

The techniques and instruments used in the information gathering process were: participant observation, in-depth interview and the rubric. Participant observation was aimed at direct inquiry into the activities of study subjects in their natural setting, direct or participatory in the events experienced (taking notes, collecting data, etc.), but always trying not to alter them with our presence. The observation was developed in parallel to the class development in the computer lab, by a record sheet, where the dimensions and indicators of the observation are recorded; the same that is carried out during the interactive activities with the computer, systematically evaluating knowledge, procedures, attitudes, constituting an effective support to analyze and evaluate the information obtained.

The colloquial or dialogical interview with the subjects under study was conducted to obtain relevant information of the students on their use of technologies during the conduct of their academic activities. Those reagents was aimed at obtaining maximum collaboration and achieve greater depth in the knowledge of attitudes and academic development of students, to have a rich content that facilitates analysis and description. They were posed as open-ended questions with the aim of finding out their opinion on the use of technological resources in the development of their mathematical tasks outside and inside the classroom. The aim of the interviews was to find out about the level of digital empowerment and its importance, and about the mathematical competences developed by the research subjects. The information obtained is categorized and then presented through semantic networks.

The third instrument for carrying out the research was the rubric, through which personalised scoring criteria or scoring criteria based on results are established. The rubric is used to communicate quality expectations in the development of mathematical competencies; the rows of the rubric format were used to define and evaluate the development of the mathematical competencies developed; while the columns defined the levels of performance in each competency.

Procedure

The first stage consisted of taking how it shows students of the specialty of mathematics and physics users of digital resources for the study of mathematics. Once the sample was selected with the students, a dialogue was initiated where they were explicitly explained the importance of the use of ICT resources in the process of learning mathematics and to have the necessary time to apply the techniques and instruments of data collection (observation, interview, survey, questionnaire).

The second stage was the design of the research instruments for data collection, observation, survey and questionnaire. It should be noted that the instruments were

designed and subjected to a pilot study in order to fine-tune the instruments, techniques and procedures that will be used in the data and information collection process.

The third stage consisted of collecting data and information through data collection techniques and instruments, obtaining from students' information relevant to the research process.

Finally, the fourth stage was developed, which consisted of analyzing and interpreting the data obtained, through this process, the results obtained were studied in order to draft the conclusions of the study. The process of data collection (observation, application of interviews and rubric), analysis of data, results and conclusions of the research was carried out during an academic semester, with a duration of 17 weeks.

Data Analysis

The qualitative analysis of the interviews was carried out using coding, categorization and construction of semantic networks. The presence and co-occurrence of the categories were considered in order to highlight the aspects with the greatest substantive interpretation among the interviewees. Text fragments and textual quotations were coded for analysis (Tójar, 2006).

While for the presentation and interpretation of the quantitative data, from the comparison list and the rubric, frequency and percentage analyses were used; using the statistical software Minitab 18 as an aid.

Results

For the participant observation, the comparison list was used as an instrument, through which relevant data were obtained on the mathematical activities carried out by the students using as a representation resource, data processing, the same that are detailed in table 1.

Table 1
Level of digital empowerment according to areas of digital competence

Level of achievement	Multimedia content	Collaboration resources	Using social networks	Use of software	Total
Start	4	3	2	4	13
	3.85	2.88	1.92	3.85	12.50
Ahievement	12	11	10	12	45
	11.54	10.58	9.62	11.54	43.27
Process	10	12	14	10	46
	9.62	11.54	13.46	9.62	44.23
Total	26	26	26	26	104
	25.00	25.00	25.00	25.00	100.00

Note: Source: Comparison list applied to research subjects

From the results of Table 1, it is evident that 43.27% of the students are considered to have reached the advanced (or achievement) level in the use of digital

resources in the performance of academic tasks, i.e. they are fully empowered in the use of digital technology; 44.23% of participants are in the process of using digital technology (they are in the process of empowerment); and only 12.5% are in the initial stage; they still do not make adequate use of the benefits of digital technology for learning mathematics. In summary, more than 87% of students make relevant use of digital technology, i.e. show an acceptable level of digital empowerment.

According to the information from the *interview*, one can appreciate in the network of concepts and categories generated by the qualitative treatment with Atlas.ti of the students' opinions, the main activities that the participants carry out with respect to digital empowerment focus on: level of use of ICT for educational purposes, time and frequency of use of digital resources, activities carried out with use of ICT, use of free software, use of the Internet among other resources. The university students consider that the use of digital technology in its diverse manifestations and uses favors the study and learning of mathematics, since they allow the investigation of concepts, procedures for the resolution of problems, through video tutorials and other means that facilitate a didactic explanation of the process of resolution of mathematical problems, likewise, they serve as support for the improvement of the conditions and the relations of the teacher and the student, in the different dimensions of the digital empowerment, (Figure 5).

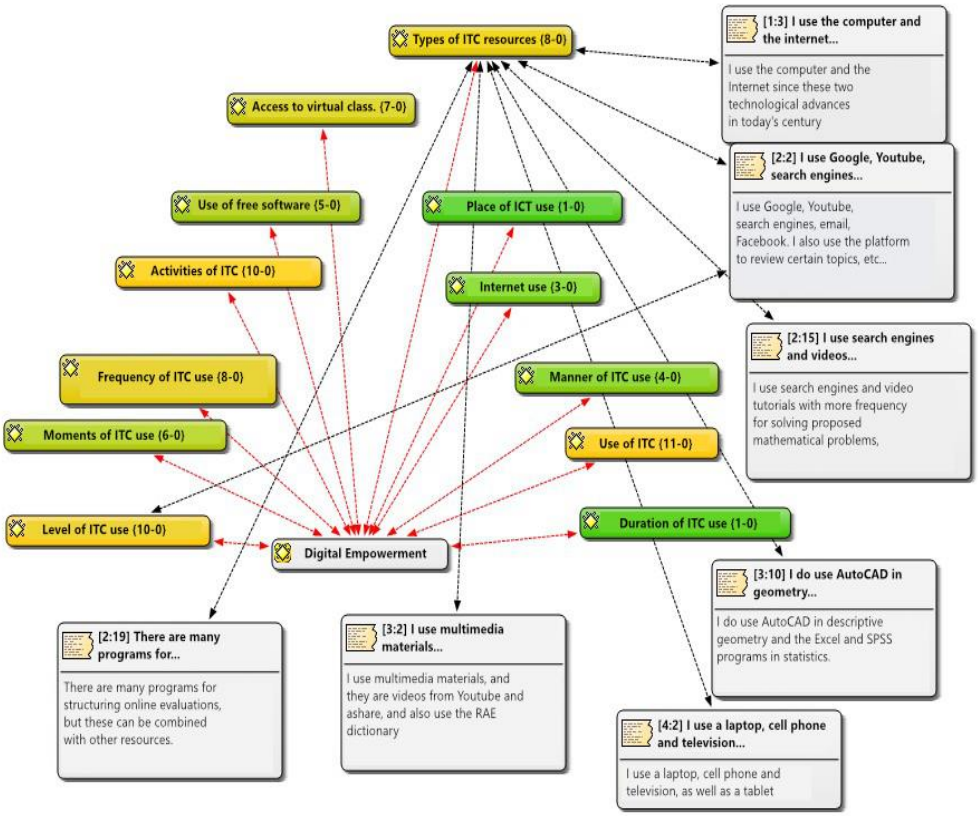

Figure 5. Semantic network of the dimensions of digital empowerment.
Note: Source: In-depth interview applied to research subjects

The graph in Figure 5 also shows the components of the digital empowerment of the interviewees, responses that underlie the different modes of use that are given to ICT resources as a means of learning for students in the specialty of mathematics. Describing some of the dimensions of students' digital empowerment based on the type

of ICT resources used during the study of mathematical topics, most of them coincide in the educational use of multimedia programs, mathematical software, social networks and the use of computers connected to the Internet. The answer to this dimension is an indicator that students, *centennials*, are capable of using learning analytics, regardless of the technological infrastructure they possess, having as their main activity the intensive use of data and information, that is to say, they are sufficiently empowered of the use of digital technology, which significantly affects the process of their learning.

As can be seen in *Figure 6*, from the results of the interview, the categories of digital empowerment and development of mathematical competence could also be established. In the same, the interviewees emphasize the importance of digital resources in the teaching-learning process of mathematics, during monitoring activities, in the stage of learning evaluation, and in the accomplishment of academic or research tasks; emphasizing that it has greater preponderance in the process of mathematical communication; the digital resources becoming effective and efficient mediators of the didactic process in the classroom and outside it. The versatility and ubiquity shown by digital technology in its use, develop students' positive attitude towards learning, as well as their motivation, reinforcing capacities and competences.

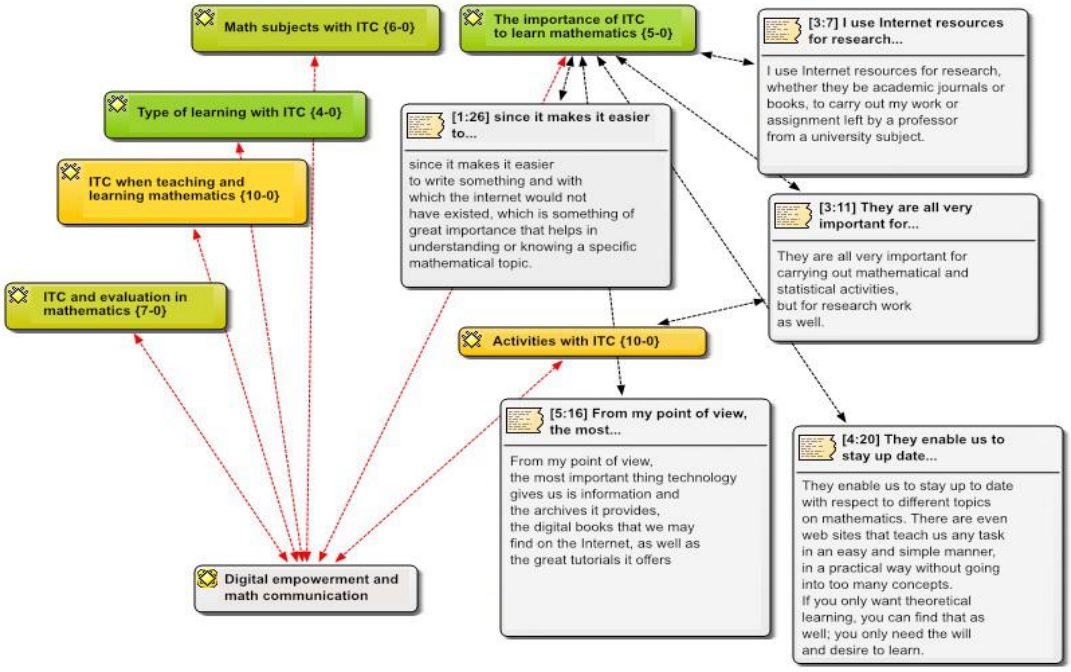

Figure 6. Semantic network of digital empowerment and the mathematical competence
Note: Source: In-depth interviews applied to the research subjects

The semantic network of the *figure* 7 indicates that there are a lot of technological opportunities, likely to be used with educational purposes and in the mathematical teaching-learning process, in accordance with the response of participants, the ICT are used in different activities, in all time, space and mean with significant pedagogical aims, which are focused on innovating the student´s teaching and studying ways, as *centennials* and participants inserted in virtual spaces. Thus, the incorporation of digital technology in learning processes motivates and facilitates the empowerment and the inter-connection of the educational practices. The interaction generated through the Internet, the network, the virtual communities, among others, evolves as a natural element within the educational process, when different technologies, the synchronous,

asynchronous, real and virtual communication spaces are articulated with the pedagogical strategies; the same which have a positive impact on learning and development of students´ mathematical competences.

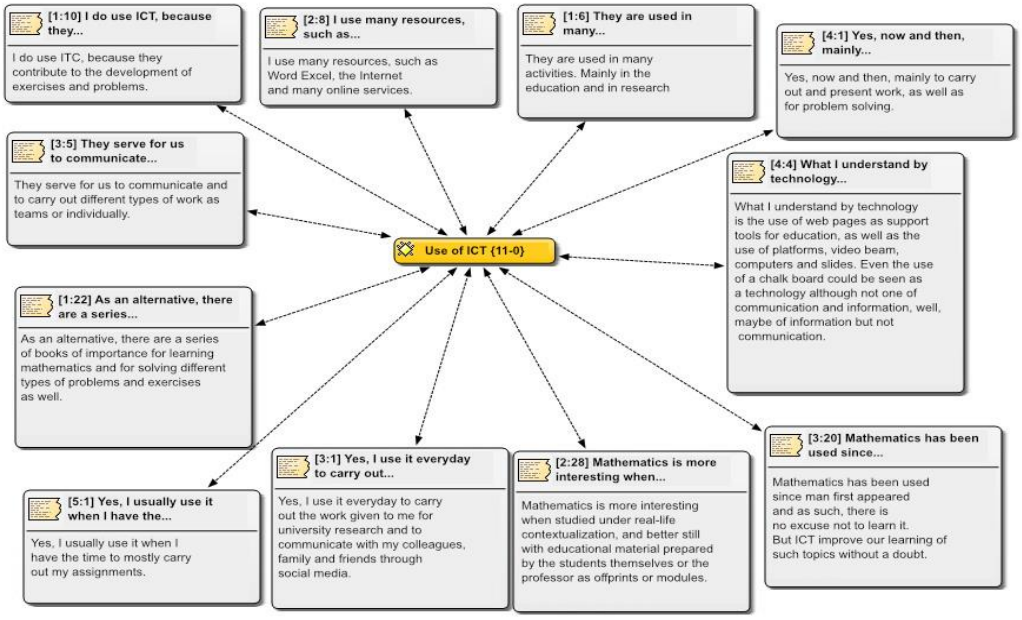

Figure 7. ICT use in initial training of the math teacher.
Note: Source: In-depth interviews applied to the research subjects

Below in Table 2, we will proceed to present the results the assessment made gave through a general and integrating rubric of the indicators on the achievement of competences, with the aim of arguing an interpretative view regarding the research intentions of the research findings associated to the six mathematical competences suggested by the Organization for Economic Cooperation and Development (OECD), through the PISA project (Program for International Student Assessment on the year 2000).

Table 2
Results of the assessment of mathematical competences and learning achievement levels

Competence	Qualifier qualitative-quantitative				**Total**
	Fail	Passing grade	Grade	Outstanding	
Thinking and reasoning	2	5	9	10	26
Mathematical argumentation	1	6	10	9	26
Mathematical communication	2	5	8	11	26
Problem solving	3	4	9	10	26
Mathematical representation	2	5	9	10	26
Symbolic and formal language	2	4	8	12	26

Total	12 (7.69%)	29 (18.60%)	53 (33.97%)	62 (39.74%)	156 (100.00%)

Note: Source: Assessment rubric applied to the research about their competence development.

According to the data in table 2, in the assessment through the rubric of the six competences considered in the mathematical area: a fail grade is given to 7.69% of the participants; whereas the 18.60& of the participants received a passing grade. This means that they have developed their mathematical competences regularly, using digital technology; 33.97% of the participants obtain a passing grade, which means that they achieved successfully the development of the mathematical competences. At the same time, 39.74% of students achieved an outstanding grade, that is to say, they developed to fullness their mathematical competences, using the digital tools. Analyzing the results of the rubric from the achievements reached as summarized in the table. We can affirm that more than 73% of participants achieved a satisfactory learning level, the same which indicates the importance which the digital technology use has in the study of mathematics.

The results shown of the findings through the three tools applied during the study, a digital empowerment has been shown, based on the use of mathematical software, collaboration resources, social networks and some multimedia contents; they have very positive effects in the development of the mathematical competences in the formation process of the future math teacher, who will have the responsibility of inculcating a mathematical culture to youth, citizens in the very near future.

Discussion

The incorporation of Information and Communication Technologies (ICT) in the educational setting, is one of the major challenges of the knowledge society. The capacity for transformation of these tools through computers and other digital devices, such as mobile phones, cameras, among others, provide opportunities to education in the different levels and modalities with infinite possibilities (Alvarado, 2012).

Carruyo et al. (2016) conclude that there is weakness in digital empowerment as an integration strategy of university, business and public policies, due to they do not handle easily the digital media, which they allow to get access to information fast and with the advantage of knowing contents deeper about a subject. This phenomenon was also evidenced in the findings made before the execution of this research, where teachers and students did not use properly the ICT resources in the learning event.

According to the UNESCO, “Nowadays, education practitioners need to be prepared to offer their students learning opportunities supported in ICT, to use them and to know how they might contribute to the student learning. These capacities are now an integral part of the list of basic professional competences of a teacher” (Catts & Lau, 2008, p.56). This assertion of the UNESCO evidences the concern of this important institution in the teacher´s development and particularly, about the use they might give to ICT to enrich the student learning.

The ICT incorporation requires not only the knowledge and control of the tools, but also a pedagogical approach aimed to the learning facilitation, the teachers´ and students´ level of digital competences is a power for the use of ICT for academic

purposes, but there is a an use with greater intensity for leisure, social or cultural activities, and to a lesser extent for academic purposes (Nakano et al., 2017, p.73).

Therefore, from the results of this study, the inclusion of ICT as pedagogical resource is deduced as fundamental for teachers, both in the actions of their initial and continuous training plan. This would allow them, among other things, to be up to date with the discoveries in their training area or specialty, to attend to the possibilities offered by ICT, to process possible innovations in the teaching-learning processes and to design strategies that satisfy the needs of their students in the development of the curricular contents they teach.

Information and Communication Technologies bring innovative aspects to the field of education, which indicate a qualitative improvement in the ways of teaching and learning, making students feel and express a great sense of relevance and commitment to the performance of academic tasks and fully develop their training actions, such as communicative skills, information selection, organization, problem solving in an interactive way with relevant use of ICT. In this perspective, it is shown that digital empowerment is fundamental for the achievement of an efficient learning of the subject under study; therefore, through the inclusion of digital resources during the academic process and the achievement of significant learning. To this end, it is essential to propose curricular reorientations with a view to overcoming the difficulties identified, and to train teachers in the pedagogical use of these technologies and to offer support to students for their true digital empowerment (Jiménez et al, 2017).

The teaching-learning activities mediated by digital technology lead to new conceptions of the didactic process, which accentuate the active involvement of the student in the learning process; attention to intellectual skills and interaction practices at a homogeneous level; the insertion of students into the constantly changing technological world; the use of digital technology as the main resource during their incursion and permanence in the world of work; and the necessary competencies to become involved in this process of continuous learning.

Finally, we consider that the use of digital technology as a didactic resource is one of the tools of this century that should not be neglected in the educational field. It is important to continue advancing in teacher training for the pedagogical use of ICTs, to offer support to students for their true digital empowerment and to create a digital culture in which university interactions function as virtuous circles according to the demands of the globalized world in which we are developing.

Conclusions

The conclusions emerge from the analysis of the dimensions of digital empowerment and the development of mathematical competencies in the initial training of teachers in the specialty of mathematics.

The use of ICT, during the initial training of mathematics teachers, as catalysts of the teaching-learning process, makes it possible to create new learning environments through communication networks, in order to provide timely responses to the learning demands of mathematics. In this sense, the educational environments mediated by ICT contribute to the generation of knowledge in the teaching-learning processes where students gain autonomy to channel their own learning mediated by digital technology resources.

The digital empowerment of students is based on (multimedia content, free software, collaboration resources and social networks) in computers or mobile phones, allowing to strengthen links and interaction with online information, which significantly favors the teaching-learning process, becoming a catalyst for the didactic process in the classroom and the performance of academic tasks outside the classroom. Digital resources are effective measures for the achievement of learning and the development of mathematical competencies in the initial training of mathematics teachers.

The incorporation of information and communication technologies (ICTs) in the educational scenario constitutes one of the great challenges of the knowledge society and contributes very efficiently to the process of problem solving. Argumentation and mathematical communication through the realization of activities of mathematical thought and reasoning, sustained in mathematical arguments, from a heuristic perspective creating, recreating concept with mathematical rigor; are able to express themselves fluently on topics of mathematical content; both orally and in writing; and also improve their ability to understand statement about these subjects from other people in oral and written form.

Through the appropriate use of digital technology, students in initial mathematics teacher training were able to decode and interpret symbolic language and understand its relationships with natural language, translating it into expressions that contain variables and expressing them through statements and expressions that contain symbols and formulas for solving equations and understanding calculations and their results; to then reflect, analyze, and offer critique of a model and its results from its practical usefulness and limitations for directing and controlling the modeling process.

References

Ala-Mutka, K. (2011). Mapping digital competence: towards a conceptual understanding. Sevilla: *Joint Research Centre* (JRC) & *Institute for Prospective Technological Studies* (IPTS). Retreieved from http://ftp.jrc.es/ EURdoc/JRC67075_TN.pdf.

Alvarado, A. (2012). *Socialización mediada por las TIC desde la interrelación de los actores sociales en el escenario educativo de Barquisimeto Estado Lara*. Tesis Doctoral. Universidad Pedagógica Experimental Libertador Instituto Pedagógico de Barquisimeto, Venezuela.

Carruyo, N.; Ureña, Y.C. y Quiñones, E. (2017). Empoderamiento digital: integración universidad, empresa y políticas públicas para el desarrollo endógeno. *Revista Científica Electrónica de Ciencias Gerenciales*, , 36 (12), 20-34. Retrieved from www.revistanegotium.org.ve

Castellano, H. (2010). *Integración de la tecnología educativa en el aula: enseñando con las TIC*. Buenos Aires.

Catts, R. & Lau, J. (2008). *Towards information Literacy Indicators*. Paris: UNESCO

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education.* London: Routledge.

Ferrari, A. (2012). Digital competence in practice: an analysis of frameworks. Sevilla: *Joint Research Centre (JRC) & Institute for Prospective Technological Studies (IPTS)*. Retrieved from http://ftp.jrc.es/EURdoc/JRC68116.pdf

Gisbert, M. & Esteve, F. (2011). Digital learners: La competencia digital de los estudiantes universitarios, *Revista La Cuestión Universitaria*: 7, 48-59.

Guitert, M. (2013). Tiempo de empoderamiento digital. Línea digital. *El País.* Retrieved from http://goo.gl/Z8pQ5V

Hitt, F. (2003). Una Reflexión sobre la construcción de Conceptos Matemáticos en ambientes con Tecnología. *Boletín de la Asociación Matemática Venezolana*, 10(2), 213-223.

Husserl, E. (2005). *Lecciones de fenomenología de la conciencia interna del tiempo*. Madrid: Trotta.

Jiménez, I., Martelo, R. y Jaimes, J. (2017). Dimensiones del Empoderamiento Digital y Currículo para el Sector Universitario. *Revista Fundación Universitaria*, 10(4), 55-66 (2017), doi: 10.4067/S0718-50062017000400006

Linares, N., Verdicia, E. y Álvarez, E. (2014). Tendencias en el desarrollo de las TIC y su impacto en el campo de la enseñanza. *Revista Cubana de Ciencias Informáticas*, 8 (1), 2014, 127-139.

Martínez, M. (2009) *Ciencia y Arte en la Metodología Cualitativa. Métodos Hermenéuticos, Métodos Fenomenológicos, Métodos Etnográficos*. México: Trillas.

Nakano, T., Garret, P., Mija, A. y Vásquez, A. (2014). La integración de las TIC en la educación superior: reflexiones y aprendizajes a partir de la experiencia PUCP. En *Blanco & Negro*, 4 (2), 65-76.

Rico, L. (2006). La competencia matemática en PISA. *PNA, 1*(2), 47-66. Retrieved from http://cimm.ucr.ac.cr/ciaem/articulos/universitario/conocimiento/La%C2%A0Competencia%C2%A0Matem%C3%A1tica%C2%A0en%C2%A0Pisa*Rico,%20Luis*competencia%20en%20PISA.pdf

Silva, C. y Martínez, M. (2004). *Empoderamiento: proceso, nivel y contexto*. Retrieved from http://www.redalyc.org/pdf/967/96713203.pdf

Tobón, S. (2006). *Competencias en la educación superior. Políticas hacia la calidad.* Bogotá: Ecoe ediciones Ltda.

Tójar J. (2006) *Investigación cualitativa comprender y actuar*. Madrid: Editorial la Muralla.

UNESCO (2004). *Las tecnologías de la información y la comunicación en la formación docente.* Guía de planificación. División de educación superior. Retrieved from http://unesdoc.unesco.org/images/0012/001295/129533s.pdf

Vivancos, J. (2008). *Tratamiento de la información y competencia digital*. Madrid: Alianza Editorial.

Date received: 02/11/2018
Date reviewed: 19/02/2019
Date accepted: 11/03/2019

MLS - EDUCATIONAL RESEARCH
http://mlsjournals.com/Educational-Research-Journal
ISSN: 2603-5820

Cómo citar este artículo:

SeyeDjité, S. (2019). Organization of the senegalese educational system. *MLS Educational Research*, *3*(1), 79-92. Doi: 10.29314/mlser.v3i1.86

ORGANIZATION OF THE SENEGALESE EDUCATIONAL SYSTEM

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Abstract. The school, in its present form, is not the product of the internal development of African societies. In the case of Senegal, the creation and development of the school network followed the French penetration. Basically, far from reducing the distance that separates the dominator from the dominated, the school has, in most cases, helped to make it impassable in order to maintain the colonial order. It should be noted, however, that in the aftermath of the Second World War, school policy was dominated by the ideology of assimilation. It is from this school that independent Senegal has inherited. It posed to the young state, among other challenges, that of building, with an extroverted school, an identity and a sense of belonging to the Senegalese nation based on the promotion of history, cultures and national languages. However, the school institution, privileged place of education, does not belong less to a global environment. Also, we are also interested in this environment... We have chosen a methodological approach favoring the analysis of educational orientation laws as well as their texting in educational programs and official instructions.

Keywords : Educational system, case of Senegal, shoo policy

ORGANIZACIÓN DEL SISTEMA EDUCATIVO SENEGALAL

Resumen. La escuela, en su forma actual, no es el producto del desarrollo interno de las sociedades africanas. En el caso de Senegal, la creación y el desarrollo de la red escolar siguieron la penetración francesa. Básicamente, lejos de reducir la distancia que separa al dominador del dominado, la escuela, en la mayoría de los casos, ha contribuido a que sea intransitable para mantener el orden colonial. Cabe señalar, sin embargo, que a raíz de la Segunda Guerra Mundial, la política escolar estuvo dominada por la ideología de la asimilación. Es de esta escuela que el Senegal independiente ha heredado. Le planteó al joven estado, entre otros desafíos, el de construir, con una escuela extrovertida, una identidad y un sentido de pertenencia a la nación senegalesa basada en la promoción de la historia, las culturas y las lenguas nacionales. Sin embargo, la institución escolar, lugar de educación privilegiada, no pertenece a un entorno

global. Además, también estamos interesados en este entorno. Hemos elegido un enfoque metodológico que favorece el análisis de las leyes de orientación educativa y sus mensajes de texto en programas educativos e instrucciones oficiales.

Palabras clave: Sistema educativo, caso de Senegal, política escolar

Introduction

The Government of Senegal's vision for education and training is as follows: "A system of education and training that is equitable, effective, efficient, in line with the requirements of economic and social development, and more committed to the care of children, and based on inclusive governance, increased accountability of local communities and grassroots actors.

For education and training to be a real vector of development, they must be understood in their individual and collective dimensions. The human rights approach has been relevant in reflecting the multi-dimensionality of the right to education.

For the Government of Senegal, the education system must better contribute to the provision of quality human resources, able to adapt to scientific and technological developments, capable of innovating. The state therefore has the ambition to create a school of equity and equal opportunities, a school that can carry its ambitions for emergence. Also, the new options, such as PACKET-EF 2013-2030, will focus on the correction of disparities further more, the professionalization of college-to-higher education, and the training of young people in demand-driven sectors.

Presentation of Senegal

Physical data

Senegal is located at the extreme west of the African continent, between 12 ° 5 and 16 ° 5 north latitude and 11 ° 5 and 17 ° 5 west longitude. It covers an area of 196,712 Km² and in 2008 has an estimated population of 11, 841,123 inhabitants, a density of 60 inhabitants per square kilometer. It is bordered by Mauritania in the North, Mali in the East, Guinea and Guinea Bissau in the South and the Atlantic Ocean in the West. Wedged between the regions of Kao lack and Ziguinchor, Gambia, which occupies all the lower river of the same name, constitutes an enclave of more than 300 km inside the Senegalese territory. The Cape Verde Islands are located 560 km off the coast of Senegal.

Climatological data

Senegal belongs to sub-Saharan Africa. The climates Sudano-Sahelian characterized by the alternation of a dry season from November to May and a rainy season from June to October. The average annual rainfall follows a growing gradient from north to south. It goes from 300 mm in the semi-desert north to 1200 mm in the south, with variations from one year to another. Three main rainfall zones corresponding to three climatic zones are thus determined: a forest zone in the south, the savannah in the center and a semi-desert zone in the north.

Hydrographic data

In addition to the Atlantic Ocean, which limits it to the West, Senegal's surface water resources consist of four rivers and their tributaries plus some temporary streams.

The basins that flow through Senegal form two important systems: the lower reaches of the Senegal River and the middle course of the Gambia River. The Sine Saloum River and the Casamance River are small coastal streams. Other rivers and valleys complete the hydrological regime. The realization of the Large Dams, Diama in particular, that Senegal shares with Mali and Mauritania through the Organization for the Development of the Senegal River (OMVS), contributes to the control of the hydraulic resources and consequently to the development of the agriculture, livestock, navigation, drinking water supply and energy for the population. XXII

Administrative organisation

Since 2008, Senegal has got 14 regions including three new ones: Kédougou, Kaffrine and Sédhiou. The number of departments (prefectures) increased by 10: - 1 in the Kaolack region: Guinguineo - 1 in the Kolda region: Medina Yoro Foulah - 2 in the new Kédougou region: Saraya and Salémata - 2 in the Tambacounda region: Koumpentoum and Goudiry - 2 in the new Kaffrine region: Birkelane and Malem-Hodar - 2 in the new Sédhiouregion: Goudomp and Bounkiling. There are now 45 departments, subdivided into Districts (Sub-prefectures), Communes, Rural Communities and Villages. The village or neighbourhood corresponds to the basic administrative unit. Cities of a certain size are subdivided into boroughs. There are 46 district municipalities in total. Dakar alone counts 19. Each level is headed by an authority namely: - a governor and a regional council president for each region; - a prefect for each department; - a sub-prefect by rounding; - a mayor by municipality; - a president per rural community and - a village or neighbourhood chief at the most peripheral level. The capital of Senegal is Dakar which is at the same time the capital of the region of the same name.

Historical trajectory of the Senegal School Organization

The first decade of the Senghorian era ends with the May 1968 explosion marking the questioning of the colonial legacy and the rise of the nationalist and Africanist aspiration. This movement inspires changes that are reflected in the law of orientation of the national education of June 3, 1971, the first since independence.

Article 1 of the said law thus expresses the national vocation of education. "National education, within the meaning of this law [...], is intended to prepare the conditions for integral development, assumed by the entire nation. Its constant mission is to maintain the whole of the national in the contemporary progress. "

The option of rehabilitating national languages through their teaching at school is also proclaimed, as is the corresponding adaptation of history and geography teaching.

The implementation of the reforms promised in 1968 could not overcome either the resistance of the system to change or the reluctance of political power to seriously question it. This, from 1976, feeds the struggle led by teachers, leading in February 1981 to the States General of Education and Training (EGEF). On this occasion, was affirmed the option of a « national, democratic and popular ».

The changes that have occurred in educational policies during the past decade fall within the framework of the various international, regional and national forums and meetings: at the international level: Jomtien (1990), which launches the concept of "Education For All "at the year 2000 At the regional level: MINEDAF VI (Dakar 1991) which takes into account the World Declaration of EFA (Jomtien) as well as the

contexts of crises and structural adjustment in Africa. MINEDAF VII (Durban 1998) from which the idea of African Renaissance is launched at the national level: The Estates General of Education and Training (EGEF) have marked all the development of the Senegalese education system, for the advent of a national, democratic and popular school. The National Commission for the Reform of Education and Training (CNREF), born the day after the EGEF, laid the foundations for a new school.

The follow-up of the World Declaration led to the following meetings: The 1993 Kolda Colloquium, which produced the action plan for non-formal education in Senegal and allowed the establishment of a consensual framework for carrying out literacy programs for young people, adults and especially women.

The 1995 Saint Louis Colloquium, which set out guidelines and strategies aimed at increasing access to education, achieving concerted management of the sector, harmonizing education, study and deepening of alternative models for basic education, etc. The Bambey and Goréeseminarsenabled the setting up of thematic commissions (Access, Quality, Management) and to elaborate a diagnosis and an action plan for each sub-sector.

It was the merger of these documents that gave birth to the PDEF (Ten-Year Program for Education and Training). It has been subject to technical validation with the technical and financial partners and political and social validation with the social partners.

The Ten-Year Education and Training Program, now called the Education and Training Development Program, which began its preparation in 1996, has capitalized on all these approaches that it has developed and deepened. to include them in a policy framework that identifies, prioritizes and plans government priorities, harmonizes and organizes interventions. It must therefore be considered as a framework for the operationalization of the objectives of the World Declaration on Education, which aims to: - democratize access to basic education - improve the quality of learning - make the management of the system more efficient States,

Governments and partners have realized that sectoral programs must break with the project approach and be part of a holistic approach that is a process of harmonization and integration of initiatives and approaches, requiring coordination stakeholders. This appears as a mechanism for greater effectiveness of actions and forcing stakeholders to work Education and Training Development Program to achieve objectives identified, negotiated and stabilized jointly.

This review shows that progress has been made in the last decade towards the realization of the principles set out in the Jomtien Declaration.

Context for development of education and training development programs

The educational policy of Senegal was inspired by the conclusions and recommendations of the international conferences (Jomtien 1990, Dakar 2000) and regional conferences (MINEDAF VI, 46th general session of the CONFEMEN, Panafrican Conference on the education of girls ...) . At the national level, the proposals of the National Commission for Reform of Education and Training (CNREF), formalizing the conclusions of the Estates General of Education and Training held in January 1981, are the basis of the law. Education Guideline No. 91-22 of 16 February 1991, which defines the profile of the new type of man to be promoted through education. The various sectoral consultations organized by the State since 1993 have been occasions for strongly reaffirming the aims and guiding principles of the

educational system recommended by the Orientation Law. At each of these consultations, a non-complacent diagnosis of the state of the education system was made, and relevant recommendations were made to operationalize the CNREF's proposals while adapting them to changes in the internal and external environment. The general policy options have recently been operationalized by the sector's general policy letter and implemented through the Education and Training 10-year Program (Development), which has been developed over the years. years, by expanding the frame of reference. The Ten-Year Education and Training Program In the continuity of the Education Reform, the Government of Senegal has formulated a new "General Policy Letter of the Education / Training Sector" for the period 2000-2017, which specifies the development policy options selected for the formal and non-formal sub-sectors, as well as the strategies for their implementation. . Education policy is now focused on strengthening the system, primarily on basic education, technical education and vocational training. In this context, the universalization of elementary school enrolment by 2010 is the overriding objective of the Government. Moreover, this educational policy is implemented through the Ten-Year Education and Training Program undertaken as part of the United Nations Special Initiative for Africa. This program defines the major axes around which the State of Senegal intends, with its technical, financial and social partners, to give a decisive impetus to the quantitative and qualitative development of the education system for the period 2000-2010. In addition, the State and its financial partners have agreed to commit, in the future, all the financial resources of the sector in the PDEF, which constitutes the instrument for implementing Senegal's educational policy. The education system thus enters a phase of reform relative to the mode of management of the sector, by passing from a logic of project to a logic of program, of a subsector approach to a systemic approach which articulates the various sub-sectors. Education sectors by better managing student flows from one cycle to another.

The reform of the Education and Training Development Program in the management of the education system has also been deepened because of decentralization. The transfer of skills in the planning and management of the education system to local authorities The decentralization process initiated in 1972 was consolidated in 1996 with the establishment of regions in local authorities with legal personality and financial autonomy to the local authorities. same as municipalities and rural communities. For this purpose, the State transferred to them nine areas of competence. With regard to education, the decision-making powers of local elected representatives have been strengthened: the region receives the general responsibility for planning the development of education at the local level. The municipality and the rural community receive skills in the management of educational services in basic education and the promotion of national languages. Through the development of the various planning instruments, such as the Regional Integrated Development Plans (PRDI), the Municipal Investment Plans (PIC) and the Local Development Plans (PLD), the local elected representatives now have the appropriate means. to consider endogenous perspectives of development by integrating educational concerns. Thus, in the framework of a partnership involving local authorities, decentralized school authorities, the private sector and civil society will be prepared, regional, departmental and local plans for the development of education, which will form an integral part of the partnership.

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regional, departmental and local plans for the development of education, which will form an integral part of the partnership. planning instruments of decentralized communities. Education policy is also marked by the evolution of the context following the international and national meetings, which broadened the initial frame of reference. The Global EFA Forum and the Dakar Framework for Action (2000) The end of PDEF development coincided with the World Forum for Education for All held in Dakar in April 2000. of these important foundations, a Framework for Action for Education for All, recommending that countries draw up a national plan of action or, for those who already have it, to strengthen it taking into account the objectives of "Dakar 2000 ", namely: To develop and improve all aspects of early childhood care and education, including the most vulnerable and disadvantaged children; Ensure that by 2015 all children in difficulty and those belonging to ethnic minorities have the opportunity to access compulsory, free and quality primary education and to follow it to completion; To meet the educational needs of all young people and adults by ensuring equitable access to adequate programs aimed at acquiring knowledge and skills needed in everyday life; Improve by 50% the literacy level of adults, especially women, by 2015, and ensure that all adults have equitable access to basic education and lifelong education programs; Eliminate gender disparities in primary and secondary education by 2005 and achieve equality in this area in 2015, including ensuring girls have equitable and unrestricted access to quality basic education with the same chances of success; Improve in all its aspects the quality of education in the interest of excellence, so as to obtain recognized and quantifiable learning outcomes for all.

Description of the education system

The Constitution of the Republic of Senegal stipulates that the State is responsible for the education policy defined and implemented by the Ministries in charge of Education and Training namely, the Ministry of Education, the Ministry Technical Education, Vocational Training, Literacy and National Languages and the Ministry of Family and Early Childhood. The state provides a public service mission at this level. To this end, the Orientation Law 91 22 of February 16, 1991 defines the orientations of the national education which tends to: - prepare the conditions of an integral development assumed by the whole nation - to promote the values in which the nation recognizes itself - raising the cultural level of the population The education system is structured in two sectors: the formal and the non-formal.

Formal education concerns several levels and types of education. It is composed of pre-school education, elementary education, general and secondary general education, technical education and vocational training, and higher education. At each of these levels, there is, alongside public education, a private education that has diversified and developed in recent years. Inclusive education and girls' education occupy an increasingly important place in the system's ambition to reduce the disparities created by disabilities of all kinds. Indeed, the care of children with specific educational needs and the massive enrolment of girls in school are now seen as strategies for providing a more equitable and democratic education service.

The non-formal education sector, under the responsibility of the Ministry of Technical Education, Vocational Training, Literacy and National Languages, includes literacy, basic community schools, schools of the 3rd type and Franco-Arab schools. The ambition displayed for the development of this sector is commensurate with the challenges of sustainable development, which must necessarily be based on the quality of available human resources. At the central level The Education and Training Sector is

organized around 13 national directorates, 6 of which are dedicated to the different levels of education, in addition to the specialized services attached to the various ministerial cabinets. ¨ At the decentralized level At the level of the eleven (14) regions, one finds Inspections of Academy (16 IA) in charge of coordinating the educational action. At the departmental level, there are national departmental inspectorates of education (59 IDEN), responsible for the implementation of the education and training policy in their constituencies.

Preschool education

Early childhood (0 to 6 years old) appears today as one of the priorities of national development. The creation of a Ministry responsible for the family and early childhood reflects this political will. Aimed at children aged 3 to 6, preschool education mainly develops in cities (72% of schools are located in Dakar, Thiès and Ziguinchor). It has 3 levels: the small, the medium and the large section. In view of improving the supply of preschool, other objectives appeared as a contribution of the partners to the evolution of the initial forecasts. In this perspective, the care of early childhood appeared as a necessity that had to be translated by lowering the age of the target to 0 to 6 years. Now the new goals will focus on early childhood development and awakening in an approach that integrates education, health and nutrition. These include: - expanding access by varying and adapting early childhood care structures, especially the underprivileged segment. - readapt the curriculum for early childhood - to experiment with new childcare facilities and to innovate in the recruitment and management of teaching staff •

Elementary education

It is designed to teach children aged 7 to 12 basic skills: reading, writing, numeracy, knowledge of the environment, useful knowledge and skills necessary to live better in community and prepare access to higher levels. It lasts for six years and is divided into: introductory course (IC), preparatory course (CP), elementary course first year (CE1), elementary course second year (CE 2), middle year first year (CM 1) and middle year second year (CM2). The teaching of the Arabic language is optional on a four-year basis. For student recruitment, the government gives priority to 7-year-olds. The youngest (6 years old) are admitted within the limits of available places, if they have completed the preschool cycle. The Certificate of Completion of Elementary Studies (CFEE) sanctions the successful completion of the elementary cycle. The same examination has been used since 1992 as a selection mechanism for access to middle education. Girls' education is an essential dimension of the universal education goals in order to strengthen the struggle to reduce disparities. At the same time, this aspect of the fight against poverty appears as a factor of improvement of the gross rate of schooling. In this perspective, in the recent past, Senegal experienced a vast movement for the massive enrolment of girls in school, which is at the basis of the significant improvement in the Gross Enrolment Rate of girls, especially in the less favourable areas. school attendance of girls.

Middle education

It is taught in medium-level colleges (CEM) whose cycle 4 years, from 6th to 3rd. It is an extension of elementary education. A reflection is underway for the establishment of a curriculum that assigns its own purposes.

General secondary education

General secondary education includes 3 years of study (from the second to the final year); in 1999: 2000, it received 53.8% of the leavers of the average education. It offers two series of studies: a literary series "L", with two options (L1 or L2) according to foreign languages and a scientific series "S", with two options (S1 or S2) grouping either the economics and experimental sciences, that is mathematics. The studies are sanctioned by the baccalaureate.

Technical education and vocational training

It is a teaching provided in technical high schools and vocational training schools that has often changed guardianship. Placed under the sole responsibility of one director in this case, the Directorate of secondary education, technical and professional until 1986 (Decree 86 of 19 July 1986), it was split in two directions by the same decree : the direction of the EST and that of the FP. Today the supervision of these directorates is ensured by the Ministry of Technical Education, Vocational Training, Literacy and National Languages. The most remarkable fact is the dispersion of guardianship and the importance of learning, as training strategies and socio-professional insertion. Continuing Education and Adult Development are supported by public and private organizations.

Higher Education

It is provided to students holding a bachelor's degree, in universities and training institutions covering areas of knowledge increasingly diverse. These universities and institutes train to the highest degrees and maintain more and more relations with foreign universities in Western Europe and North America. They also welcome students from Africa and the world. The management of Higher Education is entrusted to the Ministry of Education.

Functional literacy

It supports people over 15 years old. Under the coordination of the Minister of Technical Education, Vocational Training, Literacy and National Languages, the field is open to various initiatives. Participating in its implementation, several NGOs, development companies and organizations, cultural associations and mini stries such as: the preschool education and the box of toutpetits, agriculture and livestock, trade and Small and Medium Enterprises, Crafts and Industry, Health and Prevention, etc. It should be noted that a trulycoherentnationalilliteracyprogramwasonlydevelopedwiththeKoldaSymposium of 1993. The Action Plan for the Eradication of Illiteracy (73.1% in 1988), the priority goal is to reduce the illiteracy rate by 5% per year to 30% in 2004.

Basic community schools

They take care of children aged 9 to 14, who have not attended school or who have dropped out of school very early, by giving them access to a full cycle of basic education that is predominantly practical and pre-professional in national languages and French for a duration four years. Three possible exit profiles are available for ECB products: access to the formal through bridges designed for this purpose, direct insertion into the community, access to vocational training structures. • Third type schools These are the other forms of non-standard schools, including those of the street, organized by

non-formal and non-standardized bodies that the system must strive to accompany in the absence of capturing.

Teaching Arabic

Arabic, widely used in the non-formal, is taught on a voluntary basis in nursery and primary schools and optionally in middle and high schools. In primary school, Arabic has a dual status: it is both a medium and an object of instruction, which gives it its socio-cultural and religious significance in Senegal. In the non-formal sector, support structures for the teaching of the Arabic language are emerging more and more in the educational space under the name of Franco-Arabschools, "daaras" (Koranicschools) and literacy centers

Qualifying educational structures for young people and adults

In the new context of planning, it is about promoting structures that meet the educational needs of all young people by ensuring equitable access to adequate programs to acquire the necessary knowledge and skills in daily life. By their approaches, these structures will have the mission of capturing the whole dimension of poverty reduction as well as the fight against disparities.

Financing mechanisms for education in Senegal •

Publicfunding of education •

The state budget allocated to education With Act III of decentralization, departments and municipalities participate in the financing of education expenditure. This contribution is directed towards elementary education and preschool, followed by general and vocational secondary and middle levels. They contribute timidly to the financing of higher education except for those who grant even more marginal scholarships to students or support charges of accommodation, transport or food. The department receives skills at technical high school and vocational high schools, the construction of technical education and vocational training centers, planning and school mapping, support for the operation of management bodies at the regional level, the promotion of the school-business partnership, literacy among others. The commune receives skills at the level of elementary schools, preschools, basic community schools, daara and Franco-Arab schools, literacy centers. It supports the department in the development of vocational training To assume these competencies, they receive from the central State endowment funds, competition funds and part of the Consolidated Budget of Investment for constructions. They can benefit from borrowing or financial support through decentralized cooperation, as well as through contracting in a public-private partnership (PPP) framework. Also on own resources, they try to assume its missions fully. Decree No. 2008-209 of 4 March 2008 setting the distribution criteria of the Decentralization Endowment Fund states that in order to help local authorities to exercise the powers transferred to them, the Code of Local Authorities provides, Article 5 in their favor, a concomitant transfer of financial resources and the provision of external services of the State. In order to cope, on the one hand, with the burdens resulting from this transfer of powers and to ensure, on the other hand, the functioning of the organs of the region which does not have its own resources, it has been retained, pending the in place of a renewed local taxation, the creation of a Fund for Endowment of Decentralization.

The Decentralization Endowment Fund is funded by a levy of 3.5% on the Value Added Tax (VAT) in accordance with the provisions of Article 59 of Law No. 96-07 of 22 March 1996 on the transfer of competences to regions, communes and rural communities, modified by law n ° 2007-07 of 12 February 2007 and law n ° 2013-10 of 28 December 2013 on the General Code of Local Authorities. This fund has been broken down into three endowments:

- A compensation allowance;
- An operational endowment;
- A staffing support to the State services.
- Local government budget allocated to Education

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- An operational endowment;
- A staffing support to the State services.

In addition to the decentralization endowment fund (FDD), BCI transfers for construction, there is also the Local Government Equipment Fund (FECL) which facilitates the financing of local investments. The FECL was established by Law No. 77-67 of 4 June 1977 on the 1997/1998 Finance Law, initially as a special purpose account for two missions:

- Provide local governments with interest-free loans
- Grant competition funds for the realization of their investments.

Models of Senegalese, European (especially Spanish) and the United States

Differences

In some countries (USA) the administration is decentralized. The decisions as well as the control of the implementation depend on the organizations close to the educational center, executing absolute of the system. The technical measures of planning, of disposition of means, are taken by these organizations, which have only the constitutional bases and the outline of what the education of the country should be.

In Senegal the administration is rather centralized

It requires the existence of the ministry that carries out all the executive and directive actions, controls and planning related to education in the country.

The Senegalese school system resembles the French system. Indeed, the Ministry of National Education is decentralized at the regional level by the Academy Inspectorate and then by the National Education Inspectorate.

For financial reasons, the Senegalese government has liberalized the education system: allowing teachers, who have not finished their training, to teach with less pay and private schools to see the light of day.

In rural areas, often the local population is forced to build its own schools. On the other hand, it is the National Education which appoints the teachers in these schools

Similarities

- The organizational model of the Senegalese system is similar to that of Spain in 1857 with the Moyano law.
- Primary education, provided in schools.
- Secondary education, taught in high schools.
- Optional courses, organized in the universities and which gave the title of Mastery.
- Higher education, organized in universities and giving the title of Doctorate

Similarities also emerge with the innovations and changes brought by the LOGSE such. than :

- Inclusion of maternal education from 0 to 3 years in the education system and

- The start at 3 years of the second cycle (from 3 to 6 years). This level is given the educational character and not just help.
- The extension of compulsory and free education up to the age of 16 (or up to 18 if two years are doubled).
- The creation of secondary education, with criteria of comprehensiveness and progressive specialization.

Conclusion

The option of massification adopted by Senegal has allowed children on the margins of the school system, in this case those from rural areas and disadvantaged urban areas, to attend school. Massification is the first element in the reduction of educational inequalities since it allows the greatest number to access school. However, "if access to school is a prerequisite for the acquisition of school knowledge, it is not a sufficient condition. Students must not only go to school, but acquire the knowledge that will help them stay and progress "(Henaff& Lange, 2011). Also, for Senegal, now that the universalization of the school is in the process of being achieved, investment in quality seems conceivable and could make it possible to achieve sustainable school expansion, stimulate the demand for education and training students with better skills. "

The strategic and operational management of the Education and Training sector depends on its ability to effectively mobilize and manage the required resources at the local and national levels, to ensure quality education services for beneficiaries and finally to report to the nation and the international community its results for informed decision-making by policy makers.

References

Bressoux, P. (2007). La contribution des modèlesmultiniveaux à la recherche en éducation. *Education et Didactique*, 1 (2).

Diouf, A. (1991). Directive d'éducation n °91-22. Retrieved September 04, 2018,

from http://www.axl.cefan.ulaval.ca/afrique/senegal-loi.htm

Centre Population et Développement. (2006). Défis du développement en Afrique subsaharienne: l'éducation en jeu. Retrieved September 04, 2018, from http://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers0903/010038536.pdf

Forum civil (2011).Gouvernance dans le secteur de l'éducation au Sénégal.

Retrieved September 04, 2018 from http://www.osiwa.org/wp-content/uploads/2014/12/osiwa_ourstories.pdf

Gairin, J. (1996). La organización escolar: contexto y texto de actuación. Madrid: La Muralla

Henaff, N. % Lange M.-F. (2011). Inégalités scolairesdans le Sud: transformation et reproduction, *59*, 3-18. Retrieved from http:// www.dri.gouv.sn/loi-12-février-2007-07

MEN / DAGE. (2009-2010). Rapport sur la performance du secteur de l'éducation et de la formation. Retrieved from https://ec.europa.eu/education/sites/education/files/document-library-docs/et-monitor-report-2018-france_fr.pdf

Michaelowa K. (2000). Dépenses d'éducation, qualité de l'éducation et pauvreté: l'exemple de cinq pays africainsfrancophones. Document technique n° 157 Centre de développement de l'OCDE, Paris

Programme d'analyse des systèmeséducatifs de la Confemen. (2007). Évaluation diagnostique au Sénégal. Retrieved from www.pasec.confemen.org

Programme décennal de l'éducationet de formation. (2005). Perspectives documentaires en éducation N ° 62. Retrieved from http://ife.ens-lyon.fr/publications/edition-electronique/perspectives-documentaires/RP062. pdf

République du Sénégal J.O. (2007) .[Loi n ° 2007/07]. Retrieved September 04, 2018, from http:// www.dri.gouv.sn/loi-12-février-2007-07

République du Sénégal, J. O. (2013). [Loi n° 2013-10 du 28 décembre 2013 portant Code général des Collectivités[. Retrieved September 04, 2018, from https://www.ilo.org/dyn/natlex/docs/ELECTRONIC/97262/.../F.../SEN-97262.pdf

République du Sénégal. (1977). [Loi n ° 77-67 du 4 juin 1977 portant loi de finances]. Retrieved September 07, 2018, from www.atddlgeo-ucad.org/documents/memoire_2011/fatoumata_signate.pdf

Soumaré, C.H., & Wade, A. (2008). [Decret n ° 2008-209 du 4 mars 2008] Retrieved September 04, 2018, from http://www.jo.gouv.sn/spip.php?article6794

Unesco. (1971). [Loi d'orientation de l'éducation nationale N °5401N ° 5401, J.O. P107.N °71-36 du 03 juin.1971]. Retrieved September 04, 2018, from http://www.unesco.org/education/edurights/media/docs/7e634d754261abefab501f386836f84bb36fcaa4.pdf

Receipt date: 08/25/2018
Review date: 09/10/2018
Acceptance date: 05/15/2018

MLS - EDUCATIONAL RESEARCH
http://mlsjournals.com/Educational-Research-Journal
ISSN: 2603-5820

How to cite this article:

Alvarado Giraldo, R. (2019). Musical Aptitude and School Performance: Case Study on the Members of the Symphonic Bands of Caldas (Colombia). *Educational Research*, *3*(1), 93-105. Doi: 10.29314/mlser.v3i1.135

MUSICAL APTITUDE AND SCHOOL PERFORMANCE: CASE STUDY ON THE MEMBERS OF THE PROGRAM OF SYMPHONIC BANDS OF CALDAS (COLOMBIA)

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Abstract. Children and young people have different challenges as they progress in their school development, one of them is the maintenance of high ranks in academic performance, music as a tool to improve sensory skills has been shown to have a positive influence when combined with In the educational field, the present research, based on this premise, set itself the objective of determining the academic performance of children and young people with musical aptitudes belonging to the Caldas Symphonic Bands Program. For this purpose, a methodology with a quantitative approach and a non-experimental transactional correlation design was used. Out of a total of 1,926, a sample was selected by conglomerates in a simple stage, of 482 instrumentalists (282 men and 200 women). For the rest, the Seashore Music Skills Test was chosen for the assessment of musical aptitudes, whose most relevant results showed that the correlations among all the variables that evaluate the musical aptitudes are all positive, besides being all significant with a significance of 5%. The highest is between the time and tonal memory (0.4991), while the most incorrect is between the intensity and timbre (0.1478). In summary, it could be determined that women present better grades in Spanish and mathematics than men, while the opposite occurs with respect to tonal memory

Keywords: Fitness, academic performance, music, Spanish, mathematics.

Introduction

Generally, music education has proven to contribute positively to IQ, including mathematical and language skills (Development Bank of Latin America, 2012). In this regard, different studies have been developed that establish how much music influences academic performance, given that this is considered fundamental for the development of society and the quality of life of the population in general.

Different studies and theories show that by strengthening skills linked to the arts, music, or sports, school performance may be improved. Consequently, musical psychology and other associated disciplines insist on the importance of learning music to develop skills that not only serve to play an instrument, but for life as a whole: discipline, creativity, the

ability to abstract signs to convert them into sounds or melodies, all this strengthens the abilities of a student to be a better reader, solve mathematical problems, or adapt to social pressure when introduced to the job market, complying with routines, schedules, and so on.

While a person's musical abilities may be innate, there are others, such as the ability to discriminate chords, which are only formed as the subject grows and comes into contact with musical creations that enable them to refine their skills through practice. In this sense, the ability to recognize chords would be an artificial or acquired skill, to name it somehow. From this we can deduce that there is a decisive factor for the production of musical abilities, that is, the environment in which the child develops:

When the biological predisposition, even if high, does not develop on a favorable environment of musical experiences, innate aptitudes cannot evolve. From any standpoint, it must be borne in mind that these aptitudes are present in the musical behaviors of all cultures and at all times. (Lazaro Tortosa, 2015, p. 66)

Music production is such a human aspect that it is an intrinsic part of all cultures. While it is true that there are fundamental differences between all the very different types of music generated within human communities, it is also indisputable that there is no community or culture in the world in which there is an absence of musicians or occurrences of this type. This leads us to think that music and the skills necessary for it are part of the human condition. In this way, it is reasonable that a percentage of musical aptitudes are not inscribed in the genetics of the child but are produced within the family and the culture to which the child belongs.

On the other hand, broadly speaking, among the most important musical aptitudes are those described by Seashore, Lewis and Saetveit (2008): tone, intensity, rhythm, time, timbre and tonal memory.

Initially, regarding tone as a musical aptitude based on some studies, it is stated that "tonal discrimination shows a constant increase throughout the ages studied, with the majority of subjects capable of discriminating differences of up to half tone" (Vera Tejeiro, 1989, p. 1).

In general, according to the Real Academia Española (RAE) (2017), the word comes from the Latin *torus* and this in turn from the Greek *τόνος* tónos; which means 'tension' itself. Tone is defined as "the quality of the sounds, depending on their frequency, which enables them to be ordered from bass to treble" (Real Academia de la Lengua Española, 2017). Although this definition is correct, it is a little incomplete due to the fact that tone is defined by the human ear's perception in differentiating different sound frequencies. This in turn is defined in physics as: "a longitudinal mechanical wave, which propagates in a medium taking advantage of its elastic properties. It is the vibratory and longitudinal movements where the direction in which it propagates is parallel to the direction of vibration" (Serway & Jewett, 2015, p. 98).

Now, due to the constitution of the human ear, the brain can receive information according to the vibrations of different sound waves. In this sense, the main characteristic of a sound wave is frequency. Frequency is a magnitude that measures the number of repetitions per unit of time, which, for sound waves, is measured in hertz or Hz, in honor of the German physicist Heinrich Rudolf Hertz, whose advances enabled the development of technologies mediated by the use of electromagnetic waves.

The term tone should not be confused with frequency. Frequency is the physical measurement of the number of oscillations per second. Tone is a psychological reaction to sound that enables a person to place sound on a scale from high to low or from treble to bass. Therefore, frequency is the stimulus and tone is the response. Hence, the measure of a hertz is

the frequency of an event or phenomenon repeated per second and the fundamental frequency of a note, the inverse of its period of vibration, which can be measured by a frequency analyzer (Serway & Jewett, 2015). Other authors such as Vaseghi (2007) consider that tone is a frequency that constitutes an auditory sensation, which is perceived by the auditory system and the human brain. Here it is important to further understand that the sensations of prominent sound frequencies are understood as the tone of a specific sound. In this sense, a high tone sound will correspond to a high frequency and a low tone sound to a low fundamental frequency. Now, the harmonics of a fundamental frequency, according to the cited author, are their integer multiples. This is why combinations of frequencies that are not whole multiples, in the case of a fundamental frequency, will end in noise.

On the other hand, related to musical notes, these are considered as symbols or signs that represent the frequencies, durations and times of elementary musical sounds. That is, musical notes allow musical compositions to be represented by means of symbols, in such a way that they can be read by musicians and, therefore, interpreted. However, musical note systems facilitate the standardization of musical instruments and their tuning frequencies. Such a procedure can be observed below (Table 1).

Table 1.
Musical notes, frequencies and semitones

Notes	**First**		**Second**		**Third**	**Fourth**		**Fifth**		**Sixth**		**Seventh**
Natural	C	C#, Db	D	D#, Eb	E	F	F#, Gb	G	G#, Ab	A	A#, Bb	B
Latín	Do	Do#, Reb	Re	Re#, Mib	Mi	Fa	Fa#, Solb	Sol	Sol#, Lab	La	La#, Sib	Si
Frequency (Hz)	261.63	277.18	293.66	311.13	329.63	349.23	369.99	392.00	415.30	440.00	466.16	493.88
Semitones	1	2	3	4	5	6		8	9	10	11	12

Note: Source: Vaseghi, 2007

As you we can see, musical notes in Occident the West use the following nomenclature: C, D, E, F, G, A, B, and their equivalents in Latin are: Do, Re, Mi, Fa, So La, Si.

However, talking about the hash '#' symbol, it represents a high note. That is, it is a semitone higher than the fundamental note, which is also called Sharp. From another sense, it would be √(12&2) multiplied by the frequency, which would be equivalent to the fundamental note.

So, the sign 'b' represents a flat note, and is known as flat, the clear version of a note, in other words, is the equivalent frequency of the divided fundamental note, √(12&2)

From this perspective, it must to be like:

C = 261.63 Hz = C

C * $\sqrt[12]{2}$ = 277.18 Hz = C# = C Sharp

D = 293.66 Hz =D

D / $\sqrt[12]{2}$ = 277.18 Hz = Db = D-flat

As you we can see, when you we increase a semitone starting from C, you we have a C Sharp; and if you we decrease a semitone starting from D, you we get a D-flat, which is equivalent to a C Sharp. That is to say that √(12&2) is the step to advance in each semitone, which will give provide a total of 12 semitones to complete an octave. Moreover, an octave is equivalent to 12 semitones or 7 musical notes. It should be noted that the human ear can only perceive on average a range of less than 10 octaves (Vaseghi, 2007).

Related to intensity, according to Serway and Jewett (2015), it has been found that since sound waves are longitudinal and also travel with great speed through a compressible medium. In in relation to the elastic and inertial properties of that medium, that speed of sound in a liquid or gas that has a volumetric modulus B and density S will be: v= √(B/p)

From this position, the intensity is defined as the rate of energy flow in an area of unit in which 〖(ΔP〗 _max) is the amplitude of pressure.

$$I = \frac{(\Delta P_{max})^2}{2pv}$$

The speed of sound waves in the air is usually used constantly: v=343 m/s and air density being p = 1.20 kg/m³. Following the author's aforementioned statement, through this relationship, we find that the loudest sounds that the human ear can tolerate, comprises a pressure amplitude of 28.7 N/m².

Bearing this in mind, it can be inferred that the intensity of a wave, or the power per unit area, refers to how quickly the energy carried by the wave is transferred through a unit area A, perpendicular to the direction of the wave's travel. (Serway & Jewett, 2015)

In terms of timbre, according to Serway and Jewett (2015) the human perceptive response is associated with different harmonic mixtures, which is known as sound quality or timbre. That is to say, the sound of the trumpet, for example, is perceived with a "shrill" quality. However, it is precisely this quality that makes it possible to distinguish the sound of the trumpet from other similar instruments such as the saxophone, the quality of which, on the contrary, is perceived as "reeded". Similarly, since the clarinet and oboe have air columns moved by reeds, they are alike but they have mixtures of similar frequencies. However, here it is more difficult for the human ear to distinguish them on the basis of their own sound quality.

According to this, the timbre is a quality that makes it easy to distinguish two sounds of equal intensity and tone, produced by two spotlights or sound generators that are different. Another case is that of two violins that, for example, having different manufacturers, produce a different timbre even playing the same note. In this sense, the timbre is related to the fact that a sound almost never corresponds to a single sound wave, but that there is usually a fundamental frequency to which most of the energy of that sound belongs to and other frequencies which carry their respective amount of energy, which are called harmonics; these are those which superimpose themselves on the wave corresponding to the fundamental frequency. That is to say, sounds can be characterized by several elements as tone, volume or timbre. This last one includes the characteristics of the sound that enable the human ear to distinguish the sounds that have the same tone and volume or intensity (Mariano Merino & Muñoz Recipo, 2013).

According to the above, the timbre is determined by its harmonics and it includes some dynamic characteristics. In addition, the timbre perception has to do with complex mechanisms that the brain carries out from the stimuli that come from the neurons affected in the organ of Corti, by the different harmonics of a complex sound, as Mariano and Muñoz (2013) claim.

However, the timbre recognition depends not only on the spectral composition, but also on its temporal evolution; i.e. from the moment it begins until it becomes extinct, as shown in Figure 1 below.

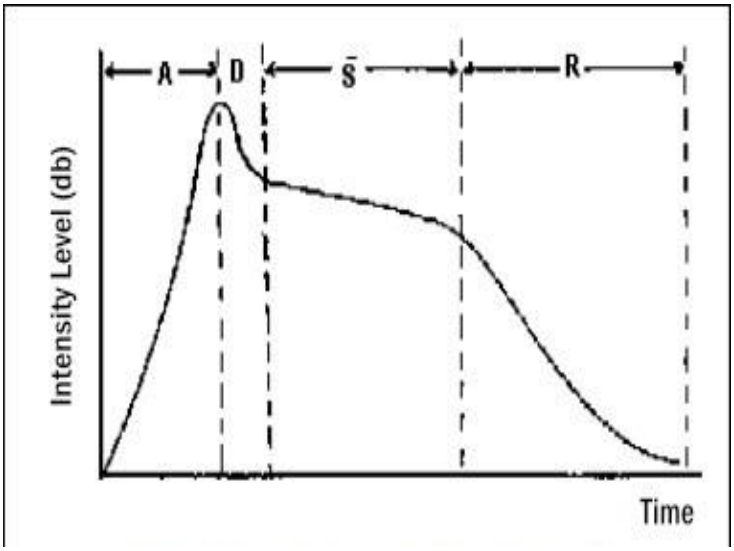

Figure 1. Structure of the surrounding sound intensity from its emission to its extinction. A. attack; D. decay; S. sustenance; R. relaxation

Note: Source: Mariano and Muñoz, 2013

The figure shows how all sound undergoes changes in intensity over time, as is evident: the intensity starts at zero at maximum intensity, which is known as Attack (A). Then, it briefly decays (D), the sustenance of the sound (S), followed by extinguishing into Relaxation (R). However, according to the authors, this evolution of intensity depends directly on the type of instrument that emits the sound; they expound the case of harmony, in which sound grows softly (A) up to a maximum height and then decays abruptly passing through (D)(S)(R) in a very short time.

Moreover, the temporal evolution of the intensity described above, in addition to the spectral composition, makes it possible to differentiate the timbre of a particular sound in relation to another. Finally, it is important to mention that in general the timbre that an instrument emits in its different notes is not the same, since each note has its own fundamental frequency and has its own individual characteristic timbre (Mariano & Muñoz, 2013).

With respect to rhythm, according to the RAE, Royal Spanish Academy, (2017), this term comes from Latin. *rhythmus*, in Greek ῥυθμός rythmós, derivate from ῥεῖν reîn meaning 'flowing'. Its definition is understood as the rhythmic order in the succession or occurrence of things, but in music, it refers to the proportion kept between emphasis, pauses and repetitions of different duration in a musical composition (Real Academia de la Lengua Española, 2017).

In general, rhythm is characterized by a pattern of short and long sounds and silences. According to authors such as Custodio and Cano (2017), this is the final result of establishing a time, i.e. the length of time that the sound or musical work lasts, using a pattern of accents with equidistant distances as a base.

From this perspective, the perception of continuity of patterns in a musical work or sound is what generates rhythm. There is even evidence that music can incite changes in emotions, in the nervous system, in some motor expressions such as smiles, as well as tendencies to dance, to sing, applause or to play an instrument. This happens because there are zones in the brain that process components such as tone, vibration, harmony, while the cerebellum itself is responsible for rhythm, say Custodio and Cano (2017).

In general terms, rhythm is a flow of movement, which is usually controlled or measured, either sound or visual, says Perez (2012). It is usually produced by an order of different elements of the environment. It is itself a basic feature of all the arts, especially music, poetry and dance. However, this same author affirms that it can also be observed in natural phenomena, that is to say, in activities carried out by living beings, since these are related to the rhythmic processes of geophysical phenomena such as ocean tides, solar days, lunar months and the changes in seasons (Peréz Herrera, 2012).

In relation to the sense of time, Correa, Lupiáñez and Tudela (2006) explain that the representation of time is still complex to solve, even from a neurobiology-based approach. However, there are some psychological, cognitive, philosophical and sensorial approaches, among others, in which we try to define how the human being generates a perception of time, and what are the mechanisms that generate this perception. Many authors such as Eric et al. (2000), sustain models based on neural networks, which are distributed by the cortex and intrinsically capable of processing temporal information. These same authors express the idea that attention "deforms time". The idea itself is that the degree of attention we pay overtime alters our perception of duration. From this perspective, the appearance of a brief stimulus in a spatial position or in an attended modality could be analyzed, with respect to which, according to the same cited authors, it is perceived as more lasting in comparison with the unattended position or modality.

However, this is also evident if attention is focused on establishing a reference point taking into account some interactions of the medium or rhythmic patterns such as speech, muscle movements or memories of a known pulse. Nevertheless, when the person is confronted with musical sounds, it is easy to orient themselves almost automatically in the music, even without having any musical training, because the human being has the ability to make quick judgments about the music, starting from very short examples, such as determining the style of the music, the performer, the rhythm, the complexity and the emotional impact.

In summary, the sense of time, although it is not easy to define, is possible to evidence as being rooted in the sensory practice of the events that we perceive, to make use of these events later in order to make a metric applied to the activities that require continuity and temporal approximation.

Finally, regarding tonal memory, several writers and music theorists such as Francés (quoted by Vera, 1989) have presented proposals for the way in which music is "understood", or in which a listener "senses everything". Almost all of these proposals have arisen out of an interest in adopting a more perceptual stance so as to include aspects of real-time thinking, retrospection or perceptual limitations in their theories of music, say Francés (quoted by Vera, 1989). For the rest, these authors explain, by comparing musically formed adults with

untrained subjects, that it has been shown that untrained subjects have "as much listening experience of musical intervals as those who had received music education" (Vera, 1989).

Other authors have considered that tonal memory is the ability to recognize the characteristics of a sound that has been previously heard, which can be acquired through musical teaching. That is, according to Vidal Varela (2010), musicians usually develop a great capacity to keep musical information in their memory, both short and long term, with the most basic type of memory being musical memory of tone, melodic or tonal, say the same authors. In addition, there are a number of in-depth studies on the subject, of which only a few will be mentioned.

In Madrid, research was carried out that relates musical training with higher cognitive functions such as attention and verbal work memory. In this study, it is stated that "musical training prolonged from infancy can produce profound changes in the structure and functioning of the brain" (Jurado, 2016, p. 2). In addition to this, it explains how there is research that shows how musicians have an advantage in terms of certain cognitive skills. Another work by Carrillo, Viladot, and Pérez (2017) resulted in "a conceptualization of the impact on music education that goes beyond the measurable aspects associated with educational reform policies" (p. 61).

On the other hand, González Moreno (2013) emphasizes that, despite the low consideration that music as a subject has among students, since it is perceived as useless or lacking in importance for the development of skills that allow the student to place them self socially as a productive element, the positive results in terms of academic performance are obvious: they are always more competitive, with better grades who, besides going to school or college, also dedicate some hours to learning music, compared to those students who only dedicate themselves to traditional school tasks, without belonging to any musical formation process. However, in the study by Reyes (2011), it was determined that music has a great influence on the intelligence of students, which facilitates the creation of connections from their inner being, allows them to work on mathematical and linguistic concepts, or knowledge that has to do with the environment, as well as benefiting fine motor skills, motor control and plastic capacity. In other words, music education is an important basis for education in general; however, it is necessary to break with the patterns formed in traditional education, in which the development of the arts as important areas for education is limited.

Method

This research uses the methodological non-experimental transactional correlational design, the research does not intend to make changes of an experimental type: it will be limited to making a study of reality, studying the different factors and variables that may intervene in the different results for students. The population that participated in the study was made up of all the titular bands that make up Caldas' band program. The sample consisted of a total of 482 instrumentalists including 200 girls and 282 boys. Two instruments were taken into account for data collection: the report card, through which the population's academic performance was analyzed, and the Seashore Musical Aptitude Test for the assessment of the other variable of the study: musical aptitude. In general, this test offers separate measures with respect to 6 tests for: tone, intensity, rhythm, sense of time, timbre and tonal memory. Finally, as for data analysis, this was carried out with a significance of 5% through the use of IBM SPSS Statistics statistical software, the data was filtered taking into account the uncontrolled variables of: age, sex, time of musical experience, band and grade, and statistical measures such as the mean and percentile of the test were taken into account.

Results

With regard to the demographic characteristics of the population, in relation to age it was found that the student with the lowest age within the sample was 9 years old, while the maximum age recorded among instrumentalists was 19 years old. In terms of grade, eighth grade students represent the highest percentage with 18.46%, i.e. 89 students; on the other hand, the lowest percentage is 0.41%, which corresponds to 2 students in the third grade. However, regarding the geographical location, it was found that the majority belong to the eastern and central regions of Caldas, of the 31.74% that belong to the eastern region of the department, 9.13% belong to the municipality of Victoria; and of the 25.31% that belong to the central region of the department, 9.54% of the instrumentalists are from Manizales. In addition, 8.92% are from Ríosucio, 7.26% from Viterbo, and 4.98% from the municipality of San José de Caldas.

However, as for the correlations between all the variables that evaluate musical aptitudes by means of percentiles, it was found that they are all positive, in addition to being all significant with a significance of 5%. The highest is among the time and tonal memory aptitudes (0.4991), while the most uncorrelated is among the intensity and timbre aptitudes (0.1478). Likewise, with respect to the areas of Spanish and Mathematics, it was found that they are correlated with each other (0.5832), but these areas do not present a correlation with any of the variables that evaluate some type of musical aptitude. It was also found that the variables of age and academic grades are directly correlated (0.8364), which explains the logic that as age increases, one ascends in the academic grades studied. On the contrary, as the age of instrumentalist students increases, their grades in Mathematics and Spanish (negative correlation values) decrease. It should also be noted that the variables used to evaluate musical aptitudes of intensity and timbre are isolated from the others. In other words, those two variables (intensity and timbre) measure a different aspect than the other variables. Similarly, it was found as a result that girls have better grades in Spanish and Mathematics with respect to boys, while the opposite happens with respect to tonal memory. Likewise, it was found that high values for *musical dexterity* (DM) are associated with low grades in Spanish (C) and Mathematics (M), although this association is very low.

On the other hand, as a research added value, the Spanish language and Math subjects were not only analyzed, but the other academic fields as well, finding that, as the Academic level in which the instrumentalists are increases, their grades in Natural Science and Arts are reduced, whereas the artistic component and English are not affected. Similarly, the instrumentalists who have high percentiles in tone, timbre and tonal memory present low grades in Natural Sciences, those having high percentages in the timbre aptitude have low grades in English and, as the grades in the percentiles of the tonal memory variable are reduced, the grades in Natural Sciences, English and Arts are reduced.

In addition to this, in a tacit comparison which can come from teaching experiences themselves, and examining holistic factors resulting from the historical analysis of the students´ development, it is necessary to consider that not only does understanding the curricula's content development improve, as can be seen above, but the behavioral development is what also attracts attention. Behavior that at one point could be considered as inappropriate or even aggressive, were reduced with the inclusion of music in the learning environment. It should be said that, in a personal way, these were the first empiric experiences enshrined with the application of music in the educational environment, and they are also the main reasons why the research project was started; then, the statistical check is part of the foundation of an already established hypothesis.

Finally, a comparative analysis between bands regarding musical aptitudes was developed, finding that, regarding tone, the person who has higher average mark belonged to the Villamaria group, with the average mark statistically the same for this group as the Victoria, Salamina, Samana, San José de Caldas and Chinchina ones. The Manzanares group, which has the same average percentile for the tone as the Viterbo, San Felix, Arauca, Manizales, Anserma and la Dorada bands, present the lowest percentile regarding the variable being analyzed. La Dorada band, with the average percentile for this group being the same as in the Salamina, San Félix, Manizales, Chinchina, Pensilvania and Villamaria bands, has a higher average mark in the intensity percentile regarding the intensity. The Anserma group represents the lowest percentile regarding the variable analyzed. Which represents the same average percentile of intensity as the San Bartolomé Pacora and Manzanares groups. For its part, the San Bartolome Pacora band represents the highest average mark in the rhythm percentile regarding rhythm, with the average percentile for this band statistically the same as the Samaná and Manizales groups. The lowest percentile regarding the variable being analyzed is represented by the Viterbo band, which represents the same average percentile regarding rhythm as the Manzanares, Arauca and Anserma bands. Regarding time, the San Bartolomé Pacora group has the highest average time percentile, not sharing any statistically identical percentage with any of the other bands in this assessed aspect. The lowest percentile regarding the variable being analyzed is represented by the Arauca group, which represents the same average percentile regarding rhythm as the Manzanares and San Félix bands. Regarding timbre, the Manizales group has higher mark in the timbre percentile, sharing a statistically identical average in this aspect with the Villamaria, Victoria, La Dorada and San Bartolomé Pacora bands. On the other hand, the Arauca group has the lowest percentile regarding the variable being analyzed, which represents the same average percentile regarding timbre as in the Manzanares Samaná, Anserma and San Félix bands. And finally, regarding timbre, the Victoria band has higher mark in the memory percentile, sharing a statistically identical average in this aspect with the Villamaria, San Bartolomé Pacora and Salamina bands. On the other hand, the Pensilvania group has the lowest percentile regarding the variable being analyzed, which has the same average percentile regrading memory as the Arauca band.

Discussion and Conclusions

The general objective of this research was to determine the academic performance in children and young students with musical aptitudes belonging to the Caldas Symphonic Band Program. After applying the instruments, it was found that, regarding the Spanish language and Math subjects, these instruments are correlated, but these areas are not correlated to any variable assessing any type of musical aptitude. Regarding this, what Gonzales Moreno (2013) says when he points that the students who receive musical education are generally more competitive and have better grades is not quite true, since almost all musical aptitudes assessed in this research showed that the higher they were, the lower the students´ grades were. However, it was determined that women have better grades in Spanish language and Math regrading men, whereas the opposite happens in tonal memory.

On the other hand, we could corroborate that, while age increases, their academic grades increase and, on the contrary, while the band-playing students´ age increases, their grades in Math and Spanish language decrease. It is possible that it is due to the fact that their musical education was begun very late in the case of this sample population, because only until when they enter superior grades, since these students achieved becoming part of these bands only after entering higher grade levels. Thus, if they would have been encouraged in this aspect at a younger age, more satisfactory correlation results might have been achieved.

training begin during childhood, in order to produce changes in the structure and the way the brain works. This is done with the interest that students become biologically stronger as they get older and more effectively respond to the academic processes that they undergo. This is why Carrillo et al. (2017) points out the need for educational policies that guarantee musical training starting from childhood, so as to create a positive impact within their general education and the student's academic performance.

To summarize, although the results from this study do not show a significant correlation evincing the fact that development of musical aptitudes contributes in the improvement of academic performance, given that the Math and Spanish areas are correlated among themselves, since these areas do not present a correlation with any of the variables that evaluate some types of musical aptitude, we can, however, conclude that musical education is an important basis for general education. Still, it is important to break away from those frameworks created in traditional education where the arts have limited importance in education. Behavioral development is also understood as driving the musical training that currently has been studied with no little or no eagerness in Colombia. Breaking away from said things is difficult for teachers, since they themselves were educated under such parameters. Thus, to break with this system, where music is perceived as something supposedly very important, but in reality, ends up having very little weight in classroom or educational policies, will take much more than a legislation. This requires real training and awareness around the positive effects of music as a fundamental part of the individual's training, as well as a constant assessment of the skills that individuals acquire in relation to their academic performance. Lastly, it should be noted that there were some constraints to this study's development. It was initially difficult to get the Secretary of Education's permission to conduct the research. By understanding the study's objective, they later agreed with pleasure and admiration due to its interest in that population. On the other hand, as there were too many schools, the field became difficult to work in, with many rectors and band directors reluctant to the process; in the case of Chinchiná, for example, though the study managed to proceed, it did so with a very small sample. Furthermore, it was complicated to obtain the report cards from some schools. In the end, they were only obtained with the Secretary of Education's help and the legal guardian's informed consent.

References

Banco de Desarrollo de América Latina (CAF). (s.f.). Música para crecer. Herramientas de inclusión social. (CAF, Ed.) Retrieved from scioteca.caf.com/handle/123456789/567

Carrillo Aguilera, C., Viladot Valverdú, L., & Peréz Moreno, J. (14 de septiembre de 2017). Impacto de la educación musical: una revisión de literatura científica. *Revista Electrónica Complutense de Investigación en Educación Musical,54*(14), 61-74 . doi:10.5209

Correa, Á., Lupiañez, J., & Tudela, P. (2006). La percepción del tiempo: una revisión desde la Neurociencia Cognitiva. (F. i. Aprendizaje, Ed.) *Cognitiva, 18*(2), 145 - 168. Retrieved from http://files.sensacion-y-percepcion.webnode.es/200000035-12fbf13f65/PERCEPCION%20DEL%20TIEMPO.pdf

Custodio, N., & Cano, M. (2017). Efectos de la música sobre las funciones cognitivas. *Revista de Neuro Psiquiatria, 80*(1), 60-69. doi:10.20453/rnp.v80i1.3060

Gonzalez Moreno, P. (2013). Motivación estudiantil hacia el estudio de la música: el contexto mexicano. (R. S. Education, Ed.) *Revista internacional de educación musical*, (1), 31-41 . doi:10.12967/RIEM-2013-1-

Jurado Besada, F. (2016). *Relación entre la formación musical y las funciones cognitivas superiores de atención y memoria de trabajo verbal.* Universidad Internacional de la Rioja, Master en Neuropsicologia y Educación. Javier Páez. Retrieved from https://reunir.unir.net/bitstream/handle/123456789/3959/JURADO%20BESADA%2C%20FRANCISCO%20ALFONSO.pdf?sequence=1&isAllowed=y

Lazaro Tortosa, R. (2015). *Relación de aptitudes musicales, intelectuales y rasgos de personalidad e identificación del talento musical en escolares de diez a doce años.* Murcia, España: Universidad de Murcia.

Mariano Merino, J., & Muñoz Recipo, L. (2013). La percepción acústica: Tono y timbre. *Revista de Ciencias*, 3, 21-32. Retrieved from http//Dialnet-LaPercepcionAcustica-4458407.pdf

Peréz Herrera, M. (2012). Ritmo y orientación musical. *El Artista* (9), 78 - 100. Retrieved from https://dialnet.unirioja.es/descarga/articulo/4099946.pdf

Quintana Guerra, F., Mato Carrodeguas, M. d., & Robaina Palmés, F. (2011). La habilidad musical: Evaluación e instrumentos de medida. *El guiniguada* (20), 141-150. Retrieved from http://ojsspdc.ulpgc.es/ojs/index.php/ElGuiniguada/article/view/415/355

Real Academia de la Lengua Española. (2017). *Real Academia de la Lengua Española*. Retrived from http://lema.rae.es/drae2001/srv/search?id=n9xyAwWbXDXX21HuKy7B

Reyes Belmonte, M. d. (2011). *El rendimiento académico de los alumnos de primaria que cursan estudios artísticos-musicales en la Comunidad Valenciana.* Valencia, España: RODERIC

Seashore, C., Lewis, D., & Saetvit, J. (2008). *Seashore Measures of Musical Talent.* The Psychology of Musical Talent.

Serway, R., & Jewett, J. (2015). *Física para ciencias e ingeniería.*. Santa Fé (México): Cencage Learning.

Vasegui, S. (2007). *Multimedia Signal Processing: Theory and Applications in Speech, Music and Communications.* Nueva Jersey, USA: John Wiley & Sons, Ltd.

Vera Tejeiro, A. (1989). El desarrollo de las destrezas musicales. *Infancia y Aprendizaje: Journal for the Study of Education and Development*(45), 107-121. Retrieved from https://dialnet.unirioja.es/servlet/articulo?codigo=48323

Vera, A. (1989). El desarrollo de las habilidades musicales: un estudio descriptivo. En Francés, *La perception de la musique* (45) 107- 170). Retrieved from https://dialnet.unirioja.es/descarga/articulo/48323.pdf

Vidal, A. (2010). *Reseña de "Tu cerebro y la música. El Estudio Científico de una Obsesión Humana" de Daniel J.* Madrid, España: Sociedad de Etnomusicología.

Date received: 22/11/2019
Date reviewed: 10/12/2019
Date accepted: 20/02/2019