Strengthening mathematical interpretation competence through the portfolio as a learning tool

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Strengthening mathematical interpretation competence through the portfolio as a learning tool

M L Niño Villan[1], **H J Gallardo Pérez**[1], **and D Villamizar Jaimes**[1]
[1] Universidad Francisco de Paula Santander, San José de Cúcuta, Colombia

E-mail: henrygallardo@ufps.edu.co

Abstract. The purpose of the research is to strengthen the competence of mathematical interpretation through the portfolio as a learning tool in an educational institution of the "Municipio de Gramalote, Norte de Santander, Colombia". The research is carried out from the socio-critical approach, qualitative paradigm and the chosen method is action research. The information gathering process was developed using the techniques of: participant observation and focus group. The key informants were two high school mathematics teachers and eighth grade students. The results show that in the diagnosis the participants' lack of knowledge regarding the process of mathematical interpretation was evidenced; elements of knowledge are identified from the previous knowledge of the students and the preparation of the researcher teacher in the didactic sequence. The use of a tool such as the portfolio made it possible to motivate the learning process and to evidence in an orderly manner the abilities and capacities empowered by the students; there was an appropriation of learning around the analysis and interpretation of mathematics from concrete situations in the daily lives of the students, taking up their previous knowledge and using didactic elements and resources from their environment.

1. Introduction

The global trend of quality in the education system of different countries now requires that children, adolescents and young people are being trained in skills. This research problem has been addressed by different countries, which have been designing the way in which teachers' pedagogical practices should be reconstructed. That is why the United Nations Educational, Scientific and Cultural Organization (UNESCO) [1], always seeking the progress of education, places the emphasis on recognizing which are the basics of the process of teaching and learning. The key is to know with certainty how the pedagogical practices of education professionals are being developed, which will allow clarity regarding the proposals for continuous improvement that must be addressed in educational institutions in order to strengthen their missional process that is anchored to the academic management of the institutional educational project.

From this international logic, UNESCO states: What is required is an "expanded vision" that goes beyond current resources, institutional structures, curricula and traditional systems of instruction, based on the best of current practices. In other words, as intellectuals of education, the reality of education must be known from the contexts in which it is developed. In addition, by placing all available resources to promote the best pedagogical practices that foster in children, adolescents and young people the necessary skills to face the challenges of a globalized world in permanent reconstruction.

One of them, led by the Organization for Economic Cooperation and Development (OECD), is the Programme for International Student Assessment (PISA) [2].

Colombia is a member of the OECD, which is why this organization issued a report entitled: Colombia, priority policies for inclusive development, in which it states that "improving the quality of education and ensuring that all students - especially the most disadvantaged - achieve minimum levels of knowledge will be key to Colombia's long-term economic and social development" [3]. If education is the motor of development, it is a priority to measure its progress, which is why, following international parameters, the Colombian state, has promoted different programs from its educational policies to evaluate the performance of the education system.

One of the evaluation tools is the day of educational excellence, called day E. The tools of day E, until this year, emphasized the areas of mathematics and Spanish language. These tools have been implemented according to the "Instituto Colombiano para el Fomento de la Educación Superior (ICFES)" [4], because from the results of the PISA tests, Colombia created the synthetic index of educational quality, which seeks that each educational institution is measured in 4 factors that allow establishing improvement plans for their work and is built on this day E.

What underlies this complexity in pedagogical practices is based on the previous knowledge of teachers in this area, from which a training based on mathematical competencies should be developed. But it is necessary to arrive at the reconstruction of the conceptions of knowledge in teachers. This leads us to think that pedagogical practices should go beyond the classroom, since when teacher is appropriate concepts to identify previous pedagogical and didactic knowledge; they will come closer to being more and more the expert in the teaching process. The responsibility of the teacher directly implies the life of the subjects he or she accompanies in learning [5].

On the other hand, the interpretation, scientifically known from the concept of hermeneutics, refers to the capacity that it has in human being to be able to express what it observes identifying certainties of the phenomenon that it describes. The interpretation supposes description, to say what is seen, following certain terms of reference, which implies the wealth of knowledge that the interpreter possesses. The mathematical interpretation, therefore, is the capacity to achieve access to the information that one wishes to transmit from mathematical elements, supposes description, to say what is seen, following certain terms of reference, which implies the quantity of information that possesses who interprets and the knowledge that possesses. Mathematical interpretation, therefore, is the ability to gain access to the information to be transmitted from mathematical elements [6].

When the competence of mathematical interpretation demands of the student the ability to observe and discern the information presented, either in a graph, to extract what is intended to be expressed there, it is necessary to have the prior conceptualization of contents specific to the area. In addition to that, it is necessary for the student to analyze two variables, in the process of mathematical interpretation, one is the local definition, which refers to the location of specific information; the other is a global definition, which focuses on the search and comparison of trends on the totality of the information, which will lead to understanding the argument presented [7].

That is to say, that mathematical understanding and interpretation is a competence that should be fostered in learning, and when it is not done effectively, it leads to disinterest on the part of the student in this field of knowledge and since it is directly related to pedagogical and didactic practice, it is the teacher who must implement tools that allow the development of this type of competence [8].

2. Method

This research is framed within the qualitative paradigm, with a socio-critical approach and action research method, which allows to deepen the reflection in front of some social phenomenon and to be able to take position in front of it [9]. Information was categorized in an inductive way, under the following steps: open coding, axial coding and selective coding [10]. The participants are thirty students in the seventh grade of the educational institution. The following phases were carried out: documentary analysis establishes the relationship to deepen and understand the national commitment to competency-based training as opposed to the institutional curriculum; from participant observation, through field journals and portfolios as academic follow-up tools [11]. In order to deconstruct current pedagogical

practices in the area of mathematics and self-stories, a semi-structured questionnaire was used to propose an improvement plan for pedagogical practices around competency-based training.

3. Results

3.1. Diagnosis of the level of performance in mathematical interpretation

In this first phase, it is part of the field diary, the analysis of the triggering activity, carried out for the diagnosis, which was structured by the researcher in six aspects that were developed by the students. The first exercise of the activity allowed to determine the capacity or not, to order data in a table. The second exercise was about the interpretation of a graph taking into account the mathematical procedure and later analysis to give a correct answer. The third exercise was performed to determine the ability to draw totals from a graph, as an element of interpretation. The fourth exercise was to know how to relate different data from a graph in order to analyze a result. The fifth exercise allowed knowing the capacity to interpret data and make forecasts. The sixth exercise investigated the ability to interpret data in order to propose alternative solutions.

The grouped inductive categories and the respective axial ones are determined and ranked by the recurrences of each category in the fieldwork. These are: ignorance of the process of mathematical interpretation (ignorance that it is the interpretation of mathematical graphs, does not interpret data or propose alternative solutions, does not interpret graphs or make forecasts, is difficult to relate different data from a graph to analyze a result, is difficult to get totals from a graph as an element of interpretation); approaches the interpretation of a mathematical graph (knows how to take totals from a graph as an element of interpretation, relates different data from a graph to analyze a result); lack of competence in mathematical interpretation (difficulty in ordering and interpreting mathematical data), competence in mathematical interpretation (appropriation of learning for mathematical analysis and interpretation, use of prior knowledge for learning), school environment (school environment conducive to learning).

This first phase of the research that aims to diagnose, from the Basic Learning Rights, the level of performance in mathematical interpretation in seventh grade students of the “Colegio Sagrado Corazón de Jesús, Gramalote, Norte de Santander, Colombia”; allowed evidencing a low performance in these competencies. The majority of students do not have the elements that allow an adequate interpretation of the mathematical data presented in a given information. It is difficult for them from the organization of the data in table and its later understanding to arrive at the interpretation. This diagnosis allows us to conclude that there is a need in this degree to strengthen the students' interpretive competence, which is the next phase developed in the research. It is important to emphasize in this first phase that the use of the digital portfolio facilitated the execution of the triggering activity and begins to be evidence in the research process and learning tool for students.

3.2. Elements to identify previous, pedagogical and didactic knowledge in the implementation of the portfolio as a learning tool

This phase was carried out using the participating observation technique and the data were collected in field diaries, which were later categorized according to the proposal of Corbin and Strauss [10]. The emerging, hierarchically organized axial categories were the following: competence in mathematical interpretation (appropriation of learning for analysis and mathematical interpretation, portfolio as a learning tool, collaborative work strengthens learning, use of prior knowledge for learning), contextualized training (use of contextual reality for learning), school environment (school environment conducive to learning).

The three axial categories show how the students took up with pleasure the didactic sequence, which was developed in eight moments with the purpose of strengthening the competence of mathematical interpretation. It is evident that the use of the portfolio as a learning tool motivates learning and allows students to carry out in an orderly manner the activities carried out from the pedagogical practice in order to empower this competence. It is also important to highlight aspects such as the use of previous

knowledge, collaborative work, and the use of contextual reality in the teaching and learning process. Finally, it should be noted that the process of apprehension of knowledge is possible when there is a conducive school environment, an aspect that emerged in the findings.

3.3. The implementation of the portfolio as a learning tool

This phase of the work allowed the evaluation of the process of implementing the portfolio as a learning tool [12,13], the data were collected through the focus group research technique. At this stage of the fieldwork an axial category emerged, made up of three inductive categories: mathematical interpretation competence (portfolio as a learning tool, appropriation of learning for analysis and mathematical interpretation, collaborative work strengthens learning).

This final moment of the investigation allowed concluding that the students get to feel motivated in the learning of one of the areas with more complexity in the secondary school as it is the mathematics with the use of the portfolio as a learning tool. As well as to be able to affirm that, it is possible to appropriate the learning of the competence of mathematical interpretation through the portfolio. Therefore, it can be stated that it is an evaluation that shows a positive impact on the implementation of this tool as a learning tool. The students evidence the appropriation of elements to identify previous, pedagogical and didactic knowledge of the competence of mathematical interpretation, with the use of the portfolio in the learning process.

The results presented at the three moments of the research are then triangulated. The findings of the diagnosis, the didactic sequence and the evaluation of the implementation of the portfolio as a learning tool are presented, which allows a holistic view of the process.

The first axial category that triangulated was ignorance of the process of mathematical interpretation, which emerged in the diagnosis that was applied as a triggering activity of the research. This category did not emerge again in the other two moments of the research, which shows the progress made in strengthening the competence of mathematical interpretation.

The second axial category that triangulated was approaching the interpretation of a mathematical graph, which recurred forty-four times in the diagnosis, but did not emerge again in the other moments of the investigation. This allows us to note that some students were approaching mathematical interpretation, so it was important to strengthen this learning with the portfolio as a didactic tool.

The third triangulated axial category was the absence of competence in mathematical interpretation, which recurred twenty-two times in the diagnosis, but was absent in the other two moments of the research. This allows us to conclude that, if the performance of the students was low in this competence, which will be strengthened with the didactic sequence implemented.

The fourth axial category that was triangulated was mathematical interpretation competence, which was resorted to in the three moments of the investigation. In the diagnosis from the basic learning rights twenty-one times, in the didactic sequence seventy-seven times and twenty-eight recurrences in the evaluation of the implementation of the portfolio to strengthen the competence of mathematical interpretation. Because of the previous findings, this is the most important category in the research, because it shows in a direct way the empowerment of the competence of mathematical interpretation in the three moments of the fieldwork.

The fifth triangulated axial category was the school environment, which recurred three times in the diagnosis and nine times in the didactic sequence. It did not recur in the evaluation, which denotes that students do not take this aspect very much into account in their learning experiences. What is clear is that there must be a teacher's interest in fostering a school environment that motivates the student to learn.

The sixth triangulated axial category was contextualized training, which only resorted in the didactic sequence in twenty-two opportunities, which reveals that there is an interest of the teacher to place learning from the context of the students. But it also denotes little interest on the part of students in showing and using their context to strengthen their learning from the reality in which they live.

4. Discussion

The purpose of this section is the confrontation of the findings in the process of investigation with the conceptual and investigative theoreticians. It highlights necessary elements that must be taken into account in the process of strengthening mathematical interpretation through the portfolio as a learning tool, so that competency-based training becomes a reality and progress is made towards quality education. This is because the initial finding in the diagnostic phase from the basic learning rights was that there is a lack of knowledge of the process of mathematical interpretation on the part of the participating students. This aspect is overcome in the course of the fieldwork and the strengthening with the focal group is evident.

The research work resulted in strengthening the competence of mathematical interpretation through the implementation of the portfolio as a learning tool, which involves addressing the previous knowledge of students, which allows placing emphasis on weaknesses to transform them into strengths. The interpretation from Carswell, Emery and Lonon [6], supposes description, saying what is seen, following certain terms of reference, which implies the amount of information possessed by the interpreter and the knowledge possessed. Mathematical interpretation, therefore, is the ability to gain access to the information that one wishes to transmit from mathematical elements. Only in this way can mathematical interpretation be brought into practice, allowing the understanding of a mathematical graph [14].

That is to say, the starting point is the simple knowledge of the subject, to dimension it to the complex knowledge of mathematical interpretation, not as a metaphysical knowledge and isolated from reality, but as a practical way of analyzing and understanding the context, as evidenced in the first diagnostic part based on the basic learning rights, where several participants managed to order in a logical and assertive way the data presented in a frequency table. The importance of interpretative mathematical learning implies the decision to transform the context after knowing it through action. But, in addition, it is to be able to evidence the errors that often have the graphs that are found in everyday life, that is, that notions of statistics obtained from everyday life outside the classroom, in the press or in the media tend to be associated with numbers, being graphical representations that sometimes are even conceptually erroneous [15].

One of the causes that does not allow training in this type of competence is the lack of effective tools for the interpretation of mathematical data. This is due, in part, to the scarce statistical preparation with which the teacher finishes his or her studies, which means that he or she has few resources [8].

The implication for the teacher is because he must have the pedagogy so that the student widens his vision of reality from the interpretation, becoming aware that it is part of a local context, but in the same way, there is a global context. With this wealth of knowledge, the teacher can use the portfolio to document and problematize the nature of educational evaluation and learning in classroom work and its derivations in curricular and institutional development.

For this reason, it is necessary for the teacher to consider both cognitive and affective aspects in the student, while taking into account the social context in which the formative process takes place. For this reason, the effective implementation of pedagogical tools must make teachers aware of their epistemic capacity, their conceptions, and at the same time, recognize in the student an integral subject. In this sense Leinhardt, Zaslavsky and Stein [7], say that it is necessary for the student to analyze two variables in the process of mathematical interpretation, one is the local definition, which refers to the location of specific information; the other is a global definition, which focuses on the search for and comparison of trends in the totality of information, which will lead to an understanding of the argument presented. As when the teacher transforms from pedagogical practices.

This research showed that it is possible to strengthen the competence of mathematical interpretation through a learning tool, such as the portfolio, which makes it possible to empower this competence in schooling and for the life of the student. The findings of this work, in relation to the theoreticians who explain what it is and the importance of this interpretive competence, show that it is possible to construct these learnings with students from a tool such as the portfolio. At first, the main finding was that there is a lack of knowledge of the graphic interpretation process.

However, in the educational process with the use of the portfolio, it is mainly evident that it is possible to empower the competence of mathematical interpretation with the help of the portfolio as a learning tool. This is why this research helped to resolve the low performance of students by empowering the knowledge, skills, and abilities of mathematical interpretation based on previous knowledge, context, and relying on the portfolio as a learning tool. This aspect was confirmed in the last phase of the research, with the main finding, where students have clarity when asked how they used the portfolio during the learning process, and without hesitation they respond as a learning tool, evidencing that there was an appropriation of learning for analysis and mathematical interpretation, because there was an order and everyone knew that they were learning and what it was going to be used for in life. In addition to achieving these achievements through collaborative work, which was evidenced when the way in which the portfolio was designed and developed was investigated, the students felt that everyone participated and felt that what they were learning was their own.

Finally, strengthening the competence in mathematical interpretation through the implementation of a pedagogical tool implies the knowledge of the teacher, who as a trainer has the pedagogy and develops a pertinent didactics to accompany the student in the appropriation of this type of competence. The gain would be in two ways: on the one hand, it would be possible to raise the level of external tests of the educational institution in the area of mathematics, and on the other hand, it would be preparing the citizen with a relevant competence for life in constant relation with others and the context.

5. Conclusions

With respect to the first objective, which sought to diagnose from the basic learning rights the level of performance in mathematical interpretation in seventh grade students of the "Colegio Sagrado Corazón de Jesús, Gramalote, Norte de Santander, Colombia", it is concluded that, in the triggering activity, which diagnosed from the basic learning rights the performance in that competence, the ignorance in this group of students in relation to the process of mathematical interpretation is evident. However, there was evidence of students approaching the process of mathematical interpretation, but with difficulty. In the same way, the importance of generating a good school environment for learning was evidenced, which was taken into account when planning the didactic sequence and the portfolio as a learning tool.

With regard to the second objective of the research, which was to identify the elements for identifying previous, pedagogical and didactic knowledge that emerge from the implementation of the portfolio as a learning tool in the seventh grade students of the "Colegio Sagrado Corazón de Jesús, Gramalote, Norte de Santander, Colombia", it is concluded that it was possible to identify elements from the previous knowledge of the students and the preparation of the researcher teacher in the didactic sequence. In terms of pedagogy, the use of a tool such as the portfolio allowed motivation to be achieved in the learning process and to be able to demonstrate in an orderly manner the skills and capacities empowered by the students. As for the didactic elements, the use of guides in the didactic sequence is highlighted, as well as taking the context as a resource and starting from the press knowledge of the students. From these elements, it is concluded that, if possible, from the use of the portfolio as a learning tool, the strengthening of competence in mathematical interpretation. In addition, it was important that contextualized training emerged as a strength in the learning process and that in coherence with the curricular planning of the didactic sequence, it emerged that the school environment is of importance in the learning process.

From the third objective, on evaluating the implementation of the portfolio as a learning tool in the seventh grade students of "Colegio Sagrado Corazón de Jesús, Gramalote, Norte de Santander, Colombia", it is concluded that the use of the portfolio to strengthen this competence was effective and efficient. This shows that there was an appropriation of learning around the analysis and interpretation of mathematics from concrete situations in the daily life of the students, taking up their previous knowledge and using elements and didactic resources of their environment. In addition, it is concluded that there is a strengthening, in this type of learning process, to carry it out by promoting group work, where collaboration allows for the strengthening of learning.

Finally, it is concluded that designing and implementing a didactic tool such as the portfolio, based on pedagogical guides and work in workshops developed by the participants, each organizing the portfolio as evidence of learning, has a positive impact on the teaching process from a competency approach. Interest is aroused and students are motivated to learn, who come to feel and think that the knowledge they must empower to strengthen a competence can be achieved from pleasant environments that break with the routine of classes and with traditional education. It is an alternative to be adopted and taken advantage of by all teachers, where there are many possibilities of didactic resources such as the portfolio, so that true training is given by competencies, which would bring the educational system closer to the purpose of achieving quality education.

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