NATURE OF DIFFICULTIES ASSOCIATED WITH LEARNING MATHEMATICS: INTEGERS, IN EIGHTH GRADE STUDENTS OF BASIC SECONDARY EDUCATION

Diego Alejandro Cruz Echeverri
UMECIT, Panama
profedace2009@hotmail.com
https://orcid.org/0000-0001-6888-5245

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ABSTRACT

This study considers the term *"learning difficulties"* as a complex unit of analysis since there may be different factors that influence its manifestation. With the purpose of understanding its nature, research related to learning and some of its faculties according to Claxton (2001) and Schunk (2012), mathematical knowledge, learning difficulties in mathematics and evaluation are taken up. As qualitative research it employs grounded theory (Strauss and Corbin, 2016) for data collection, analysis and theory building from the data and analyzed with the support of Atlas. ti software; it is developed in the field of mathematics education to make contributions in the understanding of the difficulties presented by students regarding the learning of the integer.

Keywords: Learning, Learning difficulty, Integer, Grounded theory.

INTRODUCTION

Taking into account that the present research is developed in the field of education, specifically concerning the learning of mathematics and more specifically in relation to difficulties associated with the learning of the whole number, and that education is assumed as a social phenomenon, it is proposed to approach it from a research approach that allows recognizing, analyzing and categorizing difficulties associated with the learning of the whole number that lead to the understanding of its nature, with the purpose of providing elements that favor its subsequent treatment and approach from the teaching processes. The following is an outline of the elements that are part of the research methodology, the subsequent design of instruments, the collection of data and their analysis through coding processes, mediated by the Atlas.ti software.

Research approach

Based on the need to identify the nature of difficulties associated with learning the whole number

with eighth grade high school students, which leads to a categorization of them as a fundamental purpose of this study, it is considered relevant to approach it from a qualitative approach, since it focuses its interest in identifying and recognizing what are the qualities, characteristics, actions or behaviors that lead to conclude the presence of a learning difficulty, this through observation, description and interaction, because as Minayo (2010) points out, understanding and interpreting become the main verbs of qualitative research. Reference is made to the complexity, subtlety and delicacy of seeing, hearing, observing, understanding and interpreting in the researcher's task, just as in everyday life.

In the same way, Minayo (2010) proposes the nouns for this approach, in relation to the two verbs already exposed, *"understanding and interpreting are founded, epistemologically, on the following nouns: experience, vivencia, common sense, social action, meaning and intentionality."* (p.254), elements to be taken into account in the task of recognizing the nature of difficulties associated with learning mathematics, in relation to the mathematical concept of integers, because as already discussed in Chapter 1, the presence of such difficulties is recognized, but their nature is not clearly glimpsed, being a topic of interest both for researchers and for mathematics teachers themselves.

On the other hand, Hernandez, Fernandez & Baptista (2010) point out that the complexity and flexibility of the qualitative approach are greater, in terms of the possibility of representing it through a circular scheme, given that the sequence can vary and the inquiry moves dynamically between both directions: between the facts and their interpretation. In the same way, they present the characteristics, process and benefits for this approach:

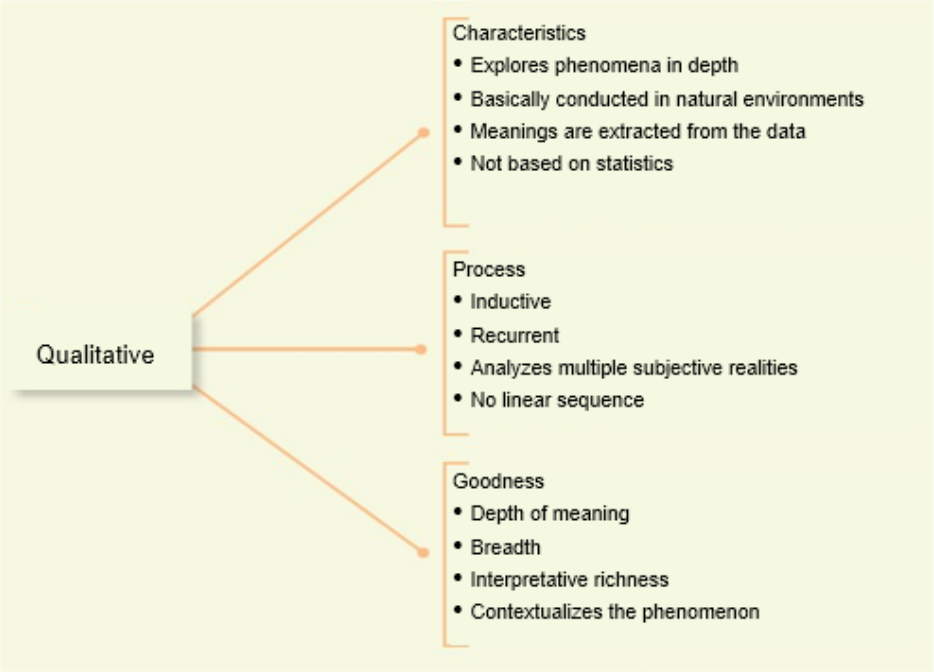


Image 1. Qualitative approach Source: taken from Hernandez, Fernandez and Baptista (2010), p.3.

In this regard, it is worth highlighting, among its characteristics, the exploration of the phenomena in depth, given that so far research has been found concerning difficulties in learning mathematics but no studies have been located in relation to the nature of these, a situation that in the context in which the research is located, merits deepening in a natural environment such as the classroom, which leads to contextualize the phenomenon and favor or enable future research, in such a way that it is possible to interact with students, observe their behavior at the moment of performing mathematical activities, testing their knowledge, dialogue with them in order to contrast answers and go on to identify possible difficulties in learning mathematics, in their approach based on integers, and a little further, in the recognition of their nature, thus making an immersion in the object of study, as a qualitative research deserves, this in order to have more than one source that provides the necessary data for the development of the research.

It is important to mention that, from the perspective of Hernandez, Fernandez and Baptista (2010), it is assumed that *"qualitative research focuses on understanding and deepening the phenomena, exploring them from the perspective of the participants in a natural environment and in relation to the context."* (p.364), hence the need for this study to require a research method that allows observing learning difficulties from the perspective of the students of the educational institution. In addition to this, they clarify that *"it is advisable to select the qualitative approach*

when the topic of the study has been little explored, or no research has been done on it in any specific social group." (p.364), a fact that has been discussed since chapter 1, since no research has been found that has delved into the nature of difficulties associated with learning mathematics, since it is common to find students in the classroom with signs or manifestations of some type of difficulty in their learning, and knowledge of their nature could contribute and favor intervention for future research.

It is expected then, under this approach, to perform an immersion that allows collecting data directly in the environment, after defining the places where they will be collected and the participants, which, in this case, is expected to be in the classroom and other places close to the educational institution, or, failing that, simulations of a school environment, with eighth grade students and in relation to the mathematical concept of integers. Thus, it is possible to observe the events that occur, simple or complex, to identify explicit and implicit aspects of them, without points of view or value judgments, through interaction with them and the use of various sources. This observation takes into account the participants in their context, and the researcher, in addition to recording facts, is in the task of understanding the participants (Williams, Unrau and Grinnell, 2005, cited in Hernandez, Fernandez and Baptista, 2010), which is why it is intended, in addition to written answers, to seek that students can verbalize and communicate the processes and other events that hide behind an answer, in order to understand them and thus build a path towards understanding the nature of possible difficulties in learning mathematics: integers, in the cases that it happens.

The above refers to the need to think about the identification of the data to be used, in the same way as the procedures to be developed and the way to communicate the results, since no studies have been identified so far that manage to highlight an order of the difficulties in terms of their nature, and hence the urgency to create theory rather than demonstrate it, for this reason, the method that is considered most relevant is the grounded theory, as a qualitative methodological approach, according to Minayo (2010) and Hernandez, Fernandez and Baptista (2010).

Grounded theory

Strauss and Corbin (2016) define grounded theory as a *"theory derived from data collected systematically and analyzed through a research process. In this method, data collection, analysis, and the theory that will emerge from them are closely related to each other"* (p.13). Its purpose is to develop theory based on empirical data (Hernandez, Fernandez & Baptista, 2010), as data collection

is planned through the answers obtained from students, both written and oral, in a systematic way, to proceed with their respective analysis and thus identify the nature of difficulties associated with learning mathematics in relation to the whole number. In this sense, Strauss and Corbin (2016) propose what they define as the characteristics for working with grounded theory:

1. Ability to look back and analyze situations critically.
2. Ability to recognize the tendency to bias.
3. Ability to think abstractly.
4. Ability to be flexible and open to constructive criticism.
5. Sensitivity to the words and actions of those responding to questions.
6. Sense of absorption and devotion to the work process. (p.8).

It is then a matter of assuming these capacities, not automatically, since they must be consolidated during the process, in the sense, for example, of paying special attention to the answers that the students may give to what they may say and even manifest with their bodies, a situation that should lead to retrospection and critical analysis of the findings, avoiding biases and allowing flexibility, the last element proper to qualitative research.

The basic approach of its design, according to Hernandez, Fernandez and Baptista (2010), *"is that the theoretical propositions arise from the data obtained in the research, rather than from previous studies. It is the procedure that generates the understanding of a phenomenon"* (p.493), being possible to recognize the value assigned to it in the research, since it is mainly about transcending difficulties in learning the whole number and understanding its nature, allowing it to emerge from the data and their respective analysis, by going a little beyond the answers that can be obtained as a requirement for the categorization of the same. According to Strauss and Corbin (2016), since grounded theory is based on data, it is more feasible to generate knowledge, increase understanding and provide a meaningful guide for action, a route that is intended to be followed to enable the understanding of such difficulties from their nature, through the processes evidenced by students when facing situations that involve and require mathematical activity in relation to the integer, as privileged mathematical knowledge in the study.

Considering that *"analysis is the interaction between researchers and data"* (Strauss and Corbin, 2016, p.14), part of the process in the task of identifying the nature of difficulties associated with learning mathematics, in the interaction of students with situations related to the integer,

points to the recognition of internal and external elements, such as predispositions by previous experiences, own difficulties with mathematical knowledge, absence of previous knowledge as prerequisites or weaknesses in them, the teacher-student relationship that embodies emotional issues, genetic causes, among others, this research merits rigorous and systematic processes, allowing for flexibility, in order to perform a coherent and relevant analysis of the problem studied. One of these processes is coding, mentioned above, whose purposes are: to build theory rather than test it; to provide useful tools for handling large amounts of raw data; to help consider alternative meanings of phenomena; to be systematic and creative at the same time; and to identify, develop and relate concepts, the basic building blocks of theory.

Coding procedures

Once the data have been identified and collected, comes the coding procedure, understood as the *"analytical process by which data are fragmented, conceptualized, and integrated to form a theory"* (Strauss and Corbin, 2016, p.3), important for the development of grounded theory, taking into account that it is a dynamic process that flows as such. It should be noted, at this point, that *"analysis is not a structured, static or rigid process"* (Strauss and Corbin, 2016, p.64), referring to the flexible condition characteristic of qualitative methods. With this, there are three main elements for analysis: the data; the researcher's interpretations of events, objects, occurrences and actions and, thirdly, the interaction between the two previous elements, in the process of data collection and analysis.

In relation to the data, essential in the coding process, its definition and identification is expected from Claxton's (2001) proposal, specifically what has to do with the faculties to learn, in such a way that they will be assumed, in their absence, as possible generators of difficulties in the learning of mathematics, from the proposal and execution of mathematical activity with integers, and it is there when the knowledge of their nature is reached, the main objective of the present study. According to the above, it will be possible, according to specific cases, to explain some difficulties by reason of the resistance that may exist on the part of the student, others by the absence or misuse of internal and external resources, or by the quality of the reflection that may be generated in the student-mathematical knowledge relationship.

Open coding

This type of coding, according to Strauss and Corbin (2016), is conceived as *"the analytical process by which concepts are identified and their properties and dimensions are discovered in the*

data" (p.110), a sense in which, in the task of building theory, it becomes the first approach and treatment of the data, since it leads directly to the collection of them, from which the categories emerge. According to Hernandez, Fernandez and Baptista (2010), the researcher must review all segments of the material to analyze them and thus generate initial categories of meaning. In this case, open coding should lead to the generation of the first categories referring to the nature of difficulties associated with learning mathematics, specifically the whole number, understanding by categories those concepts that represent phenomena (Strauss and Corbin, 2016), which are based on the data collected such as observations, interviews, annotations, among others (Hernandez, Fernandez and Baptista, 2010).

As one of the initial purposes in coding is to determine the properties and dimensions of the data, it is important to keep in mind that the former correspond to the characteristics of each category, while the latter refer to the scale of variation of the properties, as proposed by Strauss and Corbin (2016). They also state, in the sense of providing greater clarity, that while *"properties are the general or specific characteristics or attributes of a category, dimensions represent the location of a property during a continuum or range"* (p.128); in this order of ideas, Claxton's (2001) proposal in relation to the faculties to learn, are assumed as properties of the object under study, thus leading to the identification of its dimensions through the development of the same.

It is then a matter of identifying the nature of possible difficulties associated with the learning of mathematics, specifically in relation to the whole number, therefore, we start from three faculties for learning: resistance, resources and reflection, defined by Claxton (2001), and which become possible difficulties to the extent that their absence is considered and, based on them, carry out the process of open coding as described above. Once the categories have been identified and defined, according to their properties and dimensions, we proceed with the axial coding, discussed below.

Axial coding

Defined by Strauss and Corbin (2016) as the *"process of relating categories to their subcategories, called -axial- because coding occurs around the axis of a category, and links categories in terms of their properties and dimensions"* (p.134), its purpose is precisely to initiate the process of regrouping the data, relating categories and subcategories to achieve more precise explanations about the object of study.

Again, the properties and dimensions are retaken to establish such relationships, as already

mentioned, taking into account that *"a category represents a phenomenon, that is, a problem, an issue, an event or a happening that is defined as significant for the interviewees"* (Strauss and Corbin, 2016, p.136), seeking the identification and recognition of the nature of difficulties associated with learning in the area of mathematics, based on mathematical activity in the field of integers.

According to Hernandez, Fernandez and Baptista (2010), this type of coding is based on the analysis in the grouping of data, previously separated during open coding, a process in which *"a model of the phenomenon under study is constructed, which includes: the conditions in which it occurs or does not occur, the context in which it happens, the actions that describe it and its consequences"* (p.494), which in its own case, and as mentioned above, refers to the identification of the nature of difficulties associated with the learning of integers, for their subsequent categorization, being, therefore, a more analytical process compared to open coding, which requires greater abstraction.

As one of the purposes of axial coding is the establishment of relationships between categories from the data, Hernandez, Fernandez and Baptista (2010) conceive them as *"basic information themes identified in the data to understand the process or phenomenon to which they refer"* (p.495), such categories should then lead to understanding difficulties associated with learning mathematics from the identification of their nature. They also point out the usefulness of grounded theory, specifically in the understanding of educational processes, by identifying the concepts involved and the series of actions and interactions of those involved in the process.

Selective coding

For Hernandez, Fernandez and Baptista (2010), the main attribute of grounded theory is that *"data are categorized with open coding, then the researcher organizes the resulting categories into a model of interrelationships (axial coding), which represents the emerging theory and explains the process or phenomenon under study"* (p.496), to subsequently reach the integration and refinement of the theory (selective coding), as defined by Strauss and Corbin (2016).

In accordance with the above, the first step is to identify and generate the categories and properties that represent the nature of the difficulties associated with learning integers, to subsequently establish relationships between these categories and the subcategories that may emerge from them, and then to move on to the refinement and integration of the theory, as the purpose of grounded theory.

To arrive at the integration of theory, a process that requires time and does not happen overnight, as Strauss and Corbin (2016) state, requires interaction between the data and the analyst, which includes *"the evolution of thought that occurs over time through immersion in the data"* (p.158), referring to the researcher and his hard work. It is possible that at the beginning it is not so easy to identify and recognize the data, its categories and subcategories, but it is suggested then that the immersion in them and the relationships that can be established, favors the coding processes at different levels, in order to reach the integration of the theory. Reference is also made to the fact that the researcher, or analyst, *"reduces data from many cases to concepts and converts them into sets of relationship statements that can be used to explain, in a general sense, what is happening"* (p.159), so that, for the present study, it is necessary to have clarity about what may or may not be a difficulty in learning mathematics, and for this it will be necessary to contrast the data through various sources, and not limit oneself to only one, and from them generate those concepts or relationships that lead to the establishment of categories and allow continuing with the process.

To determine the data, it is thought to confront the students, the focus of the research, to the development of a physical guide, in relation to the mathematical knowledge previously selected and identified, integers, to later contrast the answers obtained by them in a semi-structured interview, in order to allow them to verbalize what they may feel, know or think in the solution of the first guide, with the intention of allowing them to go beyond the answers and understand what conditions, characteristics or processes are hidden behind them, in a deeper analysis of them.

To achieve such integration of the data into theory, the first step consists in the determination of the central category (Strauss and Corbin, 2016), which becomes the representation of the main theme of the research, which for the present study corresponds to the nature of associated difficulties in the learning of mathematics, specifically of integers. Among the techniques to facilitate both the identification of the central category and the integration of the data, Strauss and Corbin (2016) suggest some, such as telling the story, the use of diagrams and the review and classification of memos by hand or through specialized software, as would be the case of Atlas.ti.

Analysis based on grounded theory

The selection of grounded theory obeys the purpose of explaining a given phenomenon from the creation of theory, going through codification processes that lead to the generation of categories, which in their integration and establishment of relationships lead to the emergence of theory, a point at which the use of schemes is identified as necessary and relevant, considering that so far no

research has been found that delves into its study and understanding, and rather than demonstrating theory, the creation of it is sought.

The present study focuses on the analysis of processes, characteristics, behaviors, conditions, which are hidden in eighth grade students with possible difficulties in learning mathematics, specifically with integers, a situation that corresponds to the phenomenon of study, object of the research.

Field work

In qualitative research, and based on the goals set, interaction with the population under study is required, which in this case corresponds to students in the eighth grade of basic secondary education. Therefore, the field work is focused on the planning and execution of activities that enable the recognition and analysis of the nature of difficulties associated with learning, when they face the development of mathematical activities related to integers. Given the characteristics of the selected research method, some elements that guide this study are identified and detailed.

It is expected from the interaction in real classroom environments in the educational institution that is part of this study, or failing that, to perform a simulation of them, to participate in mathematics classes with eighth grade students, in which the mathematical activity is focused on verifying the learning of integers. In the first instance, it is intended to identify which students show possible difficulties in learning them, contrasting written answers with those that they can verbalize, with the detail and rigor that is deserved, because from there the data will be obtained and the corresponding coding process will begin, as described in this chapter.

Once these students are observed and identified, we proceed with the task of recognizing elements that are hidden behind the evidence of possible difficulties, insofar as it is possible to point out regularities, similarities and differences among them, a process corresponding to open coding, to subsequently establish and define the relationships among the selected elements that make possible the delimitation of categories, which group and represent the phenomenon under study, a task of axial coding, this in the exercise of recognizing the properties and characteristics that lead to the identification of relationships among them. At this point, it is important to take into account the answers offered by the students, not only in writing but also verbally, to the extent that they are given the possibility of verbalizing the processes they followed to arrive at them, in addition to their attitudes, gestures or silences.

Techniques for data collection

Based on the aforementioned elements, the use of two main instruments for data collection is contemplated. The first one corresponds to the design of a guide-workshop, which proposes to the students a series of exercises that promote the development of mathematical activity, from the knowledge of integers, as described in the Basic Standards of Competence in Mathematics (MEN, 2006). Taking into account the answers obtained by them, we proceed with the identification of those who show difficulties, based on the same answers, that is, those who have not answered correctly, a process that will be followed through the learning evidences described in the matrix designed for this purpose. With these students, a semi-structured interview is carried out, so that they can verbally explain what happened during their interaction with the guide.

Atlas.ti

Atlas.ti is a technological and technical tool created with the objective of supporting the organization, analysis and interpretation of information in qualitative research, allowing the work and organization of large amounts of information in a variety of digital formats, in addition to favoring comparison, thus optimizing research time and improving the use of information in data processing.

This software enables data segmentation into units of meaning, data coding and theory building (relating concepts and categories), as suggested by Hernandez, Fernandez & Baptista (2010), which for grounded theory correspond to the three coding processes (open, axial and selective). Atlas.ti provides various tools to perform tasks associated with systematic approaches to unstructured data, i.e. data that cannot be analyzed in a meaningful way using formal statistical approaches. It helps in the exploration of the complex phenomena hidden in your data, offering tools to manage, extract, compare, explore and reassemble meaningful pieces from large amounts of data in a creative, flexible but systematic way.

Varguillas (2006) shares, in the first instance, the following methodological recommendation for those conducting qualitative research: *"use of the Atlas.ti computer program as a tool to support the analysis process"* (p.75), since it can work with various sources of information, from texts, observations, audios, among others. In this way, it describes the program to the extent that the process involves four stages, which were already described in the section on grounded theory and coding processes, namely:

Image 2. Atlas.ti Stages. Own elaboration (Varguillas, 2006, p. 76).

San Martin (2014) considers this software as the main computer support for developing grounded theory, among other reasons, because it favors the identification of codes that require saturation, through its functions both for each code and category, oriented towards conceptualization, in which *"each step of theoretical coding (open, axial and selective coding) has a space in the program"* (p.114). The first of these, open coding, occurs with the assignment of codes to citations, in the possible formats, while axial coding arises with the creation of networks of conceptual relationships and, for the third, Atlas.ti has functions that allow a central category to be established, at which point the codes and categories established for this purpose are integrated.

In view of the above, given the contributions of the different authors cited and the characteristics of this study, taking into account that grounded theory employs various coding processes, the use of Atlas.ti is considered and assumed as a relevant support in the task of establishing relationships between data and categorizing difficulties associated with whole number learning according to their nature.

Analysis

For this research, analysis occupies a predominant place, in that it seeks to find and determine connections between possible difficulties associated with learning integers, especially their origins or causes, assumed in this case as their nature, thus becoming a continuous process that spans from beginning to end and that seeks to fulfill the objectives set, answer the question formulated and at the same time validate the results obtained.

Identifying possible difficulties related to the learning of the integer in eighth grade students, in an everyday environment for them, becomes the first step to establish relationships between them and their potential causes. In this case, it should be noted that although the learning process may differ from one person to another, so it is not possible to generalize or establish rules, what is sought is to identify and establish regularities that facilitate its recognition in the classroom, a situation

that aims to provide a greater possibility of attention by the teacher, considering the feasibility of retaking the results obtained for the development of future research. During the description and analysis process, some images taken from the answers provided by the participants will be presented in order to show the analysis process carried out on the basis of the data.

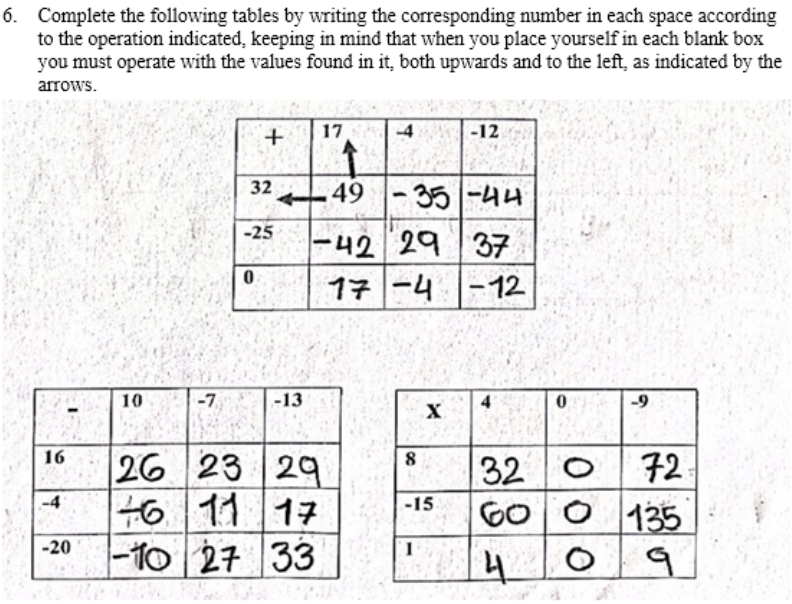
Data collection

The collection of data for the development of this study, as previously stated, took place in the educational institution of which the students are part, a natural and everyday environment for them as proposed by Hernandez, Fernandez & Baptista (2010). Initially, after dialogue and agreement with the participants, we proceeded with the application of the first instrument (workshop guide), from which we obtained some evidence of learning about the mathematical knowledge of the integer, according to the matrix designed for this purpose, but also, in the absence of such evidence, we identified possible difficulties associated with learning it, thus selecting a sample according to the characteristics of the responses and, based on the purpose of this research, we proceeded with the process of coding and analysis.

For this research, the data correspond initially to the answers that give indications of possible difficulties and that were obtained after the application of the first instrument from the development of mathematical activity around the integer. Subsequently, the answers to the questions posed in the semi-structured interview are added to the body of data, which will be processed through Atlas.ti in the different coding processes.

Written responses provided by the participants

Based on the workshop guide responses provided by the students, there are indications leading to the possible presence of difficulties associated with learning the whole number, as shown below:


6. Complete the following tables by writing the corresponding number in each space according to the operation indicated, keeping in mind that when you place yourself in each blank box you must operate with the values found in it, both upwards and to the left, as indicated by the arrows.

+	17	-4	-12
32	49	-35	-44
-25	-42	29	37
0	17	-4	-12

-	10	-7	-13
16	26	23	29
-4	-6	11	17
-20	-10	27	33

x	4	0	-9
8	32	0	72
-15	60	0	135
1	4	0	9

Image 3. Answers instrument 1

In this case, as indicated in the statement, the mathematical activity consisted of completing each of the spaces taking into account the operation present (addition, subtraction or multiplication) but also taking into account the concept of integers and the implications of the signs (plus, minus). Given that the CBEs in mathematics addressed correspond to the 6th and 7th grade cycle, it would be expected that they would be able to answer correctly, thus showing evidence of learning; however, it is possible to observe, for example, in the first box corresponding to the addition operation, that:

$$32+(-12)=-44$$
$$-25+17=-42$$
$$-25+(-4)=29$$
$$-25+(-12)=37$$

The previous answers are incorrect because it can be observed that, regardless of the signs, in all cases he performs addition operations, as well as it can be intuited that he does not know the meaning of the minus symbol and the multiplicative properties of the signs. However, given the

conditions and characteristics of this study, it will be necessary to go a little beyond them through the dialogue that can be generated by means of the semi-structured interview, thus seeking to identify the reason for these answers, understood as their nature within the research under development. Now, referring again to the answers and retaking the matrix elaborated for its analysis, it is possible to point out difficulties in the following evidence of learning, being feasible to determine it by recognizing its absence:

- Solves problems involving positive and negative quantities.
- Proposes and justifies different strategies to solve problems with integers.
- Interprets and justifies numerical calculations when solving problems.
- Proposes and uses different procedures to perform operations with integers.
- Describes situations in which integers and their operations are present.
- Uses the signs *"positive"* and *"negative"* to describe relative quantities with integers.
- Describes procedures for calculating the value of an operation (addition, subtraction, multiplication, and division) between integers.

Similarly happens with subtraction and multiplication between integers, given that as in addition, it is observed that the answers do not coincide with the indicated operation, a situation that opens the way to think about possible difficulties related to the learning of the whole number. In the case of division between integers, again difficulties are observed in the treatment of the signs, even when the instrument provided information regarding the four basic operations, addressed in the workshop guide and which it was expected that they could use to facilitate the development of the same.

Going beyond written answers

Once the instrument 1 was implemented and after reviewing and selecting those answers that showed signs of difficulties associated with learning the whole number, we proceeded in the same way with the invitation to each of the participants chosen to carry out the dialogue process, guided by the semi-structured interview proposal and also with the due authorization of their parents since, being minors, such permission is necessary to be able to make the recordings and also to process their information. Thus, the space selected for this purpose continues to be the school, as a natural and everyday environment for them, according to Hernandez, Fernandez & Baptista (2010).

Given its purpose, the meeting is carried out with each of the previously selected participants, trying not to intimidate them or generate inconveniences in them with the proposed dynamics, but rather trying to do it in the best possible way in an environment in which they feel comfortable and can express without fear what they wish, in accordance with the questions posed and those that arise in the middle of the conversation. In this sense, it is made clear that there will be no right or wrong answers, the exercise consists precisely in having the possibility, from their initial answers in the previous instrument, to go a little further to know the reason for them, so that they can expose and verbalize it with total confidence. In this process, it is possible to appreciate that, in general, the whole number is associated with losses and gains, but there is no evidence of clarity regarding the appropriation of the mathematical concept addressed.

The answers are considered as manifestations of doubts in what they verbalize and also with the silences that are present at times, facts that are interpreted as expressions of difficulties in the comprehension and clarity of the concept of integer, and as such influences the realization of mathematical activity that involves it. Initially, the participants assume that they are doing well in mathematics, as expressed by themselves; during the planned dialogue, they recognize the presence of both external and internal agents in their learning processes in the specific case of the whole number, among them the lack of attention and the role played by the teacher.

The dialogues made it possible to identify the importance of Claxton's (2001) statement regarding internal and external resources as an important part of the faculty of learning, a situation that can be corroborated in the answers given by them. Thus, it is possible to think about which resources affect the process of learning integers, which in this case identify aspects such as time, attention, relationship with teachers, willingness to work, among others, elements that are taken to define the properties and dimensions that can constitute them in categories. In this way and with the help of Atlas.ti, the open coding process is approached, focusing attention on the different manifestations of the difficulties in the explanations given by the participants.

In this order of ideas and in the task of identifying what is hidden behind the possible difficulties in learning the integer seen in the arguments received, it is also recognized the difficulty generated by the use of integers in the development of basic operations among the participants, which alludes to the nature of the same and also reaffirms the findings recorded in the written responses, extracted from the first instrument. It stands out during the analysis process, as mentioned, the conflict generated by the use of plus and minus signs in the development of such operations, explicitly

mentioned by them when, for example, instead of adding they subtract or, on the contrary, alluding that in some cases it may be due to not taking into account such signs and that, as indicated, is demonstrated in the indicated answers and the analysis carried out in the previous section.

In relation to the mathematics classes, in general they are pleased with them, including both the methodologies and the teachers who have been in charge of them; however, they are aware and also recognize the inconveniences generated by the lack of attention to the explanations and the development of the assigned activities. In the specific case of the integer, when comparing a negative integer with zero, they agree that the latter is smaller due to previous explanations by the teacher, as they can state; in some cases there is clarity about what should be done, but they do not manage to do it, thus showing confusion when performing mathematical activities involving integers.

Data analysis, coding processes

Once the data are understood as the answers that show difficulties in learning the whole number, we proceed with the entry of the interviews, their source, to the Atlas. ti software, at first as audio files and then the transcription of the same, since in text format it is easier to assign codes to the selected quotes, in order to start the coding process with the fragmentation of the same according to their properties and dimensions.

Causes associated with difficulties in learning the integer, discovering properties in the data

As a first coding process, in accordance with grounded theory (Strauss & Corbin, 2016), we start with the task of identifying similarities to the data under treatment, so that it is possible to assign codes to the selected quotations. In this way, some of these properties are recognized from the theoretical supports while others emerge from the data themselves, i.e., from the answers given. The following is a summary of the work carried out with the mediation of Atlas.ti; the image below shows the data (participants' responses) in the central column while the properties (codes) assigned to each quote are identified to the right:

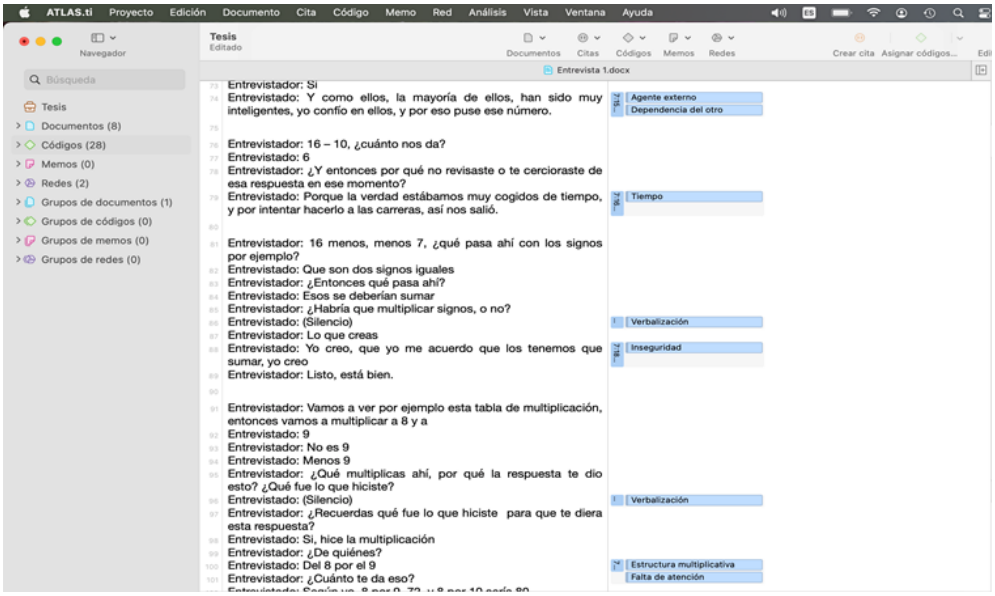


Image 4. Atlas.ti environment, coding processes.

This review is carried out with each of the sources (interviews) while the software compiles the codes that are assigned. It is possible to identify that the lack of attention and understanding arise in the data when trying to explain the reasons for the answers given, to the extent that lack of attention is recognized as one of the possible causes associated with learning the whole number, which, in turn, generates incomprehension. In this order of ideas, the time factor also appears to play an unfavorable role when it comes to mathematical activity, as well as other codes that will be detailed in what follows and that can be related to the resources necessary for learning (Claxton, 2001).

In a first exercise of identifying regularities among the data, during open coding, the following codes are obtained:

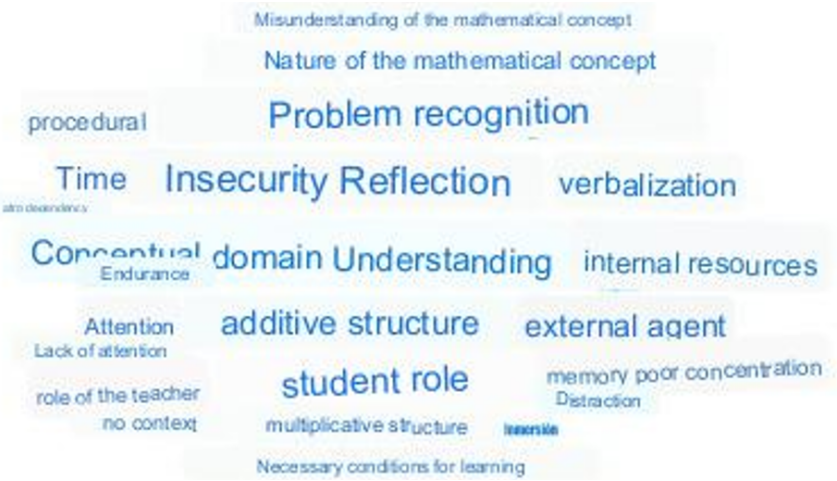


Image 5. Code cloud, open coding.

Through the Atlas.ti software, in support of these coding processes, the previous code cloud is consolidated in which properties related to them and in correspondence to conditions necessary for learning can be glimpsed. In this sense, comprehension stands out among the others because it is located in the center and also because of its size, which means that it is the code that was assigned the greatest number of times during the process and that can be verified by means of a bar diagram, provided by the same program:

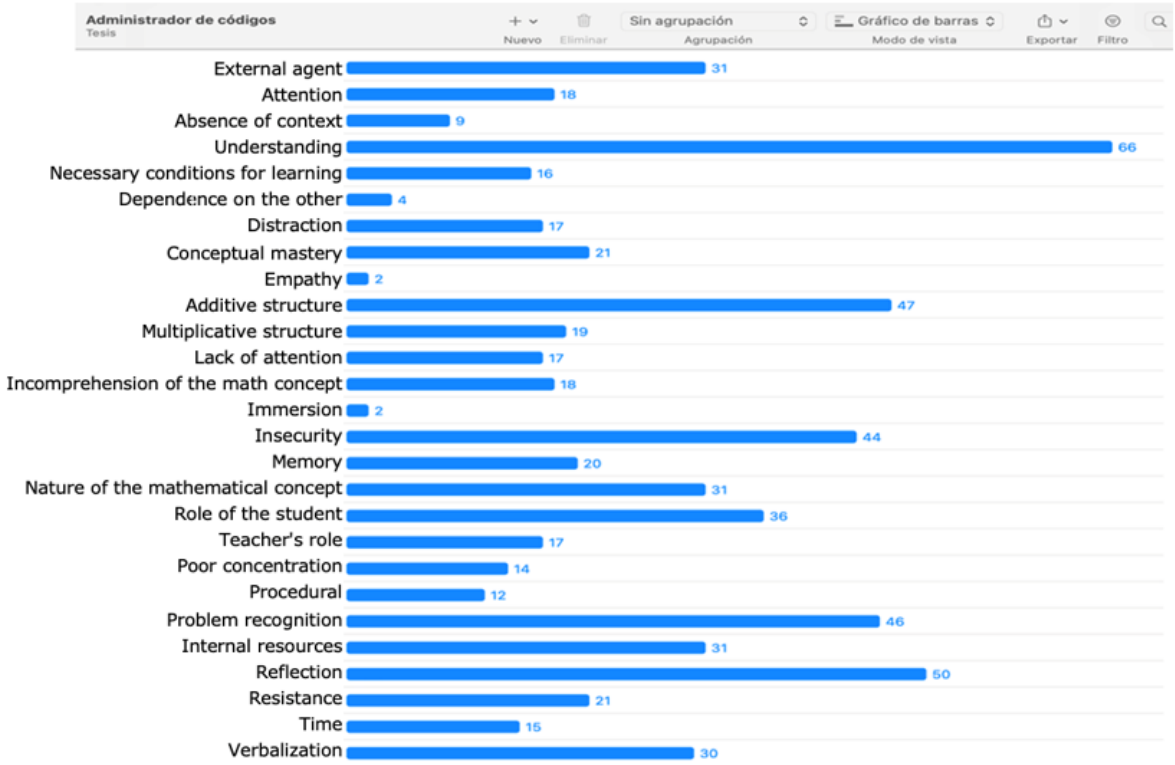


Image 6. Bar chart provided by Atlas.ti

It is possible to appreciate, from the previous diagram, that the term comprehension tops the list, followed by reflection, additive structure, problem recognition, insecurity, role of the student and external agent, nature of the mathematical concept and internal resources with an equal frequency, among those that follow. As open coding points out, these terms are defined taking into account codes created from the properties and regularities of the data; in this study they were assigned based on the characteristics associated with the phenomenon, and the way in which some of them were assigned is explained below.

Understanding is initially defined as a category since it is regularly identified in the data in different ways, for example: when trying to explain why there are difficulties in learning the whole number; when identifying the lack of understanding of what must be done (statements, instructions, indications, ...) as the understanding of the mathematical concept itself, otherwise referred to as procedural knowledge and conceptual knowledge. On the other hand, variations are identified in this category, which leads to pay attention to levels of understanding, since it is possible to be clear about what to do or how to do it, but not have the conceptual domain to achieve it or vice versa, this is interpreted within the grounded theory as dimensions. This category arises, as indicated, when identifying that they associate the whole number with losses and gains, without the possibility of evidencing greater appropriation of the mathematical concept, in addition to manifesting doubts in what they say and the presence of silences at times.

Thus, a subcategory associated with comprehension is recognized, corresponding to the ability to verbalize, since it is a way to let others understand how much has been understood or, on the contrary, to show that what was required was not understood, and which is also related to the level of security or insecurity that is demonstrated, being assumed as another subcategory in relation, aspects that will be verified in the following coding.

Similarly, another category emerges in the data referring to the use of time, which can be evidenced in different moments and answers expressed by the participants, it is recognized as a regularity that can affect the learning of the whole number. In addition to the above, these are arguments presented to justify their results in the development of the first instrument.

In this way, time management is an initial category identified during this coding process and as such, it presents dimensions related to its duration, that is to say, to its frequency, and its use can be less or greater, both at the time of performing mathematical activities and attending to explanations, which is why it is possible to relate it to other subcategories such as lack of attention, internal resources or poor concentration, also extracted from the data in the process of coding and analysis within the axial coding. In this sense, the recognition of notorious distraction, poor concentration in the face of explanations or development of assigned activities are related as subcategories for time management.

Another regularity identified in the data is that which is defined as recognition of the problem, insofar as responses are identified that directly evidence that participants recognize problems in

addressing the topic of integers, which may be aware that something is being done wrong, as well as that mistakes are being made or assume what is posed as difficult, even recognizing that the development of mathematical activity involving the integer involves difficulty and in some cases the mathematical concept itself, these aspects can be variations that lead to be pointed out as dimensions insofar as the need to solve such problem is identified, since it can vary among individuals, some will be interested in doing it while others will not, or at least not with the intensity and disposition or motivation required, also the attitude that can be assumed after such recognition is pointed out, which leads to act in various circumstances that depend on it, aspects that will be taken up again in the axial coding to refine the scope of this category.

Another common characteristic is recognized when referring to the concept of integer, starting from the presence of plus and minus signs and the interpretation given to them, becoming a regularity within the data. This is how the category use of signs is named, which properly implies the properties of two structures: additive and multiplicative, which generate confusions in the development of operations that involve them, for example, when signs are multiplied in cases that do not apply, addition is made when it was necessary to subtract or vice versa, in correspondence with their dimensions. This category is considered as significant since it was observed at different times during the development of the guide and in several participants. It is named use of signs, given that it identifies conflict generated by the use of plus and minus signs in the development of basic operations (addition, subtraction, multiplication, division), as demonstrated by some of the participants' answers.

Overall, during this open coding process, the following categories can be identified in relation to the nature of difficulties associated with learning whole number with eighth grade students: comprehension, time management, problem recognition and use of signs, names that are assigned taking into account the properties and dimensions of the concepts studied.

The above becomes a first approach to the process of codification and determination of causes associated with the defined object of study, which are expected to be specified and defined through the following codification processes.

CONCLUSIONS

Based on the data treatment proposed by the grounded theory (Strauss and Corbin, 2016), instruments have been designed to allow the interaction of participants in situations involving knowledge and processes associated with the whole number, in order to identify and analyze the

nature of possible learning difficulties associated with this knowledge.

It is important to note that the implementation of semi-structured interviews was necessary to broaden the view of other data that would allow the identification of possible difficulties in learning it, possibly from the cognitive and learning resources enunciated by Claxton (2001), based on the initial answers provided by the participants, which are retained as data for analysis and treatment. The coding of the data allowed the recognition of different categories, for example:

Use of signs (additive and multiplicative structure): conflict is identified that generates the use of plus and minus signs in the development of basic operations (addition, subtraction, multiplication, division) when, for example, instead of adding it is subtracted or vice versa; present in cases such as: *"Because of the bad thing, I have gone a little bit like that with integers, that when adding them, that when subtracting them and knowing which is the smaller and which is the bigger, that is the difficulty I have"; "It is that I stumble a lot with that, we all stumble with the signs"; "Because we forget and we stumble. Sometimes there are so many, so many signs that one says, then this one of which one is and this one of which one is, if you understand me, then there are difficulties in that."*

Incomprehension of the concept: association of the whole number with losses and gains, without the possibility of evidencing greater appropriation of the mathematical concept. Manifestation of doubts in verbalization and presence of silences at times; it is recognized in cases such as: *"No, I do not know what to say"; "Well... I would say that, for many things, but those many things I would not know how to say"; "Let's see, as we are already with something else, then let's see I remember because... I mean, whole number is not that more or less, something like that, then sometimes it also depends on the weather, the hours that one, I mean driving in the car, I do not know what else, kilos of coffee, that my families use that in kilos of coffee or something like that."*

Other categories that are part of the study are enunciated below, whose development is found within the thesis: Lack of attention; Pressure (time); Resistance; Memory; Teacher's role.

In this order of ideas, it is concluded the existence of multiple conditions that affect the presence of a possible learning difficulty with respect to the whole number, conditions that are generally not perceived by teachers and even by the students themselves. It is necessary to act upon the identification of such difficulties, a fact that will depend on the reason or reasons that generate them, since they could be defined, in general terms, as internal or external conditions of the learner

and that simultaneously attend to the teaching and learning processes.

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