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Class journals as an expression of learning and interaction for Especially Inclusive Mathematical Education - EMEI[1]

Angélica María Martínez de López
angelicademupeltd@gmail.com
0000-0003-1588-3777
Universidad Pedagógica Experimental Libertador, Núcleo Maracay, Estado Aragua, Venezuela.

Fredy Enrique Gonzalez
fredy.gonzalez@ufop.edu.br
0000-0002-8079-3826
Universidade Federal de Ouro Preto, Ouro Preto, Minas Gerais, Brasil. Departamento de Educação Matemática-DEEDMA. Programa de Pós-graduação em Educação Matemática-PPGEdMa.

ABSTRACT

There are concerns about teacher training due to the commitment to develop Mathematical Education according to the characteristics of those who are part of Special Education, so, this manuscript details experiences and activities carried out with future teachers of the Special Education Program of the Pedagogical Institute of Maracay, Venezuela, in a subject of Mathematics, reflected in their personal class journals, which served as a point of reflection to establish descriptors associated with the competences of their teacher training and linked to the initial conception of a Specially Inclusive Mathematical Education (EMEI). From the interpretative analysis, the most outstanding findings were the curricular characterization, didactic and specific needs of each specialty of the Program, which provided the organizational pattern of the Mathematics subject; and at the same time, the distinction of ten descriptors which, in turn, contribute to the formation of the EMEI.

KEYWORD: Class journals. Mathematical education. Special education. Inclusive education. Teacher training.

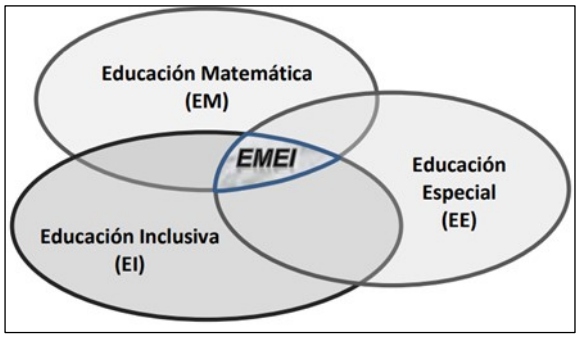
1 INTRODUCTION

The system constituted by Mathematical Education (EM), Special Education (EE) and Inclusive Education (EI) has become an issue that, increasingly, calls the attention of educational researchers in general and mathematical educators, particularly around the world. Thus, it can be appreciated in the set of works, related to the concepts, principles, evaluation procedures, and areas to be covered in this subject, included in the compendium on special educational needs, inclusion and diversity produced by Frederickson and Cline (2015). It is also important to refer to the work of Dovigo (2017) who offers us an overview of the inclusion practices developed in the educational systems of six important countries: Germany, United States, England, Italy, Norway, and Sweden. In the case of mathematical educators, we should highlight the studies on special needs in Lindenskov Mathematical Education (2016), as well as the situation that, at the international level, shows special high schools serving mathematically talented students, exhibited by Vogeli (2015).

The work of Martínez (2018) is particularly relevant for the Ibero-American region. This researcher, examining the relationships between Mathematics Education (ME), Special Education (EE), and Inclusive Education (EI), describes a conceptual approach with the notion of Specially Inclusive Mathematics Education (EMEI; Figure 1) (MARTÍNEZ; GONZÁLEZ, 2017a, 2017b) conceived as:

> […] a disciplinary field of synergistic convergence between Mathematical Education (MS), Special Education (EE) and Inclusive Education (EI) in whose context the teaching and learning processes of Mathematics have to be managed by a teacher with specific training, that includes general issues of Inclusive Education and Special Education, as well as those related to the knowledge of mathematics (MARTÍNEZ; GONZÁLEZ, 2017a, p. 330-331)

Figur1 1 - EMEI: Synergistic convergence space between EI, EE and EM



Font: Martínez y González (2017a).

The initial EMEI proposal corresponds to an international movement that aims to change segregating educational trends; evidence of this movement has been recorded in important documents such as the Warnock Report (1978)the World Declaration on Education for All (UNESCO, 1990), the Salamanca Declaration (UNESCO, 1994), the Incheon Declaration, and the Framework for Action for the Implementation of Sustainable Development, specifically as regards target 4 of the "Education 2030" program (UNESCO, 2016).

In accordance with the purposes set out in several of these documents, one of the topics of greatest interest to the EMEI is that related to the formation of teachers who must teach Mathematics in the context of Special Education as well

as Inclusive Education; that is, in school settings where inclusion processes are favored. Reflections have already been made on this training; for example, in 2013, the United Nations Children's Fund (UNICEF) acknowledged that:

> […] teachers often lack the skills and support to instruct children with disabilities in mainstream schools [...] Teacher training has proven useful in promoting commitment to inclusion (UNICEF, 2013, p. 32).

Other authors who have highlighted the relevance of teacher training and collaborative work in the framework of Special Education are López and Valenzuela (2015, p. 48) who state: "it is important to establish working groups among teachers within the school to learn about inclusive education and reflect on how to put these learnings into practice". The experience of these two authors is inspiring the search for a synergy between Special Education, Mathematical Education and Inclusive Education; as the work in the classroom of US specialists in conjunction with teachers who teach mathematics, is a factor of balance between the teaching of the notions of this knowledge area, adapting them in the curriculum and seeking to approach the universal design through which school inclusion is aspired.

As part of that research, we examined the work of Mojica and Aké (2015, p. 7) who reviewed two undergraduate programs for US teachers in Mexico, warning that "no one places an interest in future special education teachers delving into elementary mathematical concepts for special education". The authors draw attention to the fact that, at least in the Aztec country, the training of future teachers of Mathematics Special Education is not adequate, which has an undesired impact on the development of mathematical thinking of those who would eventually be their students; and that would hinder inclusion.

Prior to the two authors cited above, Guajardo (2010, p. 106) indicated that "the initial training programs for Special Education teachers in Latin America have not changed in the same proportion as the radicalism that the education model requires" an issue which I also considered to be surmountable, provided that the vocational training of future teachers took a heterogeneous view, to inclusion since it is of an eminently social nature and is achievable when education takes into account the environment and develops in an environment of cooperation and multidisciplinary work.

Guajardo (2010) also states that the transition between EE and EI is a complex process in which the EE is often seen as segregating; however, in some countries, in teacher training for EE, adjustments have been made to its conception, mission, and strategic ways to serve both Students with Special Educational Needs and Persons with Disabilities (hereinafter referred to as ENEE and PcD respectively).

In Venezuela, the terms ENEE and PcD are used in the legal guidelines and educational regulations, given the biopsychosocial character of each individual considered,

> based on an educational approach to the person's development, based on their potential and conditions that make them different, making greater emphasis on the educational response they require in their teaching and learning process from an early age and throughout life (VENEZUELA, 2017, p. 43).

In this South American country, the EE is considered an educational modality, being assumed as an "area of general education that, through specialized methods and resources, provides differentiated and individualized education to subjects with special needs" (VENEZUELA, 2017, p. 34); it is because of this that careers have been created in some university institutions to train professionals in the U.S. One such institution is the Universidad Pedagógica Experimental Libertador (UPEL).

UPEL offers training and professionalization of teachers in various specialties to attend the different levels and modalities of the Venezuelan education system; the Pedagogical Institute of Maracay, the nucleus of this university, in 2005, created the EE Program with specific mentions in: Learning Difficulty (DA), Hearing Impairments (DAu), and Mental Retardation (RM); these mentions, after the reform in the curriculum design of 2015, were named respectively: Special Education for Persons with Disabilities, Special Education for the Deaf, and Special Education for Persons with Intellectual and Developmental Disabilities.

The EE Curriculum at UPEL, includes the subject of Mathematics, still in force while moving fully to the curriculum design 2015, and this is where the interaction of future EE teachers with a specialist teacher in Mathematics develops, which allows to raise and answer doubts about knowledge and didactic concerns in this discipline.

As part of their duties (teaching, research, extension) as a teacher at UPEL, the author of the study reported they have had the opportunity to experience directly this process of interaction between students of the EE program and the subject of mathematics; so, based on their personal experience they formulated various questions related to the initial training of Special Education students at UPEL, and with the knowledge that is necessary to teach mathematical contents to ENEE and in particular to PcD; these questions were generated from the concerns raised by the students of this program, related to the subject of Mathematics: (a) deficiencies in the didactic aspects (how to teach it); (b) limitations to their study (how to study it to understand it); and (c) difficulties to visualize its application (how to connect it with the everyday).

Motivated by these concerns and with the intention of deepening the topic, the author conducted a study with students of the Special Education Program of the Pedagogical Institute of Maracay, enrolled in a mathematics course, administered by them, and those who asked them to write personal notes about their personal experiences during the course; this article details the experiences and activities carried out by these students; then, having their personal written records as basic information, they conducted reflection processes, with the purpose of establishing descriptors associated with the competencies to be developed by future teachers of EE to teach Mathematics to ENEE and PcD; one of the study's achievement was the elaboration of an initial concept of Special and Inclusive Mathematical Education (EMEI).

2 METHOD

2.1 Nature of the investigation

The research carried out was qualitative in nature, with a phenomenological approach, and interpretative-reflective nature, trying to "see things from the point of view of the people involved" (TAYLOR; BOGDAN, 1987, p. 23). In this case, they were students attached to the Special Education program of the Pedagogical Institute of Maracay, students of the Mathematics subject, who, through their own words, reconstructed and reflected on the situations that occurred in class.

The participating students expressed their experiences from their subjectivity, manifested in "psychic (reactions, emotions), spiritual (sentences, reflections), and corporal actions (sensations and perceptions)" (VENTURIN; SILVA, 2014, p. 242).

2.2 Design of the research

As for its design, it was a direct case study examined in a real classroom, where educational actions and processes were implemented, related to learning, teaching, and teaching groups of future teachers to teach mathematics, considered in their specificity for their formation in EE, observed individually with care to know in depth their perceptions towards mathematics (SÁNCHEZ, 2001).

2.3 Techniques used

The techniques to obtain information were conceived, according to González and Villegas (2009), as the instances of interaction between the participants who provide the information and the researchers; in this study the predominant technique was the participant observation (TAYLOR; BOGDAN, 1987) executed by the researcher themselves who simultaneously acted as a teacher of the course.

2.4 Instruments applied

The instruments for recording information were: (a) Notepad and (b) Class Journals.

a) *Notepad,* used by the teacher-researcher as a means of recording their experiences and impressions about the various events that took place in the classroom.

b) *Class journals,* where students recorded narrative writings which content referred to their life, expectations, and learning of mathematics. The intention of these journals was to have a source of information that could complement and be contrasted with the class notes prepared by the teacher. The students were guided to take the Journal seriously and sincerely and to feel free to express their feelings. As a guideline to create them, they were instructed to take into account that the Time of the Class is developed in cycles, constituted by three moments: beginning, development, and closure,

and that in each of these they made reference, mainly to those aspects that would have been particularly significant, taking into account the didactic contribution, the novelty of the subject, or the usefulness for their future professional practice.

2.5 Constitution of the study corpus

To constitute the *Study* Corpus, 83 Class journals were collected; Table 1 shows the identification data of these Class journals: Semester (Sem.: academic period when the course was taught); Start and Close (date of beginning and end of the course); Section number, Student Specialty (EE mention) and Turn during which the course was developed (Sec./Esp./Tur.); Number of journals collected (Am./ Days.); Days of the week during which the course was developed; Dates of the first and last entries in the journal; Total record of the number of days transcribed by students (Reg. Total No. Days). The journals of the 2014-II and 2015-I semesters were first delivered in physical format and those of 2015-II in digital format.

Table 1 – Systematization of the Mathematics course for EE taking the record of the Class Journals

Sem.	Beginning Closing	Sec. Esp. Tur.	Am. / Days.	School Days	Starting /Closing Class Journals	Reg. Total Num. Days
2004-II	16/10/2014 12/12/2014	14 DA Morning	27	rMi-J	19/11-11/12 2014 al 11/02/2015	17
	12/01/2015 26/02/2015	491 DAu Tarde	5	Ma-J	18/11-9/12 2014 al 13/01-19/02/2015	17
2015-I	23/03 al 24/07/2015	311 RM Morning	20	Ma-Mi	24/03 al 08/07/2015	28
		361 RM Tarde	1	L-Mi	08/04 al 20/07/2015	17
2015-II	11/01 al 13/05 2016	141 DA Morning	18	Mi-J	20/03 al 11/05/2015	23
		441 DAu Morning	4	Ma-Mi	19/01 al 13/04/2015	17
		191 DA Afternoon	8	Ma-Mi	19/01 al 10/05/2015	21

Legend: DA: Learning Difficulty; DAu: Hearing Impairments; MR: Mental Retardation

Font: Martínez (2018).

2.6 Selection and systematization of class journals

To define the direction that the narrations written by the students would take when recorded in their journals, we selected those belonging to the groups of the 2014-II academic period. From this analytical review, we decided to make adjustments in the characteristics that they should have; this was how it happened for the 2015-I semester: (a) they were required to use a different notebook than they would have for class notes, (b) descriptive guidelines were established, arguments and style to follow the sequence of the moments of the class (start, development, and closing) as a journal, (c) they were reiterated that they felt free to, with their own discretion and according to their perceptions, make relevant comments on the activities performed in the class.

The previous guidelines were maintained during the 2015-II semester; however, during this period the presentation of the journals became digital, which favored transcription and allowed us to obtain an overall vision regarding the course curriculum design.

In the last two periods, the afternoon groups, for distinct reasons, did not complete classes with the same regularity as those of the morning groups, being necessary to change the established activities. Given this situation and others that occurred with the initial groups, we observed marked differences in the individual records by class and even more when comparing them in a group. For this reason, the following criteria were established for the selection of the journals that would become the CORPUS of the study:

a) Representativeness: they give samples of each of the distinct groups of specialties (or mentions) within the US, in RM, Dau, and DA.

b) Homogeneity: they maintained the internal structure, the way of conducting the sequence and presentation of the discourse, without altering or changing the guidelines established for the group during its academic period.

c) Temporality: for the registration of classes from the beginning to the end of the course, notes were observed from the first day until the end of the academic period; as well, for being part of the same day or group.

d) Regularity: characteristic given for the course with the least loss of classes, despite external transport and safety situations.

e) Quantification of records: in consideration of the greater number of classes described according to those completed; this implied, giving priority to counting groups with the highest number of days recorded per class seen.

f) Comparability: possibility to make inference of each day-class when having groups where we had information of several of its members; that is, where the amount of daily delivered was greater than one.

g) Complementarity: given in effect by the relation to the number of registered classes, it is valuable to take all the journals by specific group in that one referred to an event that another had not mentioned.

h) Scriptural modality: journals presented in physical and digital format are chosen as part of the internal course evaluation, with the purpose of appreciating the didactic, affective, and conceptual aspects of the classes, but at the same time the option to value the positive aspects when there is the change between what is written on paper and what is written digitally.

i) Curricular design structure: having a group of journals made from the curriculum plan prepared for the course, such as those where the scheme was changed to teach unit one as unit three. This complied with the strategy to compare the structure of the curriculum design of the subject.

As established, forty-two (42) journals met such criteria, twenty (20) corresponding to Sections 311 of RM from period 2015-I, four (4) of Section 141 of AD from period 2015-II, and eighteen (18) of Section 441 of DA from period 2015-II, all of them on the morning shift.

2.7 The analytical procedure

The analysis of the journals was done in two moments. For Moment 1, we established the following guidelines:

a) Identification of all journals delivered via internet; first, they were collected on the computer inside a folder called "math course 2015-2016", then internally placed sub-folders by individual sections for each journal, identified with acronyms whose format XY correspond to the initial of the name (X) and the surname (Y) of the student who wrote the journal. This allowed to preserve the students' identity and avoid a prejudiced reading of their comments; moreover, this generated a procedure of registration and systematic search of the information.

b) General reading to all journals to establish timeline, start, and end of each course; and establish the maximum number of days that were recorded (See Table 1, supra)

c) In-depth reading of the selected journals, which allowed the re-construction of each of the classes, identifying the specific events that took place at each of the moments, and episodes that were significant to the authors of each journal.

d) Categorization of the information. For this purpose, we selected certain expressions recorded by the students in their journals, which referred to questions of interest to the research; the categories were created considering both the theoretical models on which the study was based and other aspects that emerged as a result of the in-depth reading of each journal.

Then, Moment 2 took place, which was divided into three phases:

First: Analytical Approach. Organization of journals and the determination of the nine selection criteria indicated in the systematization.

Second: Analytical Deepening. This was divided into two stages, following the process proposed by González (1997).

a) Definition of the Timeline: "Timeline where the activities carried out during fieldwork are presented, sequenced chronologically; shows, in summary, the series of actions starring the actors (teachers and students)" (GONZÁLEZ, 1997, p. 85). A record format was created per course, taking a daily synthesis of what happened when identifying changes or jumps in the sequence of each class, classified and numbered into episodes.

b) In the second stage, Class Schemes were described, reflected in a table identified with their respective section, academic period, specialty, shift, date, and time. This table detailed the start-development-closure, including the corresponding episodes, supported by the comments, interventions, and discourses of the students, along with the inferences and interpretations of the author in their role as teacher-researcher.

Third: Analytical Interpretation. Deductions under deep reflection, built on the basis of relationships and inferences during the Analytical Deepening. This was carried out in three stages.

a) Identification of similarities and emerging differences in both content and didactics, comparing annotations with the programmatic design of the subject Mathematics in the USA.

b) Determination of Didactic Descriptors. Based on the theoretical references of the study, the relevant expressions written by the students in their journals were highlighted; These expressions corresponded to keywords that together had a common characterization and became the basis for the descriptors.

c) Construction of a matrix representation where the following elements were synthesized: i) Category names; ii) Didactic descriptors of each category; iii) Keywords.

2.7.1 Example of the analysis

The analysis of the information was intense and exhaustive; for this article we selected only the case of section 441 for the students of the mention Hearing Impairments (DAu).

In the Analytical Approach phase, the starting point was to consider this group that, although it is from the academic period 2015-II, was incorporated into classes between the months of January and May 2016, due to multiple university stoppages and social conflicts that affected the continuity of the semester; but it met the criteria described for its selection.

In this sense, its Representativeness is evidenced, for being part of one of the specialties of EE; the Homogeneity, for maintaining the guidelines in the elaboration and sequence of the class journal; the Temporality, because the participants of this group were from the same academic period and from the morning shift; the Regularity, because the complete record of classes was

presented despite the external circumstances of unemployment or other possible reasons for not giving the class; in the Quantification of records, a number of registered classes was confirmed according to those actually taught in that period.; for Comparability, because there was more than one journal; for Complementarity, because in some cases class records were obtained that did not appear in other journals; of Scriptural Modality, all follow affective sequences of events in class, of contents, and of didactic order in reflexive form, with the fact of delivering the journals by e-mail; and of Structure of curricular design, because in this group the order of units as designed in the subject program was implemented.

This group was initially made up of nine students; but in the end it was made up of only four of them, all of them female, who passed the course and complied with the delivery of their journals; a maximum of 18 classes were recorded between Tuesdays and Wednesdays when two and three hours of activity were observed; on the other hand, some days outside the classroom were also recorded in relation to what they did on days of unemployment or vacation. Finally, the journals were coded under the initials of their authors, thus reserving their identity; for the case, the members were named with the acronyms CS, GU, QA, and YS.

Continuing, the second phase of analysis of Analytical Deepening, going through the two stages in which it is subdivide. First, we obtained the course timeline, where the essential episodes of the activities developed in class were distinguished and specified, allowing to see the general pattern of the course day by day, the connection of the classes with the curriculum plan designed for this specialty and the moments of conceptual order, didactic and interaction developed by the group (See Table 2).

Table 2 - Timeline – Section 441 - 2015 II – DAu – TM – Ma y Mi

Class / Day	Description of actions
1 / 20-01-2016 Mi	Greetings Teacher presentation Course description and evaluation plan Students' experiences and expectations
2 / 26-01-2016 Ma	Greetings Reflection on deaf students at university Change of room for fumigation Assistance step Explanation of the evaluation strategies Allocation of theme and supporting material for the working table The investigation is left on the agreed topic
27-01-2016 Mi	There is no class due to the professor's protocol activity, at the graduation ceremony of his MS Master's tutors
3/ 02-02-2016 Ma	Start of class in another classroom with small delay Allocation of items to those missing Math concept The anecdote about the life of Gauss Crisis within Mathematics and its philosophical aspects The worktable is explained again. Students' reflections
4/ 03-02-2016 Mi	Greetings and review of material for the exhibition. Description of Mathematical Education and its international development.

	Aspects of Mathematical Education in Venezuela. Reflections on the importance of MS in EE
9 y 10 - 02-2016 Ma y Mi	Holidays for the carnival season
5 / 16-02-2016 Ma	Greetings, attendance, and group organization Exhibitions of the working tables Assignment for the following class: Describe what Arithmetic consists of and investigate the life and work of Pythagoras
6 / 17-02-2016 Mi	Greetings and setbacks from the teacher Participation of the students with the research and explanation of the subject by the teacher Farewell with reflection on the pending issue.
7 / 23-02-2016 Ma	Welcome greetings and pattern for the day Van Hiele's Model Exhibition Clarification of the subject by the teacher
8 / 24-02-2016 Mi	Greetings and passing of assistance Space opens for the last worktable Continuation of unit two, arithmetic concept, number and numeral Guidelines for the development of teaching materials Reflections on the assignment.
9 / 01-03-2016 Ma	Greetings and review of the previous class The numbering systems are explained Use of the vertical abacus for numbering system changes Practice with the students, assignment. Reflections of the students.
10 / 02-03-2016 Mi	I greet with expectation to continue the class Other numerical representations: quinary and decimal numbering systems. Successive divisions and graphic form to obtain numbering systems. Description and use of the Roman system. Assignment of activity and students' reflections.
11 / 08-03-2016 Ma	Greetings and classroom search. Review of assigned activity. Review of previous class and practice cases. Set of natural numbers and addition. Highlights on addition with a deaf learner. Subtraction with natural numbers. Practice with the abacus. Assignment of activity and students' reflections.
09-03-2016 Mi	Classes suspended because there is a strike in the university.
12 / 15-03-2016 Ma	Greetings and passing of assistance Definition of division and practice with Napier power strips Division algorithm. Explanation of the distributive property of multiplication. Practice exercises in the classroom. Advice for final work.
13 / 16-03-2016 Ma	Greetings and passing of assistance Definition of division and practice with Napier power strips Division algorithm.. Explanation of the distributive property of multiplication. Practice exercises in the classroom. Advice for final work.
22 y 23-03-2016 Ma y Mi	No academic activity in the university due to the celebration of Holy Week
14 / 29-03-2016	Greetings, attendance verification, and material review.

Ma	Algorithm review for the workshop. Explanation and comparison of the properties between multiplication and division. Closing of the workshop and appreciation of the students.
15 / 30-03-2016 Mi	Greetings and attendance verification. Comparative table of properties with the four basic operations. Definition, characteristics, and use of multiples and dividers. Allocation of materials for unit III.
16 / 05-04-2016 Ma	Greeting and registration of attendance Going over prime number dividers and prime numbers. Fractions and their possible interpretations. Decimal fractions and decimal numbers. General comments of what was seen in class and aspects to be addressed for unit III.
17 / 06-04-2016 Mi	Greeting and registration of attendance Review of fractions and decimal numbers. Basic concepts of geometry. Polygons, triangles and quadrilaterals, characteristics and classification. Drawing of lines in the Chinese Tangram. Allocation of materials for the next class and reactivation of pending activities. Students's reflections.
12-04-2016 Ma	There were no classes because the students did not go to the University.
18 / 13-04-2016 Mi	Greetings and adjustments in the day's schedule. Assistance step and location search for daily activity. Chinese tangram cut and explanation of each figure obtained. Wit activity using tangram. Assignment and Recommendations for pending evaluations. Joining the DAM Prevention Forum.

Legend: DAu represents the group of Hearing Impairments, TM refers to the Morning Shift, Ma and Mi are used to identify the days, in this case Tuesday and Wednesday
Font: Martínez (2018).

After the above, the second stage of the analytical deepening was carried out, describing each of the moments lived during the subject and allowing to specify the episodes of relevance.

For the process of this stage, a table was designed, subdivided by class days and segmented at start, development, and closing, where some writings were included as they appear in the journals even with spelling errors (to reliably preserve what was expressed there) as a means of ascertaining what happened, contrasting with the notes made by the teacher. Table 3 shows part of class number nine, with one of the participating sections.

Table 3. Class outline – Section 441 - 2015 II – DAu – TM – Ma y Mi

Class 9 / Day Tuesday 01-03-2016 / 10:00 am to 12:00 m
BEGINNING Episode 1. Greetings and review of the previous class To begin the class, you greet and pass attendance verifying that each student has their abacus, since this is part of the evaluation plan. Once the approval was given to the different apses, the closing theme of the previous class is recalled, when the concept of number was mentioned, this time it was expanded a little more, so a drawing is made

on the board with the image of a hand and five cows, then it is commented that a cow will correspond each finger and a line is drawn that connects one with the other, under this way of relating "one to one" or correspondence "one to one" of some objects with others we have the idea of number, in this case such a group shall be numerically rated as five. With this procedure, formerly people could know if their flock reached the corral in full, having in a bag the number of stones according to the number of animals, carrying for this purpose the correspondence one by one, they would know if any animal was missing; in a very similar way, children do this type of beads with their fingers, even though they do not yet have the precise notion or concept of number. Together with this, the difference between number and numeral is explained.
For this day, we had to bring the abacus, since the guidelines for making it had already been given to us in a previous class...
Before doing some exercises with the mentioned resource, the teacher first talked about the concept of number, since it was the basis to start talking about numerical systems. The number is "the internal interpretation we get when we compare sets or groups of objects and establish between them a relationship one by one; this is what children do when they compare an amount with their fingers. (YS)
This day we all carried our abacus, which varied in sizes and colors, but not in purpose. After discussing the concept and the difference between number and numeral in the previous class... (GU)

Today, we explained the number significate, to my surprise number is not all I thought I knew. Until today, what I understood by number was the representation of it. But the number is that one-to-one relationship that is when the child grabs with his fingers and begins to count one, three, four. That was what we understood by number. Instead, it is a numeral, a symbol representing a quantity. (CS)

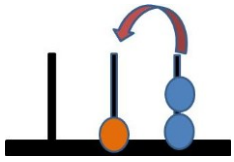
DEVELOPMENT

Episode 2. Numeration systems explained
3. Use of the vertical abacus for changes in numbering systems
Starting from the concept of number, the numbering system is explained, as part of the numerical expression in different cultures or social groups, which is shaped by the use of symbols and rules. One of these is the binary system, which has as symbols 0 and 1, among its rules we have positional, additive, and multiplicative laws, generating orders in powers of two; that is, that groups of two units are formed to convert them into a unit of higher order, each top order goes to the left side of its immediate bottom, so from right to left you have first order of units or powers of two to zero, second order of two to one, third order of two to two, fourth order of two to three, and so on; therefore one order to the left is greater than another to the right, but in addition the system is reversible because I can return a unit of higher order to a lower one. To explain this better, an example of conversion is made with the number five passing it to base two, but the procedure is performed with the support of the vertical abacus taking into account that at the time of using it is left fixed its frontality; that is, it must consider its position in uses only form to maintain the characteristics of laterality that must in turn be explained to the educator as the system basis.
After this, the precede begins by placing five beads in the first column on the right; from these, two pieces are extracted to transform them into a higher order, or a nugget in the immediate column on the left; then this step is repeated, returning to draw two accounts that become one of higher order, until only one remains in the first column so the process is closed in this column, and the next because in this column two accounts remain that in turn become one of higher order (immediate left column); with this, it is warned that any column where the option to form groups of two remains requires this conversion until it is no longer possible to extract more groups of two, in which case it will be when there is one or zero accounts. From the above, it is then observed that the process has ended, leaving in the third column an account, in the second zero and in the first one; and for this reason, now the number reads one, zero,

one in base two. Again, the importance of including good management of laterality is discussed, previously evaluating this in future students to whom they should teach the subject to. Later, other examples are made with 8 and 13, and we talk about the use of the binary system in the conformation of the internal language of computers, for this reason in the film Matrix scenes were made where some and successive zeros appear. Such an explanation was narrated by the students in their own way: ... talked about numerical systems. The first of these was the binary system, whose base is power of 2, the orders are set from right to left and is reversible. For this we did some exercises in the abacus. For example, converting the 5 to the binary system: we placed 5 pieces in the first column (with power 0) and were passing groups of 2 as 1 to the upper immediate column (with power 1); in other words: the first group of 2 was passed, leaving 3 in the first column and 1 (representing the 2 that were passed) in the second column. Another group of 2 as 1 was passed, leaving 1 in the first column and 2 in the second column; since another group of 2 could be taken from the latter, it was taken and passed to the immediate upper column (with power of 3), remaining finally: 101(2), i.e. 102 (at base 2). (YS)

… we followed the content, learning about the different numbering systems which is based on the use of symbols, with the purpose of generating a numbering process. Among them, we can name the binary system, which is based on forming a group of two in two to turn it into a higher order, increasing the orders from right to left and admitting reversibility, we can observe this by manipulating the abacus.

Example:



Se escribe: 10(2) (GU)

For the numbering system, these require symbols and rules, there are different number systems. The teacher began to explain the binary system to us, its symbols are 0 and 1. He did not teach the rules and gave an example; so, we used the abacus for different examples.

… We converted 5 and 8 into the binary system. It should be noted that the binary system is used in the computer programming language; In fact, the teacher gave us the example of the movie Matrix in which the numbers 0 and 1 appear in several scenes. (CS)

CLOSURE

Episode 4. Student Practice and Assignment

5. Students' reflections

As a closing day of class, a final practice is done in the abacus to convert a number into the binary system or base two. Finally, students are asked to bring the abacus for the next class, and it is left as an assignment to investigate what addition is and its properties.

Repeatedly, the journals record some reflections on the activity with the abacus:

It seemed very easy the example with the abacus since in my opinion the learning becomes more significant.

I understood and learned how children relate that one to one and understand that it is a number.

…to represent the binary system, for me it was not so easy since I did not remember how to do it, thank God the methodology used by the math teacher is very easy to understand. (CS)

Thanks to the guidelines provided by the teacher we managed to make our first assigment, which will be very helpful in teaching mathematics to children with hearing impairments, since it allows the student to observe the procedure and the operation. (GU) … All this was new to me, I had never used the abacus, it really was significant, I consider it an excellent resource to explain the simple operations of arithmetic... It was easy, but the abacus really served me a lot as a resource because it was easier to understand doing the exercises there... (YS)

Legend: DAu represents the group of Hearing Impairments, TM refers to the Morning Shift, Ma and Mi are used to identify the days, in this case Tuesday and Wednesday

Font: Martínez (2018).

This last stage, was very enriching by the awareness of what was the educational process in the subject, since this activity was not only about transcribing or verifying the facts, it implied putting every moment developed in class into action, the impact on the student and the effect of internal self-evaluation reflection for those who as a researcher saw their teaching role, it became evident to have the moment lived again, was once again listening to the voices of the students themselves in the interventions, expressions resurfaced that were not in the journals but that by reading them it was easy to evoke them; for example, explaining the use of the abacus, in the direct memory of the moment, the students mention the option to place in its support the initials of the words unit, tens, hundreds, to guide the names of each unit; however, this also led to consider their adaptation for numbering systems on a non-decimal basis, so we preferred to use beads of different color or size.

In the journals, other expressions of very explicit impact also appeared, to indicate how much they favored the explanations or the use of didactic materials for the learning of mathematical contents. Table 3 shows, for example, the case of GU, who comments on how the use of the vertical abacus can influence the teaching of mathematics in children with hearing impairments because it is a material that "allows the student to observe the procedure and the operation management" which makes it clear that in the context of school inclusion, mathematical contents must be taught considering the visual, tactile, or auditory perception that prevails in the student along with the use of alternative communication systems, in this case, the appropriate sign language for mathematical terms.

It also became evident the significance of his mathematical training for his future professional practice, or even to expand his mathematical knowledge; As CS says, he did not remember the binary system but with the teacher's explanations it was easier for him to understand the subject and see the support provided using the abacus for his learning.

Following the same analysis in each class, we obtained the debugging of ideas that led the information to the third phase of Analytical Interpretation. As part of the procedure (See Table 3), we first marked the phrases whose wording showed a moment of student reflection, but where words were also appreciated that accentuated the sense or intention of such reflection, words that appeared repeatedly in the different journals, to refer with similarity to specific subjects of each course. The second was the extraction of these words to contrast them with theoretical foundations previously contemplated in the macro research development, including the Ontosemiotic Approach (EOS) and Neuro Linguistic

Programming (NLP) and how they were linked to their teacher training. Thanks to this, it responds to the purpose set out in the manuscript, resulting in the breakdown of the characterizer elements of training for future US teachers in the EMEI conception, explained below.

3. RESULTS

Taking what was done in the analytical deepening phase, we made a reflective interpretation of the convergence between the experiences with the three groups of students and what was observed by the teacher-researcher. This is adjusted in two stages; in the first, we talk about the curricular, didactic, and needs aspects of the specialty (See Table 4 with the comparison of two sections), which give the organizational pattern of the mathematics course for EE.

It was noted that in the different groups it was possible to complete the curricular content of both arithmetic and geometry; in the didactics it was worked with teaching materials, some of them with previous research and generation of proposals for their use; and also, there were some differences in the needs expressed by the students, in consideration of the singularities of the ENEE and the PcD.

Table 4. - Comparative curricular, didactic, and course needs development

Section / Aspects	Section 441	Section 141
Curricular	The linear structure and monitoring of the units designed in the subject curriculum: It complies with the didactics of mathematics in Venezuela and its impact on special education, arithmetic, and geometry. Separate development of the topic on fractions, proportions, and percentages at the end of the course	Likewise, the linear structure and monitoring of the units designed in the subject curriculum: It complies with the didactics of mathematics in Venezuela and its impact on special education, arithmetic, and geometry. Separate development of the topic on fractions, proportions, and percentages at the end of the course
Didactic	Realization of Didactic Materials: Open vertical abacus, Napier abacus, Tangram Chino. Forum participation Elaboration of didactic proposal to teach mathematical content. An atmosphere of group participation is encouraged. The teacher is seen as a recurring agent of facilitating explanations and conducive to learning.	Realization of Didactic Materials: Open vertical abacus, Napier abacus, Tangram Chino, Geoplans Activity with dynamics: Coconut oil. Elaboration of didactic proposal to teach mathematical content with variety of topics: fractions, cylinder, pyramid, logical-mathematical processes, rule of three, remarkable lines of the triangle. An atmosphere of group participation is encouraged.

	Research and reflection are taken as other ways of generating learning	The teacher is seen as a recurring agent of facilitating explanations and conducive to learning. Research and reflection are taken as other ways of generating learning
Needs	Students have fears rooted in math. Reference is made to educational problems for the deaf: there are no interpreters, evaluation based on activities and neglect in the conceptual area. Signing required for mathematics. Mathematical topics are contextualized in EE	Students have fears rooted in math. Mention is made of individual problems when learning mathematics with the search for options for future attention of learners with learning difficulties. Further work on DAM is required. Mathematical topics are contextualized in EE

Legend: Section 441 is Hearing Impairments, and section 141 is Learning Difficulty

Font: Martínez (2018).

For the second stage, the didactic descriptors are defined (See Table 5) that emerge from the events highlighted in the stories and considered favoring the process of teacher training of those who studied the subject of mathematics in EE.

Visualizing the example for a descriptor, with words extracted such as: "the guidelines, the teacher spoke to us, to explain, He taught us the rules and gave us example, the methodology used by the teacher, talked about" (taken from Table 1, supra); in parallel to the researcher's notes, by their characteristics they referred to moments where the intervention gives to understand the relationship produced between teacher and student, in this case positive and related to what is called as interactional suitability according to the EOS (GODINO *et al*., 2016). But, in addition, they were observed concatenated to other words such as: "to bring the abacus made, we managed to make, we converted, we made some exercises", which indicated the provocation of actions in the participating individuals directed to changes in their usual proceeding, compared to what they considered of Mathematics, or referred to the activity given in the class. In union and contrast of the collected, the emergent descriptor for the expressed characterization was that of interactional/actions.

Table 5 - Analytical and interpretive development of didactic descriptors

Descriptors	Characterization	Keywords
Epistemic / Conceptual	Associated with the mathematical entity seen in class, its conceptual vision, the aspects that define it, properties, examples given, historical aspects reviewed, ways in which procedures or algorithms are assumed.	Defined, concept, property, form a group of two in two, requires symbols and rules, number, relation one to one, difference between number and numeral, is the employee, we follow the content

Cognitive / Concerns in the learning process	Referring to the student's learning process, it refers to what the student mentions as new knowledge for him, or represents a change in his understanding of the mathematical concept; or in another case because it manifests giving it importance, interest or would like to continue learning; also in this descriptor are considered those comments where it is observed that even the student omits, generalizes, distorts or faces a conflict in concept, property, procedures, arguments, of a mathematical entity	It is important to know, I learned, I knew, understanding, new data for me, where it comes from, to learn, it was a new knowledge, I get more knowledge, a different way of doing it, I did not know, I have the same development, I understood and learned, learning, what until today understood
Interactions / Actions	It is manifested in the moments where the intervention gives to understand the relationship produced between teacher-student, student-student, student-content, or student-with social environment where the environment can be your classroom, your home, the institute where it is formed, your community; but also, In these interventions there are actions of the participating individuals that leads us to understand the usual proceeding against what they consider of the Mathematics, or of the given activity in the class.	Through dialogue she allowed us, she was worried, she explained in detail, looking for methods, her perseverance to teach, discuss the concept, I looked, the teacher explained to us, the teacher facilitated different ways of teaching, I asked my partner for information, copy some notes, I wrote to my partner to inform me, the teacher spoke to us, we did some exercises, convert, bring done the abacus, we managed to perform, we talked about,
Mediational / Didactics	Here, we consider everything related to the positive or negative qualifiers given to a teaching material, as well as its use, appreciation, realization. It also refers to the factors that influence the achievement of activities, such as time, how to teach the class (slow, paused, detailed), the distribution or physical classroom environment, changes in environment, use of other means or physical or human resources. Also considered are the aspects that affect the discourse or development of the teacher or students when working with mathematical contents both in the process of their teaching and their learning and that are usually mentioned as didactic aspects	The most didactic part, practical facilitator, easy strategy, practical strategy, funny strategy, quick strategy, the interval was new, innovative strategy, quite didactic, easy to use, very didactic method, more practical way, I love the strategy, much more practical and easier, pedagogical tool that helps, easy strategy to apply, the strategy seemed nice cool, much content for the same day, I would like to have more time to see it, they take three hours for me no problem
Affective / Emotional	It involves everything where the student manifests personal feelings or affections for both mathematics and	I was surprised, I like, it was interesting, a lot of success, it went very well, I

	what happened in class, or feelings that are directed to a particular person and that involves the way he sees, as it perceives sensibly the relations with its environment in the classroom and with the process by which both the teaching and the learning of the contents developed or that it affects in some way in the personal thing or in relation to the other members	love it, it was very entertaining, I don't like math, it became manageable, it is very fun, it impacted me, quite boring, fun, anxious, I loved it, very rewarding, interesting, I didn't have the same motivation, I don't like
Ecological / Linkages	It is estimated everything that implies the vision of mathematics in relation to other areas of knowledge, with the everyday, with daily life, or with what refers to care for future students with disabilities	Being able to work with students, is part of our daily life, for everyday life, is the employee
Discursive representations/ Ways of capturing information/ Tendency to internalize	In this descriptor the situations are grouped where the development of the class evidences that the visual, the auditory or the kinesthetic is favored, but also the discursive presentation of the educator is considered in his what narrates in his diary, where it links the different ways of presenting the given activity in class, in this case by means of graphic forms (drawings, diagrams, images), figures (objects), linguistics (by symbolic writing, formal mathematical descriptions, reflective own writing, alludes to sign use)	I saw other forms, we use games to visualize, use, it looks complete, allows the student to observe, when the child grabs with his fingers, with the fingers of the hands, manipulation
Professional introspections	It is about the personal expressions and reflections of the students, which involves questioning their future teaching work, or questioning the work of teachers close to them who at some point taught them classes in mathematics, or to doubt how they were taught mathematics, their appreciation of this area and what they will do if they are to teach it. Mention the past, in terms of experiences with mathematics, how they saw her in school and at home.	Professional future, my teaching practice, if I had been taught like this, this is a very practical way of teaching, can help us, I learned to teach, how to explain it, it looks complete and understood, never my teachers could explain, in my home my father likes everything that is multiplying, it costs me a lot, on many occasions, I had never been taught so,
Roles of the teacher according to the teacher / Reflection of the teacher in his action	It is related to the intention of the teacher when he assumes different situations in the classroom, if he presents himself as a mediator, as an observer, if he places himself in the situation of the student, and also enters the teacher's own appreciation when reflecting on himself, about their performance in the classroom or what is manifested in how students see them	Real situation presented by student, attract attention, give participation option, explaining, show various options, detailed description, put possible concerns first, reinforcing it,

Inquiry / research as a formative strength	It refers both to the research proposal that the teacher requires of his students, as the own one that the students develop when trying to deepen a topic or by the fact of taking the initiative of investigation in the measure that it affects to widen the mathematical knowledge, the use of strategies, future performance as an educator.	We had to search, command to find out or investigate some terms, they could expose their investigated topics, terms that we must investigate, consult that they are, corrected us the investigation,

Font: Martínez (2018).

The ten descriptors give an estimate closer to the meaning of teacher training in relation to mathematical needs and inclusion within the EE Program, but in turn favored the consolidation of the EMEI, as soon as they have a support point to manage the EMEI Decalogue, whose dimensions frame their professional profile in such guidance, and briefly come to be:

> personality aspects supported by sensitivity and awareness, the treatment of the communicative which implies the management of linguistics and the neurological; classroom actions (discursive, participatory, supportive, individual or group practice); the grounding of family support; interaction with support entities, professional specialists and other colleagues; participation in events; inquiry; self-regulation through critical reflection; projective creativity; and emotional intuition. (MARTINEZ, 2018, p. 561)

4 FINAL CONSIDERATIONS

When reading what the students said in their journals again, was a way to go back in time to tell a very particular story that activated the conception of how to be a teacher in the context of teaching mathematics for Special Education, which involved recognizing how much or little was done both in terms of content and strategies, both academically and emotionally, because much of what was said there reveals what the students felt at heart about the subject, their teacher and also what they themselves had previously learned about mathematics.

The observation of the information collected in the journals and class diagrams allowed to detail the needs of each specialty required for the teaching of mathematics; including the expansion of educational applications and adaptations considering the use of alternative communication systems (sign language, Braille, pictographic, Bliss, etc.).

The production of class journals made it easier to recall events through a chronological reconstruction, marked in a timeline, but also come to extract a number of elements that give account of how should be the course of mathematics for EE and the teacher training in the area of mathematics of those who graduate from that program; for this reason, this was an ideal means to obtain information based on the conceptual bases of the EMEI.

Although this work is a step forward in such training, it also highlights the need to continue investigating: the teaching work, the PcD or with NEE, its uniqueness, by the use of other teaching materials in addition to the strips of Napier, the abacus, the Geoplans; also expand other mathematical contents in the training of EE teachers (not only of arithmetic and geometry), and at the same time the needs

of the mathematical educator in terms of their preparation within an inclusive education, and many other issues that become key points to be addressed in the EMEI field.

Another latent concern is that although the mathematics subjects taught in the US are in line with basic education and that the students themselves expressed a desire to return to them in the mathematics department, either to reinforce their knowledge or because they did not have clear processes in basic operations, as was often the case when dealing with the issue of division; it is worrying that, in the near future it will completely govern the new curriculum design and in this does not have the subject of mathematics, which we consider may negatively revert to what was managing.

To conclude, we want to highlight that qualitative studies such as the one described above, mark a coming and going between the information collected and the analysis of it, the structure was taking shape but not linearly, as it happened in the elaboration of the tables that emerged from the same analysis; and in this study remains the echo of the particular point, for which nothing is definitive; however, it represents a leap to continue building, to give others the option to look with this proposal for an alternative teacher training and continue opening other doors around the topic.

DIARIOS DE CLASE COMO EXPRESIÓN DE APRENDIZAJE E INTERACCIÓN PARA LA EDUCACIÓN MATEMÁTICA ESPECIALMENTE INCLUSIVA – EMEI

ABSTRACT

Existen inquietudes sobre la formación docente ante el compromiso de desarrollar una Educación Matemática acorde con las características de quienes son parte de la Educación Especial, por lo que en este manuscrito se detallan experiencias y actividades realizadas con futuros docentes del Programa de Educación Especial del Instituto Pedagógico de Maracay, Venezuela, en una asignatura de Matemática, plasmadas en sus diarios personales de clase, que sirvieron de punto de reflexión para establecer descriptores asociados a las competencias de su formación docente y vinculados a la concepción inicial de una Educación Matemática Especialmente Inclusiva (EMEI). Del análisis interpretativo, los hallazgos más destacados fueron la caracterización de las necesidades curriculares, didácticas y específicas de cada especialidad del Programa, que proporcionaron el patrón organizativo de la asignatura de Matemáticas; y paralelamente, la distinción de diez descriptores que, a su vez, contribuyen a la formación de la EMEI.

KEYWORDS: Diarios de classe. Educación Matemática. Educación Especial. Educación Inclusiva. Formación de professores.

DIÁRIOS DE AULA COMO EXPRESSÃO DE APRENDIZAGEM E INTERAÇÃO PARA A EMEI

RESUMO

Existem preocupações sobre a formação de professores diante do compromisso de desenvolver uma Educação Matemática de acordo com as características do público alvo da Educação Especial, pelo qual, este manuscrito detalha experiências e atividades realizadas com futuros professores do curso de Educação Especial do Instituto Pedagógico de Maracay, Venezuela, em uma disciplina de Matemática, captadas em seus diários de aula pessoais, que serviram como ponto de reflexão para estabelecer descritores associados às competências de sua formação docente e vinculados à concepção inicial de uma Educação Matemática Especialmente Inclusiva (EMEI). A partir da análise interpretativa, os achados mais notórios foram a caracterização das necessidades curriculares, didáticas e específicas de cada especialidade do Programa, que forneceu o padrão organizacional da disciplina de Matemática; e, paralelamente, a distinção de dez descritores que, por sua vez, contribuem para a formação da EMEI.

PALAVRA-CHAVE: Diários de Aula. Educação Matemática. Educação Especial. Educação Inclusiva. Formação de Professores.

NOTES

1 This research was conducted in Venezuela and in accordance with the guidelines established by the Ministry of Popular Power for Science, Technology and Intermediate Industries (MPPCTII) in the Code of Ethics for Life (VENEZUELA, 2011) provided complete information and protected the identity of those who took part in the study, which was carried out in accordance with the formats "Informed consent of the participant" and "Ethical-moral commitment of the researcher", which currently remain in force in the UPEL Manual (2022).

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Mailing address: Fredy Enrique Gonzalez - fredy.gonzalez@ufop.edu.br