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# Discussing school mathematical narratives in early childhood future teacher education

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*In this work we recognise how a group of future teacher of Early Childhood Education, analyse narratives about rich school experiences. We presented a professional task, in which we wanted to see how future teachers recognize initially the potential of the mentioned experiences to promote mathematical processes. We recognise that future teachers give a limited value to the problem-solving process and have difficulties in recognizing the processes of reasoning and proof. We found it is not because of a mathematical previous weak formation, but rather it points to the need of analysing school practices and narratives as good examples of action.*

*Keywords: Early childhood, future teachers, mathematical reasoning, problem solving.*

## Introduction

NCTM (2000, 2013), as other new national curricula, suggested that teachers could design better rich school activities, if they can identify the power to develop mathematical processes in their classrooms. In Spain, authors like Alsina (2014), pointed out that to achieve a quality of mathematics education for early years, it is important to implement curricula focusing on mathematical processes in a systematic way. It is important for the teaching and learning of mathematics to use mathematical models in relevant everyday contexts.

Preservice teacher's mathematical knowledge plays an important role when teaching mathematics. It is clear that for early years, almost no one remembers about his own experience. Therefore, their knowledge for teaching at early years is limited, and based upon personal theories and preconceptions (Jaworski & Gellert, 2003). "Little improvement is possible without direct attention to the practice of teaching ... [h]ow well teachers know mathematics is central" (Ball, Hill & Bass, 2005:14). In this paper, we assume that narratives are a wonderful way to allow students to personalize mathematics (Kurz & Bartholomew, 2013) and develop mathematical knowledge. In such a framework, the use of narratives is a powerful tool for teacher professional development and an useful research methodology for those interested in the study of teachers, teaching and teacher development (Ponte, 2001).

Llinares, Fernández, & Sánchez-Matamoros (2016) pointed out that for teacher education purposes, it is important to promote that future teachers (FT) grow on mathematical understanding by noticing mathematical aspects when future teachers analyse school experiences. It is also important for FT to know about designing rich practices. What about Early Childhood Education? In some countries as Spain, there is a global curriculum for Kindergarten, without any explicit mathematical goals for children's mathematical knowledge. Therefore, FT must have a preparation to understand the emergence of mathematical objects and processes from good early school practices. In the case of Spain, it is difficult to involve FT in implementing designed tasks, as it is for continuous training. There is a danger when considering the practice of teachers, and therefore presumably the experience of learners, of focusing exclusively on pedagogic practices, without reflective processes (Shulman, 1986). It seems to be the main reason for the need of mathematics reflective activities for prospective kindergarten teachers. In this presentation, we want to analyse the initial position of future teachers

when they analyse narratives about school experiences, in order to find how they relate the richness of school actions and the emergence of mathematical objects and processes.

## **Theoretical framework**

As Ponte (2001) wrote, we use teacher narratives as a way to represent a school experience for oneself or for others. A narrative involves three basic elements: i) a situation involving some conflict or difficulty, ii) one or more agents that act on that situation with their own intentions, and iii) a temporal sequence of related events in which the conflict is resolved in a certain way. It involves people, settings, and events that take place in a given time. The acceptance of a story is oriented by convention and by “narrative necessity” (Bruner, 1991). In pre-service teacher education, narratives such as these provide good starting points to discuss issues faced by a teacher in making curriculum decisions and conducting classroom instruction. Some authors, like Chapman (2008) and Ponte (2001), mainly use narratives to reflect on future mathematics teachers’ thinking and actions in relation to mathematics and mathematics teaching and learning, aiming to broaden their understanding of new curriculum orientations.

In this paper, we use narratives to study teacher’s knowledge when analysing innovative teaching practices (Ponte, Oliveira, Cunha, and Segurado, 1998). In the current study, we focus on identifying, planning and enriching mathematics practices, made by others. We consider such activity as a fruitful starting point for inquiring into how FT should anticipate the enactment that will occur. Some future teachers of early childhood want to know and copy nice school experiences. Instead of this, this research leads to understand that richness of a school activity relates to the possibilities for emergence of mathematics objects and processes. Our aim is to recognise the initial reflection of future teachers about the emergence of mathematical objects and processes, as a noticing professional competency (Jacobs, Lamb & Philips, 2010). In this presentation, we focus on the analysis of problem solving processes, and analysis of the reasoning and proof processes. We assume that the practices in reading, analysing, and discussing narratives generate a number of insights that provoked to modify future teachers’ planning for instruction. Many studies have reported that narrative data helps to validate the learning results as a basis for understanding of human actions (Polkinghorne, 2007), and to understand the role of intentionally drawn school practices (Font, Godino & Gallardo, 2013).

## **Methodological issues**

We use a qualitative, naturalistic research perspective (Creswell, 1998) focusing on capturing and interpreting the participants’ thinking about narratives as a case study. To achieve our aim, we designed a professional task. The professional task is structured in two parts. In the first part, FT are asked to read two articles: "The map of a treasure" (De Castro & Escorial, 2006) and "Where is Paula?" (Feixes, 2008). These articles describe two school experiences about geometrical itinerary aspects and spatial references, made with children of 5-6 years old. We select these two narratives because they describe rich (Woodham & Pennat, 2014) and high quality (NAEYC & NCTM, 2002) of school experiences for children from 3 to 6 years of age. Both school experiences use a continuous dialogue in the classroom. They also explain didactical orientations to planning and managing activities, connecting geometrical objects and processes. During the first experience, the idea is to promote a problem solving approach to “know about” the space of the school, as a provocation to find the place where a treasure is. Children spontaneously use paper and pencil itineraries, written codifications, and gestures to discuss in groups how to go from one point to another among other decisions. During the second experience, the teacher proposed to talk with Paula (a child that left the school to come back to her country, Uruguay). The five years-old children immediately ask where Paula is. A nice discussion about at what time do we call her, helps the children to discuss how the difference of time relates to the difference places in Earth, and different hemispheres. Our interest in

choosing these two narratives is to look at two sides of the problem of situating points in the real world space: the local or short distance problem (narrative 1) and global world problem (narrative 2).

In the second part of the professional task, four questions are posed to guide the analysis of the two narratives read in the first part. These questions are: 1) Talk about what raise your attention after first reading. 2) If you should recommend to your teacher friends these experiences, what do you explain for them? 3) What is the role of the teacher in both experiences? 4) Why do you think there are rich practices that develop the emergence of children's mathematical thinking?

The participants in our study are 33 FT of Early Childhood Education at the Barcelona University. To describe how they explain the emergence of mathematical objects and processes in the two narratives, we collect all the individual responses to the questions proposed in the second part of professional task. To analyse the data, we used a tool raised by Coronata & Alsina (2014). This tool includes five categories that correspond to the five mathematical processes proposed by the NCTM, (2000). For each of these categories, 6-7 indicators are provided for evaluation. In our study we only consider the indicators of problem solving and indicators of reasoning and proof processes.

The analysis takes three moments: a) The research team answer as experts giving a set of the processes observed; b) the future teachers' answers are analysed by using the methodological tool cited above; c) the research team explain some hypothesis about why the results appear. We assume that some text is related to one or more indicators, if there is a sentence evocating such principle by means of discursive argumentation (Gee, 2014). General sentences are not considered. For instance, the sentence "The teacher develop the capacity of creating arguments to explain children's curiosities in reference to mathematical concepts as distance, space and time" is assumed as relating to an indicator of reasoning and proof. But a sentence like "It is considered the interest of children" is not assigned to the indicator, because it is a fuzzy simple comment without any explanation given to what is the text or mathematical idea in the narrative.

## Results

Many mathematical objects are easily identified by almost all the FT, but it is not enough explained how these objects emerge from the examples given in the narratives. In general comments, many FT talk about the differences among space by using time, and the idea of having different periods in a year. They talk about the meridian as a reference for timing. They assume the need of codes in order to represent itineraries among other geometrical objects.

Many FT also consider that problem solving is a common framework in both school experiences, but they explained some of the mathematical processes superficially (See Table 1). We find that future teachers identify issues related to problem solving more easily than other processes, and have difficulties in explaining aspects related to the processes of "reasoning and proof".

In Table 1, we associate examples of the responses made by FT to each indicator and we include an expert comment when FT identify problem solving process in the narrative 1, as an example of the use of indicators for problem solving. Some FT tell us that children's participation in narrative 2 stimulate imagination and creativity. Nevertheless, we only observed two out of 33 FT on where is it possible to see such promotion of creativity as an inquiry problem solving process.

The main indicator found is related to the assumption that contextualisation plays a role in problem solving activity. Nevertheless almost a half of the students write sentences in which FT talk about problem solving without any explicit indicator

In some cases, as FT14 and FT 24, they do not express any sentence about contextualisation and interest. We also see that 27% of the FT talking about mediators and interest are the same as those

who talk about contextualisation. It is possible that the lack of processes recognised relate to the mathematics background of the FT.

Indicators	% FT n=33	Examples of FT's responses	Responses from experts
Questions generate inquiry and exploration	6%	<i>"Helps to develop math thinking... Formulate questions, hypothesis, to find answers, explanations..."</i> (FT 3) (FT 6)	"Where is Paula" is a challenging starting question. Teacher promotes exploration when asking for information at home about time zones
Propose open problems	--	--	The teacher use children's open (non easy) proposals to analyse cultural influences about spatial relations
Contextualise in familiar contexts	52%	<i>"learn from the surrounding environment"</i> (FT 2)	The teacher contextualise to travelling problems to see what is invariant and changing in different positions
Promote discussion and participative debate	3%	<i>"contrast and reveal with different representations as figures, pictures or the use of dialogue the different knowledge"</i> (FT25)	The teacher promotes discussion about the need of comparing points and itineraries in the space, the use of references
Maintain the interest and curiosity	13%	<i>"...From the beginning, through their (children) questions we observed that is of its interest"</i> (FT2) <i>"children achieve different learning from curiosities"</i> (FT7) similar (FT9)	The school teacher focus on a lived experience to base a set of continuous problems related to the use of images to solve the problems
Use different type of mediators when solving	30%	<i>"The maps used by children are different from those done by adults"</i> (FT 9) <i>"...It is a dream...to know about now it is early morning..."</i> (FT 24)	Children construct and read maps in big spaces with the Earth globe as a powerful semiotic mediator. It emerges the idea of meridian line as a reference. The experience itself has an emotional background.
Reinforce the process using different support	6%	<i>"...using trial and error, children structure math knowledge..."</i> (FT14)	The teacher promotes the use of the starting situation to promote the use of spatial relations and references

**Table 1: Responses associated to the indicators of problem solving process (narrative 1)**

We can see that the FT do not relate some verbal aspects as discussing as a part of the problem solving process for narrative 2 (See Table 2). They realise that contextualisation is the main aspect behind problem solving activity for having good answers. It is expected that the FT talk about the role of mediators in this initial moment of analysis, but the justification they give is very limited focusing on having a "meaningful task" without any relation to a specific mathematical knowledge. They talk about "learn from the surrounding environment" without explaining that the need of a reference line (Greenwich Meridian) appears when we have numbers to indicate points in the space (initial idea of geographical coordinates). This could indicate a rather weak mathematical background of the FT, and the need for having a professional reflection about what mathematical knowledge emerge from a mathematically interesting activity like this. Precisely, this is the role of training process and professional activity never done before. The results show that narratives help to focus the reader's attention for recognising more mathematical connections (distance/speed; codification/itineraries; real world/representation) than expected.

Indicators	% FT n=33	Examples of FT's responses	Responses from experts
Questions generate inquiry and exploration	6%	<i>"build hypothesis, elaborate representations"</i> (FT3)	The teacher promotes different strategies as situating, identifying, recognising, building hypothesis
Propose open problems	--	--	There are open strategies, but no open problems
Contextualise in familiar contexts	36%	<i>"To know what is a map, which is its use"</i> (FT4) <i>"...The problem promote meaningful knowledge"</i> (FT3)	The context of "find treasure" help to identify the role of registers when solving itinerary problems.
Promote discussion and participative debate	9%	<i>"...and the colleagues were able to decode the information"</i> (FT9)	The dialogue gives challenges for coding/decoding processes
Maintain the interest and curiosity	3%	<i>"Children take and search at home more different maps ... helping the comprehension and motivation"</i> (FT4)	The use of a school as a milieu, and the aim of arriving to a treasure, ensure interest and give opportunities for maintaining interest as a long job
Use different type of mediators when solving	15%	<i>"The maps done by children were functional, ...they served for the purpose of representing a space indicating the place of a treasure"</i> (FT9)	The maps, are used to identify itineraries, distances, directionality

**Table 2: Responses associated to the indicators of problem solving process (narrative 2)**

It is difficult to find explicit children's arguments and reasoning in the narrative of "Where is Paula?" In fact, the teachers tell us many sentences (as "we always ask why") about the use of argumentation and reasoning, without explaining all the details. Nevertheless, in the children's pictures we can observe that they talk and argue when they observe the Earth globe, or when they talk about "Uruguay is far away". We only find general statements about reasoning and proof as we can see in Table 3 and Table 4.

Indicators	% FT n=33	Examples of FT's responses	Responses from experts
Helping to develop student's thinking	12 %	"Children structure their mathematical knowledge" (FT 13).	The Teacher promotes reflections and arguments about the invariance of day/month/year but different time and season, by seeing to the Earth globe.
Inviting to explain conjectures	6 %	"The need to have good questioning"(FT4) "revealing initial ideas and preconceptions" (FT 16)	The practice promotes to use arguments relating conjecturing about the need for having time references
Promoting to control conjectures	3%	"to establish hypothesis to understand zones having the same time...to understand why it happens in the world... and which are the lines that make the difference, when situating places in the map" (FT 16)	The teacher promotes some deductive reasoning. To argue, Bernat uses if...then as a deductive reasoning. Describes the relation between numbers (+1) and going to the right. Also (-1) means going to the left.
Questioning to evaluate arguments	3%	"...develops the ability to create arguments explaining the concerns of children which refer, in this case, to space and time (FT 1) "being aware of time and its difference" (FT 17).	The teacher promotes adjusting variables and control validity when talking about "that fit with those from other sources as it is the case of having information about time zones"
Promote reasoning by giving feedback	--	"...the children in both experiences offer the possibility to establish arguments and generating hypothesis" (FT 9).	Teacher promotes inference levels of spatial reasoning: What it is possible to see; what I see without specific attention to particular students
Promoting divergent thinking when arguing	3%	"Permits the children to observe, to explore, and to determine what is more important or less..." (FT 16)	Promoting children arguments about why do we say "Uruguay is far away" The need of relating two points in the space. The need of having a global view to understand it, by arguing that the flight is long (according time)
Promoting discoveries, analysis and arguments	6%	"About the project...it pays my attention the amount of information that children can draw (extract ideas and conclusions) from the maps....arriving to conclusions that children assume as the best and right" (FT2)	The teacher promotes the need of connecting children's surprises to math or science knowledge (children see Paula as summer dressed)

**Table 3: Responses associated to the indicators of reasoning and proof process (narrative 1)**

Clements & Sarama (2009), tell us about the need for promoting reasoning since early years, however, FT in the research do not identify the amount of possible quotations in the narratives relating reasoning and proof. We observe that, in general, many of the future teachers do not offer specific mathematical examples from the narratives to illustrate the reasoning and proof processes.

It is surprising that inquiry attitude not seems to be considered as part of a problem solving process, perhaps because FT have the belief that the most important for a problem solving is to have a right solution. In fact, many of the future teachers' comments do not pay attention to the role of the teacher giving opportunities for continuous problem posing moments, promoting hypothesis and conjectures. The FT explain that the teacher in both narratives promote the use of arguments, but none of the FT mentions the importance of feedback.

Indicators	% FT n= 33	Examples of FT's responses	Responses given from experts
Helping to develop student's thinking	15 %	<i>"In this practice... the teacher ask questions to influence children's reasoning, to improve their thinking"</i> (FT 19)	The teacher tell us explicitly the use of the students' natural environment to promote spatial thinking
Inviting to explain conjectures	3 %	<i>"The teacher tries to improve autonomy to reflect, to produce hypothesis about the ways of coding"</i> (FT28)	The teacher promotes the emergence of Students' conjectures about maps and big distances o represent travelling by using descriptions.
Promoting to control conjectures	6 %	<i>"The teacher permits that children explore information given by the maps, and select which information is relevant and which one is not"</i> (FT 19)	The teacher tells about reflections and argumentation, but it is not explicit how the teacher controls the conjectures, because the focus is the codification process.
Questioning to evaluate arguments	6 %	<i>"Sharing and contrasting</i> (FT 17) <i>"Discussing about his or her discoveries"</i> (FT 23)	They discuss to have a common result, but different representations and evaluate the representation used
Promote reasoning by giving feedback	--	--	The teacher find that David, use a comparison (small globe vs big Earth) to reason that from Madrid to Lanzarote you must use a flight.
Promoting divergent thinking when arguing	--	--	The teacher promote that Children adjust their arguments about which objects must be in the map, where to place and how to represent them.
Promoting, analysis and arguments	6 %	<i>"..revealing initial ideas and preconceptions"</i> (FT 16)	The teacher promote the emergence of Students' ideas (Luke : Itinerary as a set of steps; David what we can learn from Earth globe

**Table 4: Responses associated to indicators of reasoning and proof process (narrative 2)**

After this professional task, we devote some time for collective reflection not detailed in this paper. Some new processes appear as: "The teacher drives arguments, and promotes different possible contents and meanings" (FT 19) or "by dialoguing, the teacher gives immediate answers to students, reinforcing children's knowledge about coordinates" (FT 16), or "Children almost prove their conjectures, in a way that surprises us" (FT 9).

## Conclusion

Future teachers are able to identify many mathematical objects and some processes implicit in the narratives analyzed. We see less process than it was expected. The main one is problem solving. The analysis promoted by the two professional tasks has allowed us not only to characterize some aspects of professional noticing of the future teachers, but also to establish a basis for recognizing the role of mathematical discourse (Adler & Ronda, 2015). In fact, after the implementation of the professional task, we find a more structured discourse of future teachers, more connections, didactic arguments, recognition of a greater number of processes and more justifications. With this research, we enlarge the conjecture done by Llinares et al. (2016) that noticing also promote deeper subject-matter understanding of pre-school's future teachers. Therefore, we consider that the implementation of this type of tasks is relevant in the training of future teachers of early childhood education.



Finally, it stands out that discussing and reflecting on school narratives such as those presented here has allowed future teachers to contrast school practices, different from those they have traditionally observed giving mathematics knowledge improvement.

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