Family mathematics education: building dialogic spaces for adults learning mathematics

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In this paper we discuss the idea of building dialogic spaces as a way to promote teaching and learning mathematics in adult schools. Prior research suggests that social and cultural contexts are relevant variables that have an important impact on how adults learn (according to the thesis of transferability). We claim that building spaces where adults feel free to participate is a fundamental factor in promoting this 'transfer' of knowledge from home practices to school practices. We draw on data coming from a research project with families involved in their children's mathematics education. Data collected is qualitative, including interviews, observations (field notes), discussion groups, and classroom activities. We videotaped all the data and used specific software to analyze it. Discussions show several episodes that illustrate the impact of 'dialogic spaces' to promote adults' mathematical learning. Several elements involved are analyzed. We conclude with the idea that dialogical spaces give adults a chance to exchange their different approaches to mathematics in order to learn the formal concepts of academic mathematics.

Introduction

Most studies of adult learning have taken place during the last few decades, for example Merriam & Cunningham (1989) and Sheared & Sissel (2001). According to these authors, research in the field of adult education has been expanded from the historical to life development and learning, including gender issues, education as a strategy to get more economic opportunities, citizenship, the use of ICT, vocational training and specific fields such as numeracy.

During these decades of study, we have gained important knowledge about the facts involved in adults' learning processes. A central idea about how adults learn emerges from amongst all these different approaches: according to these studies adults learn by making meaningful connections to their previous experiences (Flecha, 2000; Freire, 1977, 1997; Knowles, 1984; Lave & Wenger, 1991; Mezirow, 1997; Rogers, 1969). Adults are conceptualized as agents of their own learning process. Active learning methodologies are based on theoretical approaches to how adults learn (Flecha, 2000; Freire, 1977, 1997; Knowles, 1984). Terms such as 'situated learning', 'prior experience', 'everyday life', etc., have become important to understand these kinds of processes.

During the 70s and 80s researchers pointed out that social class and cultural background have a key impact on the 'one-way flow of information' from school to home, which penalises people from disadvantaged environments and environments which are socioculturally different from those of their schools (Abreu & Cline, 2005; Secada, 1992; Gallimore & Goldenerg, 1993; Tate, 1997; Civil & Andrade, 2002). From a theoretical point of view, concepts such as the ones developed by Bourdieu (1977) or Bernstein (1973) have been useful for ALM in order to understand how this process of adult learning works. A prolific line of research has been the discussion of how to transfer the home-based knowledge to academic practices. Gonzalez and colleagues perfectly summarise this idea: Predicated on the assumption that classroom cultural and linguistic patterns should be congruent with cultural and linguistic community patterns, researchers and practitioners sought to bridge what came to be regarded as the discontinuity or mismatch gap." (González, Andrade, Civil, Moll, 2001, p.116).

FitzSimons, Wedege and Evans have discussed the idea of a 'transfer of knowledge' (from everyday experiences to academic experiences) in ALM, looking for evidence to explain how adult learners use their own experiences to make sense of academic concepts related to mathematics.

All these studies provide a well-grounded frame that suggests that ALM (and adult learning as well) somehow is a 'situated practice' (Lave, & Wenger, 1991), which is culturally transmitted (Scribner, & Cole, 1981; Lave, 1988) through dialogical practices (Flecha, 2000; Freire, 1997; Aubert, Flecha, Garcia, Flecha & Racionero, 2008; Bakhtin, 1981; Wells, 2001).

Research questions

In this paper we discuss the idea of building dialogic spaces[1] as a way to promote the teaching and learning of mathematics in adult schools. We draw on a research project with families involved in their children's mathematics education. They are adults doing and learning mathematics to help their children at home. As adults, they have particular characteristics that influence the learning practices carried out within the classroom. We want to go further with the discussion of how adults learn (mathematics). Prior research suggests that social and cultural contexts are relevant variables that have an important impact on how adults learn (according to the thesis of transferability). The research question examined here is how dialogic spaces facilitate adult participation in mathematics learning activities and hence promote their learning. Our thesis is that building spaces where adults feel free to participate is a crucial component in promoting this 'transfer' of knowledge from home practices to school practices. Ideas such as 'funds of knowledge' (González, Andrade, Civil, Moll, 2001), or 'situated learning' (Lave, & Wenger, 1991) acquire a complete meaning only when the possibility exists for adults to establish an egalitarian dialogue. Egalitarian dialogue promotes the participation of all and enables them to exchange their different

[1] We define 'dialogic space' as a place built by participants, where participants feel as members of this group, which has a particular identity. Every member plays a particular role within the group. The interactions between group members are based on dialogic interactions. According to Flecha (2000), we talk about dialogic interactions when all participants have the same opportunity to participate within the dialogue, drawing on what Habermas (1988) call validity claims (not power claims).

approaches to mathematics in order to end up learning the formal concepts of academic mathematics.

Methodology

Data discussed in this paper comes from a research project entitled *Teacher training for a family mathematics education in multicultural contexts*, funded by the Research Department of the Catalan Government (AGAUR, *Agència Catalana de Gestió d'Ajuts Universitaris per a la Recerca*).

The goal of this project is to improve the quality of teaching practice in Catalonia through an intervention in family training. The specific objectives include: (1) to identify elements and educational strategies in the work with adults in the field of mathematics education from a multicultural lens; (2) to create training resources addressed to teachers of mathematics in adult education, in order to promote equality and opportunities for everyone to learn mathematics; and (3) to offer resources for a teacher training of quality, connected to real classroom-situations, in order to promote inclusive family training in mathematics education.

In order to achieve all these objectives, we conducted a case study (Stake, 1995) that includes several workshops of mathematics targeted at families. The workshops were conducted in two schools, following the research work developed by CEMELA in the United States and CREA in Spain and Catalonia.

A total of four workshops of mathematics for families were carried out during 2008. The workshops were conducted in two different schools: an elementary school placed in a city south of Barcelona, and a middle/high school located in a working-class neighbourhood in Barcelona. Twenty-five families were involved in these four workshops. The families' countries of origin included Catalonia, Morocco, Colombia, Ecuador, Romania, the Czech Republic and Armenia.

The data collection is qualitative. Videotapes, field notes, discussion groups, and in-depth interviews were collected. The methodological approach used has been the critical communicative methodology (Gómez, Sánchez, Latorre & Flecha, 2006). In order to analyse the data we used TAMS Analyser. This is software for qualitative research analysis developed by Matthew Weinstein (2006). This software allows us to implement an analysis based on the Grounded Theory (Glaser & Strauss, 1967).

Results and discussion

'Ice-breaker' activities are a good way to start a workshop with adults (Díez-Palomar, & Prat, 2009). First of all, we need to 'create' a safe environment for adult learners in order to promote the participation within the classroom. There is no possibility to teach something about mathematics (or at least, it is very difficult) until a feeling of confidence is built among adult learners involved in the mathematical classroom. We know that before addressing any content of mathematics, we need to (a) bridge the gap between 'home-based practices' and the school ones, and (b) create this environment of safety, because if not, previous research suggests that it is very difficult for adults to develop the self-confidence required to address mathematical challenges (Díez-Palomar, 2004).

For this reason, we started our work with families by building this safe environment. In order to do that, we drew on *dialogic learning* principles (Flecha, 2000; Aubert, Flecha, Garcia, Flecha & Racionero, 2008). In that sense, the space was conceived as an egalitarian space for adults to express their opinions, previous knowledge, ways to solve a particular activity, etc. With the principles of 'equality of differences' and 'cultural intelligence' in mind, the premise to build this space was to establish a common rule for all participants: everybody was allowed to participate; all opinions were respected; and all interventions were judged in terms of their validity, not in terms of the power position of the person who makes the statement. These rules were the result of a process of agreement (in terms of Habermas, 1987). Constructs such as 'funds of knowledge' or 'situated practices' provide us with theoretical tools to understand how adults' previous experiences inform their understanding of the academic concepts presented and discussed within the classroom (fractions, rational numbers, irrational numbers, equations, algebra, different ways to solve a system of equations, etc.).

The next quote illustrates this process of 'space building' by breaking the differences between participants. The facilitator proposed an activity to meet each other. At the same time all individuals were 'breaking the ice' while they were starting to work together.

> [Javier] (facilitator): So... eh... as I was telling you... The first activity... Can be to introduce ourselves to each other and we can meet each other... is to draw a graph using our own personal data. So, for instance, the first question could be "How many children do you have?" So that way...
>
> Joan[2]: We write down... Do we need to write down our name?
>
> [Javier]: Yes. If you want, I can write it down for you...
>
> Maria: Ah, ok. So he can start... the 'gentleman'...[3]
>
> Joan: Me? I have no children.
>
> Maria: Three.
>
> Celia: One.
>
> Hadiya: Three.
>
> Kristina: Two, two boys.
>
> [Javier] (facilitator): And Javi... at the moment zero.
>
> Participants: - laughing-
>
> (Fieldwork, CEIP Las Flores. First session; 2007/ARIE/00026; AGAUR, *Agència Catalana de Gestió d'Ajuts Universitaris per a la Recerca*).

During the first session, the facilitator and several other teachers of the school presented the program of after-school activities for the incoming semester. At the end of the presentation the facilitator proposed an activity to 'break the ice'. Their first words were: "You can work together; please, make groups and put your chairs in a

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[2] All names (schools and persons) are pseudonyms, to protect the identity of people and institutions involved in the research project. The only real names are those ones of the members of the research team.

[3] Maria used the word 'caballero', which is a regular expression in Ecuador, the country were she came from.

circle". Actually, the organisation of the classroom was fundamental. At the beginning of the session, two sections in the classroom were clearly identifiable: the 'teacher's space at the front, and the 'audience's space'. People were sitting down in rows of chairs, looking towards the front. They were 'hearing', rather than 'participating'. The organisation of the classroom itself was promoting this attitude. After the facilitator changed the placement of the chairs (to circles of chairs), a noise coming from the audience appears in the videotapes: adults started to speak to each other. They were sharing their approaches to the problem proposed. They were trying collaboratively to solve the activity, using dialogue as a tool to express their answers and reach agreements to later present to the whole group. The problem was an activity about proportional reasoning, based on a Catalan tale. This was about a giant, and the challenge was to try to figure out the height of this giant from a footprint.

> [Javier] (facilitator): It seems that there are more groups solving the problem in this way: that is, they call the height of the giant 'x'. Then they established the relationship: if my height is this, and my foot measures that, then the giant should be... if we know the length of the foot, then 'x' would be that. So they used the 'rule of three[4]'.
>
> (Fieldwork, CEIP Las Flores. First session; 2007/ARIE/00026; AGAUR, *Agència Catalana de Gestió d'Ajuts Universitaris per a la Recerca*).

The facilitator summarized the groups' contributions to the audience. But he opened up the discussion to all the groups together, to promote participation. It worked. Data videotaped shows that people were open to participating in the activity. The 'public exposure' to the group was not a handicap to their participation in the class. Will and Maria, for instance, took a prominent role in the group, and they were making relevant contributions to expand everybody's understanding of the problem about how to use proportional reasoning to calculate the giant's height.

> [Javier] (facilitator): Ah... Over there, I think that you also were doing something in relation to statistical average of several feet...
>
> Many people: Yes, yes...
>
> Will: ... This is a way to explain that too...
>
> Maria: You explain!
>
> Will: Well, we took several samples to calculate it more precisely, more exactly... So we did it by statistics. This is statistics sampling. Then you calculate the average. That's why I was asking you. Because to me... I already knew that, as average. To me the rate does not make any sense.
>
> [Javier] (facilitator): Aha, aha... ok. This is another way to solve it.
>
> (Fieldwork, CEIP Las Flores. First session; 2007/ARIE/00026; AGAUR, Agència Catalana de Gestió d'Ajuts Universitaris per a la Recerca).

This excerpt illustrates an interesting situation. Will is a Colombian man. His first language is Spanish. But there are some differences between Spanish used in Spain and the one used in Latin-American countries. 'Promedio' (average) is an example of that. We were getting to know each other, and of course everybody had their own

[4] The 'rule of three' is an intuitive 'algorithm' used in Catalonia and other regions of Spain and other European countries to solve algebraic problems.

'funds of knowledge'[5], which appeared in the middle of the discussion. The facilitator was using the Spanish word 'ratio' (rate) to explain the relation between the giant's height and his foot length. He calculated the result of this division (total height of a person / foot height of this person), and then, he used this number to multiply it by the giant's foot length. To Will, this was a 'promedio' (which has a statistical meaning for people from Spain). Will solved the problem by comparing the relationship between total height and foot length of every member of his group, and then calculating the average. He got a number ($\pm$6.5cm), which was the result of this average. Then, Will multiplied this number by the giant' foot length. To him, $\pm$6.5cm was a 'promedio' (average). To the facilitator, this was a 'ratio' (rate). The facilitator and Will discussed their own strategies to solve this activity. Everyone in the different groups had the opportunity to learn from this discussion. This is the kind of impact that dialogic spaces have on adults' learning mathematics.

These kinds of situations were regular during the time that we worked together. They appear not just in one of the schools involved in the research project but in all of them. Data shows a common trend among all workshops that we conducted during one year in different schools. When adult learners felt comfortable in the classroom it was easier for them to get involved in the classroom dynamics. This was the 'perfect' situation to share their understandings, concerns, doubts, sometimes misunderstandings, etc. with the whole audience. It also was the 'perfect' situation to 'problematise' their own previous knowledge (that kind of knowledge that Skemp (1980) and Piaget (1952) call 'schema'). They did it in a critical way. The result was more learning for everybody (as discussions were public and open to all of them to participate in).

> Context: We are in a classroom placed in a centre with Middle and High School. First row of chairs was empty. Five mothers were sitting in the second one. In the third, three mothers. Behind them, three more mothers are present in the classroom. We know that there is a man also in the audience: a father. They are working on lineal equations (like $ax + b = c$). They are translating sentences from regular language to algebraic language. Tona (the facilitator)[6] is solving a equation on the chalkboard. Some noise is in the room. It seems that some mothers do not understand the strategy that Tona is using to solve the equation.
>
> Tona (facilitator): Every equation such as $ax + b = c$ has one unique solution.
>
> Mother 1: But... but...
>
> Tona (facilitator): Yes... (At the same time).
>
> Mother 1: I always did it like this, and I understand it that way... But teachers now they teach children to simplify, to let the "x" like... to have all numbers simplified. Then if I get three "x" here, and two more "x" over there, to make them "disappear" I need to take away these

[5] We use 'funds of knowledge' as defined by González, Andrade, Civil, & Moll (2001): "Funds of knowledge, then, are the historically accumulated bodies of knowledge and skills essential for household functioning and well-being" (p. 116). Language would be a privileged depot of 'fund of knowledge', as language is a cultural tool to transmit our World view from one generation to another.
[6] This was Tona's first day as a facilitator, working with this group of people.

two “x” in this side and I also need to take away the same 2 “x” in this other side...

Tona (facilitator): They [the children] do the same...

Mother 1: Yes, but this is more complicated...

Tona (facilitator): Let me explain you.

Mother 1: Because she [the teacher] wants [the homework] like this... and to me is, is...

Tona (facilitator): Let me explain you.

Mother 1: It is more complicated.

Tona (facilitator): Yes, it is more complicated, but the teacher may considerer that this is more clear in terms of concepts.

Mother 1: Yes...

(Some noise can be heard in the background. Tona starts to write down something in the board –see the figure-). [Javier] (facilitator): Aha, aha... ok. This is another way to solve it. (Fieldwork, IES Las manzanas. Third session; 2007/ARIE/00026; AGAUR, Agència Catalana de Gestió d’Ajuts Universitaris per a la Recerca).

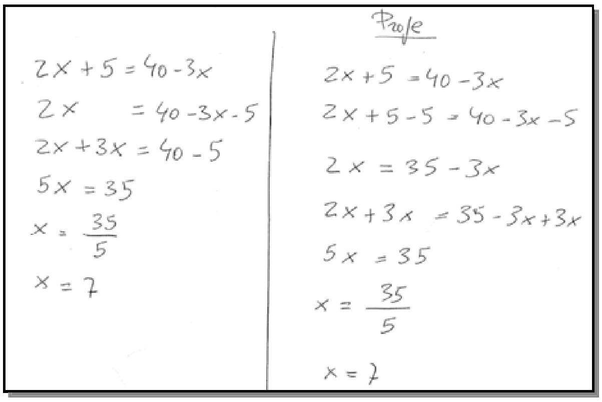
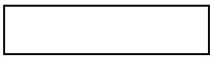


Fig. 1 Notes from the chalkboard

Here the problem was that parents did not understand the teachers’ explanation of how to solve a linear equation. There were reasons related to the differences between current strategies used by teachers and the way that parents learnt how to solve this kind of problems years ago. We discuss these reasons in other articles [Civil, Díez-Palomar, Menéndez, Acosta-Iriqui, 2008]. Here the important fact is the impact of the 'dialogic space' to promote this type of discussions. Adults feel free to participate and share their concerns about mathematics with the whole group. They present their own understanding, their own ways to solve the activities, drawing on their memories, experiences, and so forth. This dialogue is what promotes learning.

The class works as a common project for everybody. It is like 'team-work'. The agreement about respect for all opinions according to the merit of the arguments provided by the person to prove the validity (or not) of his/her statement becomes a fundamental element.

Context: Parents are working to solve this problem:

“If  is $\frac{3}{4}$ parts of a ribbon, draw the ribbon corresponding to $\frac{1}{2}$,$\frac{2}{4}$,$\frac{4}{3}$ and $\frac{3}{2}$. You may justify your answer."

Agustín: To four... three fourths... since they are the same, this bit would be the whole ribbon. That means...

(Some noise in the background)

Pilar: The total... the ribbon would be that...

Alberto: The unit is four fourths. You need to divide the bits, so you get four fourths.

Pilar (at the same time): ... we need for the whole unit...

Agustín: I don’t remember the percentages...

Somebody: The half.

Agustín: ... so if we have five sixths, then... here we can add as much bits as we need, and this would be the parts that correspond.

[Javier] (facilitator) –He stands up and goes to the board-

Somebody: There are two.

[Javier] (facilitator): Do you understand?

(Source: Fieldwork, IES Las manzanas. Fourth session; 2007/ARIE/00026; AGAUR, Agència Catalana de Gestió d’Ajuts Universitaris per a la Recerca).

Conclusions

Drawing on a sociocultural approach based on Vygotskian and anthropological perspectives (Scribner, & Cole, 1981; Lave, 1988; Saxe, 1991; Abreu, 1995; Rogoff, 1993), and also drawing on a dialogic perspective (Flecha, 2000; Aubert, Flecha, Garcia, Flecha, Racionero, 2008; Freire, 1997; Bakhtin, 1981; Wells, 2001), we highlight the necessity to build open 'dialogic spaces' to bridge home-based knowledge (funds of knowledge, situated practices) and academic knowledge. Previous literature provides a plethora of evidence that illustrates how adult learners learn by making meaningful connections between their prior experiences and new concepts. However, somehow this is difficult when adults need to overcome their own fears, lack of self-confidence, or differences in their previous experience because of age or their country of origin. Our research question led us to discuss the idea of building dialogic spaces as a strategy to facilitate adults’ participation in learning mathematics. Our data reveals that parents usually feel more engaged in the activities when they perceive themselves as members of a 'group' with a particular identity, and when parents envisioned themselves as playing a particular role within the group. Since many of them have some concerns regarding mathematics (such as fear, lack of self-confidence, etc.), dialogic spaces become safe places for adults to discuss mathematics while drawing on their personal background. This is the case of Maria, an immigrant from Ecuador, who felt really insecure at the beginning of the sessions and became more and more engaged in the classroom discussions (see dialogue between Maria and Will, above). Tona’s session is also an example that suggests the importance of the space. 'Space' includes not just the actual classroom, but also the group (with its own 'identity' as a group). When Tona attended the workshop for the first time, no one was sitting in the first row of chairs. All mothers chose seats from the second row to the end of the classroom. It was hard for them to start participating in that session, because there wasn't already a set of relationships built over time between parents and facilitator (Lave, 1988; Lave & Wenger, 1991).

We have discussed that parents from other countries use other 'funds of knowledge' to solve the activities proposed in the workshops. There is also evidence that exemplifies how parents learn different methods to solve the same activities that their children are doing currently in school. People come with their own understanding of mathematics, their own memories, procedures, and so on, to solve the different situations. For this reason, many different strategies came up. Will, for instance, came with the idea of calculating an average in order to figure out the size of the giant's footprint. He made a relevant contribution to the discussion, drawing on his memories from school in Colombia. As Will did, everybody was building on his or her own 'funds of knowledge'. Kristina (a mother from Romania) with elementary education, introduced the idea of 'rule of three' to solve the problem. Our data suggest that 'dialogic spaces' have the potential to impact on adults' learning because they may create a safe space for adults to feel free to share their previous knowledge, ideas, concepts, etc. The discussions rooted in these environments may open a space for adults to gain from each other's funds of knowledge. Further research is needed for a deeper analysis of the kind of processes carried out by adults in these kinds of situations. The study of interactions may be relevant to understanding these.

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