USE OF INFORMAL COGNITION IN TEACHING MATHEMATICS

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ABSTRACT

The new curricula are based on the premise that the inclusion of mathematics of every day life in the teaching of mathematics is very important in order to make school mathematics meaningful. In Greece also, there is the same spirit in the new curriculum, without it being noted that the mathematics of every day life is not common for all students.

Through a comparative study, we have already conducted, in two culturally different groups of students we found that they carry in to their school different informal cognition. In particular, we have posed activities, based on conditions of every day life, to a group of gypsy students and to a non-gypsy group. The way these groups negotiated the activities made it obvious that the different cultural context dictates different strategies in problem solving. This leads to the conclusion that, formal education should take in consideration the backgrounds students have.

1. Introduction

Over the last few years there has been an ongoing interest in socio-cultural elements that are related to the teaching and learning mathematics. This turn of researchers and mathematics educators is a consequence on the one hand of the fact that cognitive approaches don't give working answers for school failure and on the other hand of the fact that current research shows that mathematics and social-cultural context are indissoluble related.

Stefano Pozzi (1998: 105) and his associates note that the cultural context is an important framework to think about mathematical activity since people think and act within these contexts. "New investigations tend to focus on how activities are shaped by the social practices and to examine how this shaping informs our understanding of mathematical behavior and learning".

Lave (Lave 1988) through her research distinguishes every day practices from school mathematics. She notices that in every day practices individuals use any available resource –based on common sense— in order to transform and solve problems, as there are no imposed strategies.

Freudenthal (1991:7) points out the very important role of common sense as the root of early mathematics development: "In the course of life, common sense generates common habits, in particular where arithmetic is concerned, algorithms and patterns of actions and thoughts, initially supported by paradigms, which in the long run are superseded by abstractions."

There is evidence from around the world that children develop mathematical knowledge through the every day activities in which they are involved. (Brenner 1998: 216) And as the activities depend on cultural context the children acquire the corresponding informal cognition.

Although this is something obvious very often the cognition the children acquire before –or out of—schooling and "which is usuful one for every day life and work lost during the first years of schooling……..The former spontaneous abilities have been downgraded, repressed, and forgotten, while the learned ones have not been assimilated. Thus, early education instills a sense of failure and dependency".(D'Ambrosio 1985)

Curricula of the past that used to focus on typical and formalistic teaching were characterized by the underestimation of this kind of cognition. The new curricula focus on the inclusion of every-day mathematics in teaching school mathematics.

The usage of mathematics based on students' every day experiences --meaningful mathematics for all students-- is at the heart of the mathematics reform movement[i]. Likewise, in Greece, in the new curriculum the including of mathematics in classroom teaching and the development of what students have already learned is one of its objectives. Particularly, through problem solving, what is aimed at is "knowledge stabilization and application of what students have already learned through matters of their experience and through their environment". (Greek Curriculum)

The fact that the new curriculum mentions the value of using every-day mathematics is of course of great interest. Nevertheless, it is not taken into account the fact that mathematics of every day life are not the same for all students; students who come from different cultural groups other than the dominant one. So it is considered that low school aptitude and achievement of minority groups students is their own responsibility.

What it is presented here concerns a comparative study that has been conducted in groups of Romany and non-Romany students. Through this we can see the results we have if activities referred to are familiar and also the way of negotiation isn't strictly formal.

2. Context of the research and of the group

The study we present is based on research, which is conducted in the framework of a Ph.D. dissertation[ii]. A part of the first interesting findings that concerns the four operations is presented here.

The methodology that has been used is both ethnographic and educative. It is ethnographic in relation to the tools of data selected to find the answer to "what" connects cultural context and mathematics; it is educative in its purpose to make proposals that could improve mathematics education of the particular group and probably of minority groups, in general.

The main part of the fieldwork is a first grade class of exclusively Romany children. In the school there are also mixed background classes and pure non-Romany ones. During the past year we conducted observation, we posed activities as well as interviewing the students.

We extended the observation during the break to the school canteen where the students had to undertake transactions. The ease with which the Romany students conducted their dealings was remarkable and it is obviously a consequence of their way of life - of their cultural context.

Their different cultural context consist of the following elements:

-Semi-nomadic way of life with directs consequence on their schooling such as the time of starting school and the inconsistency in attendance.

-The socio-economic organization which is based on family and so children are involved in their families' business and through a horizontal way of teaching they become familiar with doing mental calculations.

-The fact of being a minority group which is related to their background and also to their limited expectation of education depending on their cultural fund.

Initially there were about 30 students, but after Christmas holiday there remained about ten. Only three of them had the corresponding age of their class --among them a girl. The rest were aged of ten to twelve. Some of the students were brothers with two and more years age difference.

The observations extended to the students' families and mostly to their businesses in order to examine the context in which the students develop. The parents of all the students deal with commerce. The majority of them are street greengrocers or sell household items on the street. One family apart from street commerce had got a small shop where we also observed young children in money dealings.

During the observation we were impressed by the fact that even children who were only three years old were dealing with money. Although they didn't know the value of coins they managed to carry out their purchases. Even children of five years old could distinguish between coins, mainly the ones they use more frequently.

Through the research we realized that Romany children are very much familiar with doing calculations—especially regarding money dealing. The following questions are posed:

1. What kind of informal cognition do students acquire through their every day practices?
2. Does this informal cognition dictate solving strategies in the class and out of it?
3. Could this cognition become a suitable didactical context, especially for these students, to teach mathematics and so to improve their aptitude?

3. Presentation of activities

Á. During the first period of the research in October, we conducted a test, mostly diagnostic. Among the activities there were two with money dealings context:

a. You have 5 hundred drachmas and you want to buy two cheese pies. If every cheese pie costs 2 hundred drachmas, would the money be enough?

b. Your father has given 1 thousand drachmas to your brother and to you five hundred drachmas, four hundred drachmas and two fifty drachmas coins. Has either of you got more money than the other? if so which of you?

At this time the number of students was about twenty-five. Twelve of them were selected as a sample representative in relation to age, gender and aptitude. The test was administered to each student separately at different moments and the students didn't collaborate.

With the exception of one girl who possibly got confused with the actual price of the cheese pie, all the rest answered correctly to both questions, although in some cases they could not justify their answers. In relation to the first question, the majority of them answered spontaneously and how much the change was. Almost all the anwers were of this kind:

"yes, I get 1 hundred drachmas change"

"yes, and I keep 1 hundred drachmas "

Some of the answers to the second question were:

" the same we get together, the same we get together"

"mine becomes one thousand"

"1 thousand, are all of these"

"9 hundred, and two fifty drachmas coin, 1000, the same"

"they will become the same, he gets as much as I get. ***We know them Miss****"*

We would like refer to an example of the way in which the students justify theirs answers:

"how did you find the answer;"

"I thought it up, in my mind Miss"

"please try to explain to us Anna!", (Anna was a girl of 7 years old.)

"*my mother told me that 4 hundred and 5 hundred and 2 fifty drachmas coins give us 1 thousand"*

A boy, of the same age, justified his answer with this way:

"I was looking for, I was looking for, I was looking for …."

Since the results were fascinating the test was tried in a non-Romany first-grade class. The sample was one boy and one girl with the best aptitude, one boy and one girl of bad aptitude, according to their teacher's estimation.

There are quoted all of theirs answers to show the differences.

-*"No, I need 1 thousand",* (to buy two cheese pies).

*"My sister" (*has got more money*)*

-*"Yes, the money is enough. I don't know how much change"*

"I get more than 1 thousand. I don't know how much"

-*"It is enough, I get 4 hundred change"*

"Fanis", he means his brother gets more money.

-*"No, the money is not enough"*

"To me"

B. Activity

In this class a group of 4 students –with ages ten to twelve- had separated themselves from the rest of the class and progressed at their own pace. The activity that is presented here is in a familiar context for them; even the name of the student and his father's occupation was true.

Basilis wanted to help his father to distribute apples in crates, which his father had got from the vegetable market. All the apples were 372 kg and every crate hold 20kg. How many crates does he need in order to put in all the apples?

Because of the limited of the space only some parts of the negotiation of the activity there are presented here. Students were encouraged to cooperate, without being obligated it.

(Apostolis was drawing lines on his desk: for every crate one line).

R: *please, tell me Apostolis what are you doing here?*

A: *10 crates Miss.*

R: *How many kilos do the ten crates hold?*

A: *20 kg every crate.*

R: *So….*

A: *Well, 20, 40, …….180, 200.*

R: *And how many are there?*

A: *372*

Cr: *I am thinking Miss….*

J: *(He continues) 220, 240, ….*

R: Y*ou Cris, what are you doing;*

Cr: *On this hand 72, the 60*

E: *What sixty; you mean sixty crates;*

Cr: *I don't mean crates, 3 crates.*

R: *How did you find it; (at the same time Apostolis and John continue to step by 20 up to 372).*

Cr: *I said 20 (he shows for every crate one finger) and 20 and 20, 60 and the rest are 12. I get for these (and shows the hand he imagines that he has the 300 kilos) 8 more, so I have 4 crates.*

……..

Cr: *I get from the 300 the 8, 4 crates miss, 8 and 12 miss the rest are…….. 302. No they are ….*

A: *250*.

Cr: *Wait! 292.*

R: *Bravo Cris. You had better write down the number so that you don't forget it.*

Cr: *I get from the 292, the 20, 5 crates, and the rest 272. Is it ok miss*

………..

J: *Should I also do the same miss?*

…….

Cr: *10 crates and the rest are 172. I get some more and they become 152. I am correct* (with self-confidence).

J: *look at him miss, he is doing them, he is doing them!!!* (with admiration).

Cr: *I get one more. I have 12 crates and the rest are 132. Now I get these 20 and the rest are 112, and I have 13 crates, all right?*

A: *All right.*

Cr: *Then, miss the rest are 112. Am I right; from the 100…. What I have done now, I am confused.*

E: *You are here at 112, you get the 12…*

Cr: *And I get 8 more from the 100, and now I have 92.*

A: *look at it! Look at it!*

Cr: *I put one more here (he means one little cube, he used for corresponding the crates)*

…………….

A: P*ut one more crate, the rest kilos are 12*

Cr: *Twelve*

……….

Cr: 1,*2,   19* (he counts the cubes)

E: *So, we needed 19 crates. What did you find?*

A: *19*

E: *Could you show as your one solution;*

A*: (Corresponding every line to 20 kilos) 20, 40, ……*

B: *100, 120, ….360, 380.*

E: *This last crate is going to become full?*

All together: *no*

Reviewing Chris solution we see that he used continuant subtraction. He got to subtract, from 372, 20 kilos at a time and so he found the number of the crates were needed.

It must be noted here that the students didn't know the algorithm of division, as they are students of first grade level. What they had been taught were simple operations with number up to 20.

After this, the test was tried in a fourth grade non-Romany class to see the differences in relation to children of the same age that had been taught the algorithm of division.

The results of the test were very important and very different from the results of the Romany students. Namely, none of them managed to find the correct solution. Only a few of them selected the correct operation and nobody of them used the algorithm correctly. The majority of them selected the operation of subtraction in order to solve the problem. Although they found illogical results they didn't question them. Many of the answers were: "he needs 352 crates", having selected the operation of subtraction. Some others doing multiplication: "he needs 7440 crates".

After these very disappointing results we conducted the test in a fifth grade class. Here six students of a total number of 18 selected the correct operation and also performed the algorithm correctly. Some of the rest selected the correct operation but made mistakes in calculation. About the half of the total number of students, used subtraction and multiplication. Of the remainder one of them firstly did multiplication and then to check, he did division. As he found the correct number (372) he was sure that his answer was correct.

4. Discussion

The way Romany students manipulated the activities makes it obvious that they had acquired concrete informal cognition through involvement in their parents' business. They have become conscious of the fact that: if you have to solve a problem which presents itself you should invent any suitable strategy to deal with it.

From the money dealings activity it is evident that money is a particularly familiar context to Romany students for teaching mathematics in primary school. Maybe it is useful to note the fact that Romany students approach decontextualized problems differently than in a money context. For example:

-5+3 =?

-……… (pause)

-You have 5 hundred drachma and your mother gives you 3 more.

-8 miss.

-

In the second activity we see that Romany students invented different strategies --subsequent subtraction, subsequent addition-- even the strategies they selected were based on the same store of cognition. As the context was a familiar one for them they faced it in the way they would do it in their life, out of school. They got over the fact that they hadn’t been taught the algorithm of division, mobilizing what they had already learned; mostly the out of school cognition.

Chris acted in an absolutely ‘natural’ way. His strategy reflected a real situation. If he had been called to solve a problem like this he would probably have taken 20 kilos at a time and put them in the crates. In this negotiation he used addition, subtraction, multiplication and also correspondence[iii] in order to solve a standard division problem in terms of formal education.

The main feature of the other three students’ strategy was the spontaneous selection of correspondence: for every crate (20 kilos) of apples they drew one line on their notebooks. This was also based on their parents’ every day practices as observed during the research. Apart from that, the students used multiplication in the form of subsequent addition.

The results become more important if we compare them with those of the students of the dominant cultural group.

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Firstly, in relation to the money dealing problem it is evident that the students of the first grade level didn’t have any familiarity with money dealings as unlike the Romany students they don’t use to have these kinds of dealings without someone else who has the responsibility.

More remarkable is the fact that the students of 4th and 5th grade (10-11 years old, that is the age of the Romany students) although they had been taught the operation of division and its algorithm didn’t get the correct results. It is worth how far formal education leads the students to solve problems mechanically and not to care if the problems have any meaning for them. They didn’t feel the need to reconsider of the results—to see if they were logical. They accepted even the number of 7440 crates in whicht to put 372 kilos of apples.

So we think that what arises here is the fact that these students who are presented as having low aptitude for school mathematics simply don’t have the suitable didactical context for it. If we had tested the same groups of students in strictly typical form it is certain that we would have had different results.

5. Conclusions

The weakness of the educational system to be designed or at least to be adaptable for Romany students --and generally for students with cultural diversity-- is presented as incompatibility between typical education and Romany children. More than this, formal education ignores or has the contempt for the cognition children acquire through their everyday context.

The particular case is indicative of the particular cognition students have got as they live in a group with different cultural elements such as their involvement in families business. Also, an other point that differentiates them is the non-corresponding age to their grade.

If we accept that children learn more easily through problems of every day life—problems through their experience fund—it is necessary research to be conducted that tracks down which are the practices and the techniques that are used and what kind of informal cognition arises from them.

Then this information should be utilized in design the curricula and also to educate teachers. It is very important for future teachers to know the cultural differences of a group, the special practices and the cognition the children could carry to school being members of this group.

If the teacher is contemptuous of and rejects cognition that children carry from their home culture the consequence would be school failure by students by different cultural groups and their alienation instead of empowerment.

School also should compose the expectations[iv] these students have from education and the objects of the typical education. In this framework a crucial issue arises: how school could develop the students informal cognition and at the same time find suitable didactical ways to pass in the typical form.

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[i] As Brenner (Brenner, 1998a: 216) points out.
[ii] The title is "The Role of Cultural Context for Mathematics through the Study of an Ethnocultural Group".
[iii] During the process of solving the problem he used a cube for every crate (20 kilos) of apples.
[iv] To notice that they are related with students background.