

Informal learning in mathematics

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Introduction

My research work stems from my personal experience with home education and from my belief in individualised, child-centred education. The aim is to find evidence of patterns of effective pedagogy in this type of education and phenomena that describe this kind of education in mathematics.

Theoretical background

Home education encompasses a number of different types of learning (Lowe et al., 2002) and every home educating family is quite unique, therefore, the process described in this paper should be seen as only one possibility or one approach to home education.

What is meant by *home education* is the situation when parents choose to take full responsibility for their children's education and to educate them without regular school attendance, out of institutionalized education system (Petrie et al., 1999). Dobson (1998) calls it *family-centred education*.

The flexibility of home education allows greater freedom in structuring days. A timetable is unnecessary and lessons can be put off if a child is not learning effectively for any reason. The parents are able to take advantage of those times when their children are most receptive, including the evenings and weekends. At home, lessons are often concentrated and intensive.

The focus of my research is a *child-directed learning* (Thomas, 1998). That is, children can often choose what they are going to study and when. By no means a situation of 'anarchy' or leaving children to their own devices is promoted but in this approach to education, children are not pushed to study mathematical (or other concepts) for which they are not yet mature.

By child-directed learning, we mean a situation when a great part of time devoted to education is led by the child's immediate interests, although some workbooks with drilling exercises in maths and spelling and some fill-in workbooks for science or history can be used, too. However, working with these workbooks, watching the TV news, everyday life activities, reading fiction or imaginative children books aloud and many other informal situations are often starting points for various kinds of *learning projects*.

The great advantage for home educated children is the individual approach in their learning process. The emphasis is often not on what they learn or on reaching standard benchmarks, but more on how they learn and reasons why they learn this or that. This may be one of the reasons why children in home education and their parents have relatively few problems with motivation (Meighan, 2001). This more "informal" approach is much more responsive to the child's developing interests. When a child asks a question, he/she is often mature enough for grasping the concept though in a simplified way. Learning, in this sense, is seen as something very natural and continual rather than something that occurs during the "school lessons".

Earl in his dissertation work loosely cites Fortune-Wood (2002) when he

expresses the opinion that autonomous education has a real theoretical underpinning in constructivist thinking as constructivism places the learner at the centre stage as the creator and processor of the learning. In other words, the learner defines the educational environment with the 'teacher' or 'instructor' in a facilitating role. (Earl, 2006, p.16)

The constructivist theory promotes real life situations and these are most common in home environment. Learning at home becomes an interactive process rather than a series of tasks to be tackled. Parents repeatedly refer to being able to 'strike while the iron is hot', to deal with problems as they arise (Thomas, 1998). If children get stuck, the parents do not proceed until the problem has been dealt with. Any mistakes children make, rather than creating barriers to learning, simply inform parents of thinking processes of their children.

When a child is allowed to organise his/her own learning process, to ask questions and then look for answers with the help of his/her parents or with the help of various study aids, then he/she has lots of opportunities to develop the competencies which should be the main goals of general compulsory

education. These competencies could be understood either as ‘*the ability to apply the knowledge and skills imparted by education to real-life situations*’ or as ‘*the development of key competencies, i.e., those that are essential in order to participate effectively within society.*’¹

It has become quite popular to say that in the future, the key skill will be the skill how to learn and how to acquire new knowledge. This skill requires the ability to find information, to ask appropriate questions and to check the answers. In that case children can learn a great deal of what we call curriculum informally, even in mathematics. However, on the other hand, mathematics is considered to be the subject which most parents teach in a more formal way than other subjects.

My research work is an intrinsic case study as it deals with only two children whose process of grasping mathematical concepts is followed, described and analyzed. The research questions are:

What ways do children use when they want to grasp a mathematical concept? What kind of real-life situations are motivational for their doing mathematics? How can discussions between two siblings influence their mathematical development? What obstacles are there in this type of education in mathematics?

Although some research has been done on motivation for home education (Fortune-Wood, 2002; Meighan, 2001), on academic achievements of children (Rothermel, 2002; Ray, 2003) or on cultural-historical background of home education (Kostelecka, 2003), almost no materials could be found on mathematics in home education.

Methodology

The methodology is based on the grounded theory approach (Strauss, Corbin, 1990). The main methods of collecting data include observations of home educated children in one family, field notes on interesting discussions between them and with their mother, taking photos of artefacts or videotaping various situations (when possible), doing self-reflections on mother’s dealing with the children, etc. Naturally, I face a problem of being the mother, ‘educator’ and independent observer at the same time. From this point of view my work can be likened to the action research works where the authors play a role of a teacher and a researcher at the same time.

A complementary set of data is based on a questionnaire for other home educating families which I prepared to enrich the collection of appropriate data and for triangulation purposes. In the pilot stage of the questionnaire, various obstacles arose. First, parents who have chosen this type of education for their children are often quite cautious when giving information on their educational experience. Some of them do not have much trust in institutions and try to avoid too much contact with them. Second, some questions of the questionnaire were misunderstood by parents. Parents (usually mothers) do not know how to answer them. It appears that discussing problems in a face to face conversation is more fruitful. However, this is only possible with parents who know the researcher personally.

Let us look at the example of misunderstanding a question. The question was as follows: *Do your children provide themselves with common household items when looking for any models for mathematics?*

The usual answer was: *No.*

But when discussing the matter, I often realized that there were various types of household items (cups for measuring ingredients for cooking, measuring tape or a compass) used during mathematical activities. But they are not viewed by mothers as „models“ for mathematics. Thus, I probably will have to complement the questionnaire with an interview with parents educating their children at home.

Finally, I want to mention another practical problem. It is quite difficult to say at any particular time which concepts have already been grasped and at which level as it is difficult to test children educated informally. If we want to measure their knowledge in a usual institutional way, they may be at a disadvantage. Consider the following story.

¹ *Key Competencies A developing concept in general compulsory education*, Eurydice, the information network on education in Europe, 2002, p. 31.

An eight year old girl works with numbers as big as 1 236 (grams) when baking and weighing ingredients. But at the same day, during term evaluation at a primary school, she is confused by the teacher's question: "Up to how many can you count?"

The question seems to be pointless to the child. She does not know how to answer because she has never tried to count up to something.

Case study

Our family has been home schooling our three children for six years now. During these years I have tried various approaches to mathematics teaching. My first experience with my oldest son could be called as a transmission way of teaching (Hejný, Kuřina, 2001). We started our home education in the fourth grade, so I bought a set of appropriate maths books from a common Czech publisher. Every school day we went through one page of the book, I explained new information to my son and then he was drilling it with the help of tasks in the book. We did not have any problems with this system but my own feeling was that acquiring new knowledge could be done in a more enjoyable way.

This progress is quite usual in home education. Despite the differences between the school environment and home, lots of parents start to educate children under the impression that it can be realized only by following some variation of the public school curriculum at home. This approach is often called *school-in-the-home* at internet pages intended for home school support.

I started to write down various questions my younger children asked² during the week and after a short period of time I realised that the scope of interest even by preschoolers was so wide that it covered compulsory material for school education nearly fully. At the same time I bought a Hejný's and Kuřina's book (2001)³ about a constructivist approach to the teaching of mathematics. This was the turning point of my thinking about learning mathematics.

When my middle child started the first grade I decided not to teach mathematics formally but to wait for questions and interesting situations. This is easier said than done. Sometimes the problem for me is that it is difficult to determine if anything important is actually going on and to start acting (or to use it for the learning purposes in mathematics). As Thomas stated:

What makes informal learning so difficult to pin down is that parents themselves are for the most part unaware of what their children are learning. As some parents remarked, it was only when they looked back over what they had done, or kept a careful record that they could see how much learning had taken place. (Thomas, 1998)

Another problem is assessment of the child's knowledge of mathematics. I finally decided to copy the tests at the end of textbooks. If my daughter solves these tests quite successfully I am sure we are able to keep up with traditional schools.

Above I mentioned workbooks with exercises which some parents use. I use them too, as they save time for the preparation of practice materials, however, I almost always use them in the process of crystallisation⁴ of new knowledge, not for the introduction of new knowledge.

For informal learning it is typical that concepts are often non-sequential and seemingly chaotic but very well *interrelated*. As soon as they are completely grasped they are durable and prepared for application when solving problem in real life situations.

For informal learning what Thomas (1998) calls *purposive conversation* is typical. As Thomas states, conversations are spontaneous and the child is an equal and active partner and s/he is almost unaware that s/he is learning. And sometimes the parents use the child's question as a starting point for an "educational" conversation and offers his/her "expert" knowledge.

² When young children reach the age of five, they are asking, on average, 30 questions an hour based on their natural curriculum. Tolstoy suggested that the only real objective of education was to create the habit of continually asking questions. (First published in the Roland Meighan column of Natural Parent, March/April 2000 under the title of 'The natural curriculum'.) <http://edheretics.gn.apc.org/EHT015.htm> accessed on 27.03.2007

³ Hejný, M., Kuřina, F.: *Dítě, škola a matematika* (Child, school and maths) . Praha, Portal 2001

⁴ Crystallization, according to Hejný (2004) is the last phase of the mechanism of acquiring new mathematical knowledge when new knowledge is being practised and connected with previous knowledge.

Some examples of purposive conversations follow.

Decimal numbers

In March 2007 my daughter (9 years 8 months old) was searching for information on the length of the Vltava river. In a set of maps intended for fourth graders⁵ she found: Vltava river – 430,2 km

This information led to the following conversation:

(S – student, M – mother)

S: Mum, what does it mean, four hundred and thirty comma two kilometres? (Comma is used in the Czech language for a decimal point.)

M: This comma is a decimal point. It is used for numbers we have not been dealing with yet. Would you like to know more about it?

S: Yes, I would.

M: What do you think? Is Vltava longer or shorter than four hundred and thirty kilometres?

S: Longer.

M: And is it longer than four hundred and thirty one kilometre?

S: No, it is not.

M: Well, the decimal point is used for a figure that is not exactly an integer. That means something is behind the ones. Do you remember which length unit is smaller than one kilometre?

S: One metre. One kilometre is a thousand of metres.

M: Well, the number two in the length of the Vltava river means two tenths of a kilometre. We need to divide one kilometre to tenths at first.

S: One tenth of a kilometre is one hundred metres.

M: And two tenths?

S: They are two hundred metres.

M: Well, the number for the Vltava length means that Vltava is four hundred and thirty kilometres and two hundred metre long.

A situation one week later:

During the dinner my daughter is studying a cocoa carton. She is reading about the importance of calcium for our bones and then the instruction for a cup of cocoa preparation.

The conversation follows.

S: How much milk is a zero twenty-five of a litre of milk?

M: A zero point twenty-five hundredths of a litre is a decimal number.

S: How much is a litre of milk?

M: It is one thousand of millilitres. (I was not sure what she meant with her question)

S: I think it is a half of a half, so it is one quarter of a litre of milk.

M: Yes, you are right.

S: I have thought it but I was not completely sure.

When my child does not ask other questions about this topic I do not usually deepen the concept. But my experience has already shown that if the child is mature for grasping it, he/she goes behind my explanations and wants to know more. During the time several conversations like the one mentioned above

⁵ *Vlastivědné mapy pro první stupeň ZŠ* (Homeland maps for primary school), Kartografie Praha, 2000.

may occur and when the time for studying decimal numbers in a more sophisticated way comes, the child has usually quite exact awareness about the concept.

Conclusions

Learning at home is a type of highly individualized education which is very interactive and in which no person takes the main part. The parent often serves as a facilitator for children and tries to be prepared at every part of the day to facilitate children's learning. The process of education is interactive, intensive (when proper time arises) and flexible.

As for my research, my task now is to put together all the data of my case study I have collected so far and analyse them using the grounded theory approach with a view to find phenomena describing informal learning of mathematics. I have to find a way how to structure such an analysis. One possibility is to follow over time the development of some mathematical concept(s) (such as decimal numbers above) and describe how it evolved in a more or less informal way and which role was played in this process by the child's motivation, by my intervention or by naturally arisen situations.

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