Introduction of the Concept of Length and Perimeter in Primary School

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Abstract: This paper investigates the acquisition of the concept of conservation of length and perimeter. Conservation means the invariance of measurement of a figure under some geometrical transformation, e.g. rotation, translation, reflection and construction of isoperimetric triangles, squares, and rectangles.
The study describes an experiment, which focuses on the issue whether measuring length and perimeter of different objects (buildings, fences) by both old Hungarian units and standard units might provide a contribution to the development of the concept of perimeter.
We have studied how the various educational activities performed in whole class, small groups, in pairs or individually can contribute to the cognitive development and creativity of pupils in this field.
Hungarian folk tales, the different activities and games play an important role in this experiment, which turned out to be efficient in teaching the subject matter.

Abstract: L'article s'occupe du concept de la conservation de la longueur et du périmetre. Conservation s'ignifie l'invarience de la mesure au cours du certaines transformations géométriques, comme par exemple: rotation, translation, reflection et de la construction des triangles, et des rectangles isopérimétriques.
L'étude décrit une éxpérience qui concentre sur la question si la mesure de la longueur et du périmetre des objets différents (clotures, batiments) avec des anciennes unités hongroises et avec des unités standardes peuvent contribuer au dévéloppement du concept du périmetre. Nous étudions en meme temps comment contribue au développement de la connaissance, a la créativité et a la facon de penser des enfants les différentes méthodes de l'éducation utilisées (toute la classe, groupes, couples, individus).
Au cours de l'expériences les contes, les activitées différentes et les jeux ont un role important, ils étaient tres efficaces en ce qui concerne l'éducation de ce theme.

Introduction:

Teaching measurement of the length is one of the most important parts of mathematical education in primary school, since this is the basis of measurement geometry. As experience has proven students have serious problems with measurement in every age group. The reason for this can be the following:

- In the first class pupils have to learn concepts and connections which most of them are not able to understand due to the characteristics of the age group.
- Children generally gain few experience in measurement and their experience acquired in real life is not used at school. Discovering the connection between the terms of everyday life and that of science is essential in education. (Vigotsky: Thought and Language)
- In Hungarian mathematical education according to the curriculum the measurements of length, mass, time and liquid measure and their units are introduced from the first grade to third. So we assume the children have acquired these quantities and level of relationships and abstraction that enables them to change the units of measurement in given number sets. This is inconsistent with theory of Piaget and also everyday experience.
- In our opinion it is probably not a good idea that the different kind of measurements follow one after the other in our textbooks and most of the teachers follow this order. So all units of measurement and the connection among them are taught at the same time, which will inevitably be confusing for the children.

In this paper we focus on how children gain experience in measuring length and perimeter and how they can combine it with their knowledge in real life. We suppose that collecting a large amount of

experience in measurement can help the pupils to grasp the concept of perimeter and area in mathematical education.

Research Question

We have attempted to find an answer to the question as to how we manage to put the concepts of length and perimeter into real life context, and to introduce these concepts after the required preparation through measuring in our environment, drawing open and broken lines, making polygons and defining their length.

Hypothesis

We assume that plenty of experience in measuring and also a lot of practice will contribute to the acquisition of the concept of perimeter and thus children will perceive more clearly the relationship between the concepts of perimeter and area.
While working in groups and pairs children help each other in various activities which is beneficial to their cognitive processes and level of knowledge.

The content and method of the study

The research has been carried out in the first and second grade of a school in a housing estate (Bocskai István Primary School in Debrecen, in Hungary). The class is average, the children are of different ability and their attitude to mathematic is varied too. The school is poorly equipped and the teaching methods lag behind the requirements of our age.
The children took part in the activities in the afternoon, and it was not the class teacher who was in charge of these afternoon sessions.
These aspects are very important in the choice of the school so that we could come to the right conclusions with respect to mathematical education

1. It was in the spring of 2004 that our research began. It was carried out in 12 lessons. At first we used the measurement units of Hungarian tales for the introduction of the measurements of length. We introduced the concepts of arm, fathom, span and step. After introducing and using these units the standard units of length, such as metre, decimetre, and centimetre were gradually presented.
   We have taken into account the following aspects during the experiment.
   a. The children are able to estimate and measure with various units the length, height, and width of the objects in the class.
   b. Children are able to put the various units of length into order according to size and verbally express the relationship between them.
   c. The data they gained can be organised in a given table and they can find the data in the table and the connections between them.
   d. The children often worked in groups to help and teach each other and to think together.

   The lessons were videotaped.
   At the end of this work the children wrote a test paper and the researchers checked the knowledge of pupils in this theme, another test was written a month later. We have made use of the experience gained here when planning the next stage.

2. The research was continued in the autumn of 2004 with the same children. In the second stage 14 afternoon sessions were held. We didn't introduce new length units; we focused on the connections of the units the children learned and the preparation of the concept of perimeter.
   We concentrated on the following aspects during the teaching:
   a. the children estimated and measured the length, width and, heights of large objects (e.g. the fence, the building of the school and the school yard) using different units (fathom, meter, arm and step). Actually we walked out of the classroom so that we could see how children are able to put their knowledge into practice.
   b. The children had to draw opened and closed figures by line segments on the square grids, then determine the length of them first by counting, then by using thread and ruler. At the beginning children were drawing according to the teacher's guidelines, then later on children themselves planned similar paths (broken lines). It was a great pleasure for them to share their paths with their classmates and also the managed to make them draw these paths.
      Problems during the drawing and counting
      i. At the very beginning only few children were able to define the length of the line by counting, since they calculated either the number of the inside tangent squares or the outside ones. A few of them changed directions during the count. These tasks developed beyond the determination of the length of line in counting and in orientation in plane.
      ii. In the course of measuring with thread the children observed that every line could be rectified, i.e. they discovered that the perimeter was identical with length. These measurements were carried out in pairs, otherwise it would have been rather difficult for them to fit the thread to the line.
      iii. Measuring with ruler helps to define the concept of perimeter, since the figure by line segments have to be added up in order to get the full length of the line. .
   c. For the preparation of the concept of the rectangle and square children worked in the school yard and classroom. The groups had to form different rectangles or squares by means of string of various lengths. (4 m, 6 m, 8 m, etc.) While doing this, children found out there were more isoperimetric rectangles, but there was only one square. This task was performed in groups of 6 or 7 , as four children were need to form a quadrangle, and one child was giving instructions and one was in charge of the tables.
   d. Children had to compare broken lines of the same length which were gained from coincidence transformations, and we were eager to see whether the children would notice it or not.

   The pupils' level of knowledge was continually checked by means of test papers whose results were applied in course of planning of the further work.
3. At the beginning of the third stage, in which twelve sessions were held, the children wrote a test since we wondered how much children could recall from what they have learned and what their shortcoming were. After analysing the solutions of the tests we made interviews with children. First we made interviews with groups, then with pairs. In the course of the group interviews those children were rather shy, who were not very active in the lessons either .The interviews carried out in pairs were more successful because they revealed more from the children's way of thinking.

We have taken into consideration several aspects when we selected the pairs.

a. We put an efficient pupil with a less efficient one in pair, and these pairs generally worked well together. However, there was an efficient pupil, who was not willing to work together with a less efficient one.
b. We have also noticed that friends worked together well, and they listened to each other very much.
c. The pairs of efficient pupils with the same level of knowledge didn't help each other very much either because they hadn't taken the work seriously or they were rather competitive
d. The pairs of less efficient pupils made progress rather slowly, but they helped each other.

The interviews were taped

The children made triangles, squares, and rectangles from colour straws according to various requirements in order to separate the concept of perimeter and area from each other. Pupils worked in pairs. The requirements were as follows:

i. The children had to construct from given colours,;
ii. The children had to construct polygons with equilaterals;
iii. Polygons had to have given length of the laterals;
iv. Polygons had to have different length of the laterals, but the same lateral had the same colour.

First the children measured the length of the pieces of the straws one by one and after threading the pieces on a string they measured the total length, which was compared with the sum of the lengths in the table. This act of comparison was not very precise several times because they thought it was unnecessary, the total length of the threaded straws was the same as the sum of the lengths in the table, and the difference came from the fact that they either did not manage to cut the piece of straw properly or they did not quite manage to fit the pieces together.

v. Construction of triangles and rectangles of perimeter of the same length respectively was a lot more challenging task for the children. While constructing triangles they insisted on having two sides of equal length, and in case of rectangles they insisted on having sides with length of a small difference.

One of the tasks was to construct a triangle of 16cm perimeter. One of the children, called Máthé immediately came of with the idea that "it is impossible to make such triangle as sixteen is not divisible by three". After showing them some models we could convince them that not every triangle is equilateral, however no one constructed general triangles.

One of the most creative children called Tamás came up with several solutions to break up sixteen. 10cm, 3cm and 3cm was one of them. The teacher praised them but also told them she would agree with their solution if they construct the triangles. Children worked in pair in this activity, and at this point the pair realised that something must be wrong as they were not able to tie the threaded straws together. At first they though they did not get the order right, but after trying hard in every possible way, they turned to the teacher. After understanding that the trouble was not in their measurement and threading, they realised that it was an important geometrical problem,

which was immediately solved by Tamás:"The two small sides together have to be longer then the big one."
These activities proved to be so successful that the pupils asked for subsequent tasks and forgot about even having dinner.

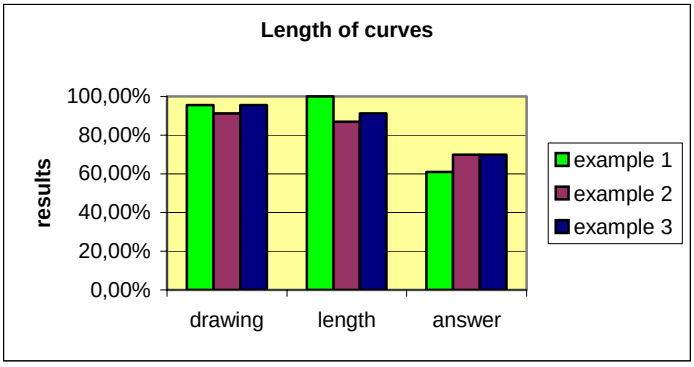
Results:

a. **S**ince during these activities children started from scratch, they did not have to face the fact of being stereotyped in the learning process. Thus even some of the pupils could have come into the limelight who were not able to do so earlier. It was particularly demonstrated in drawing open and closed figures by line segments and constructing polygons from straws and measurements in groups.

The length of the fence at the street (Munkácsi Street)	estimation	measuring
Fathom	28-32	53 and half
Meter	50-60	103
Arm	70-100	136
Step	115-120	163

b. The children were able to estimate much better than earlier, which is demonstrated by one of the measurements in groups. The table below shows how children were able to estimate during the first term of the second class and, it gives an account of the deeper understanding of the sizes of measurement units.
Four years ago we asked some of the third graders pupils about the length of the fence and they estimated it to be from 1.5 to 80 meters long. The whole length of the fence is 384 meters.

c. All of them were able to use the ruler properly, which can be due to the fact that in the pair interviews the more experienced pupil helped his or her partner to eliminate the mistakes
d. As a result of conversations, folk tales, interpretations of tales, interviews in pairs and group work their vocabulary has also increased and more and more pupils were able to express themselves and to come up with their opinion.
e. The majority of children could exactly identify the length of the segments which is also demonstrated by the results of one of the test papers in which the length of an open and two closed figures by line segments had to be identified, and one of them was a rectangle.



f. They do not mix up the measurement units of length with other units they have learned before, but they may have problems with other types of measurement units.
g. Identical lengths are recognised by half of the class in case of translation.

Conclusions:

a. The majority of children even in the second grade have difficulties in changing measurements of simple units. E.g. every child knows 1 meter = 10 decimetre but some of them are not able to express 5 metres in decimetres. Probably abstraction poses difficulties for them and they are able to carry out only conversions which they have done before.
b. More time should be allotted to teaching measurement, the materials to be covered according to the curriculum is too much. Therefore the time is not enough for measurements and the structure of course books is not really suitable to gain the necessary amount of experience in measurement.
c. The afternoon activities are absolutely suitable for carrying out measurements while the children are outdoors as if they were just walking or playing games in the playground. Their knowledge gained from everyday life could also be used in education. We could also make use of these afternoon activities, thus geometry and teaching measurement could be a more integral part of the curriculum.

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