Identification Games in Early Mathematics Education

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This article describes a type of identification games called "my sign - your sign", which can be used to develop, primarily at an intuitive level, a variety of mathematical concepts in early mathematics education. The article also presents our experience in using these games, suggesting two programming environments whereby a computer-based version of a "my sign - your sign" game may be implemented.

Introduction

Writing about concepts, R. Skemp stresses two concept components: its name and a class of corresponding examples (Skemp, 1986). Examining early mathematics education, we have found it useful to extend this view, by considering a concept as a three-component entity, the components of which are concept name (and symbol), concept examples and concept mental picture (Fig. 1). While concept name (and symbol) and concept examples are society dependent, concept mental picture, an internal product of concept formation processes, is fully individual, being, by itself, an important building block in our intuitive thinking. A complete formation of concepts requires the building of all three components along with their mutual links, but if a child's command of the language is not yet well developed, this building is bounded to the "examples - mental picture" fragment (Fig. 2). Note that an alternative concept schema may be more convenient for some other purposes (e.g., Vinner, 1983).

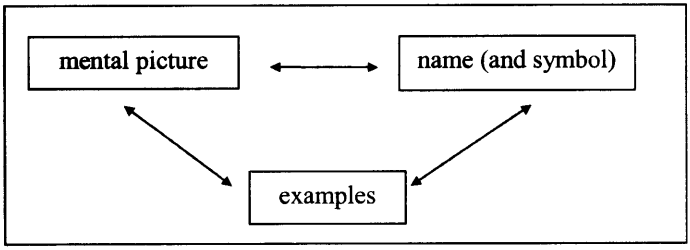


Fig. 1 The three-component concept schema

In the pre-school and early school periods, children learn a number of important mathematical concepts. Some of them are topological in nature: closed and open curves, various incidence relations, an abstract schema upon which the meaning of prepositions "in", "at", "on" and "out" is based, etc. Some deal with the concept of geometrical shape (all geometric properties of a figure preserved by homoteties), which seems to be the most fundamental geometrical concept when seen analogously with the conception of cardinal number in arithmetic. Some are concerned with orientation related concepts of "right", "left" objects (the case of congruence of two objects necessarily realised by means of a line symmetry). Others deal with cardinal and ordinal properties of natural numbers. Mathematical descriptions of such concepts usually involve (very) complicated formalizations, and the learning of early mathematics could be slowed down (or even blocked) if these descriptions are left undeveloped at an

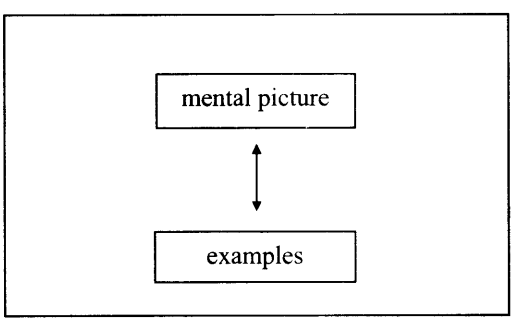


Fig. 2. The "examples - mental picture" concept fragment

intuitive level.

Our aim is to sketch a way of building fragments of the above listed mathematical concepts without the use of language beyond the child's spontaneously developed frame of vocabulary. This will be, of course, related to the schema represented in Fig. 2. To attain our aim, we suggest a form of two-person identification games called "my sign - your sign (Marjanovich, 1975).

Description of games

"My sign - your sign" games are implemented in the following way.

- For a chosen concept, two sets of pictures are presented (usually on the same page of a sheet of paper): a set of frequently scattered pictures labelled "my sign" and a set of ordered pictures labelled "your sign". These sets are often separated by a visible line, having the "my sign" set on the left. The game clue is given in the "your sign" set by pictures, each representing disjunctive groups of concept examples from the "my sign" set. The pictures within a particular group differ in colour, size, orientation, etc. Noise[1] could be gradually added, producing several levels of the game refining the same concept.

- The game is played by two players: an adult (the teacher, or a parent) who chooses pictures from the "my sign" set and the child who is left to choose pictures from the "your sign" set. The rule is: find your sign that matches my sign. The adult plays first.[2]

[1] A collective name for the set of all non-structural properties of an object.

[2] If not, he/she should make some mistakes in order to promote the child's explanations and get insight into his/her way of thinking, but this approach might be suitable only for older children who have achieved an adequate language command.

To make children familiar with the way the game is played, introductory games may be based upon matching of almost identical pictures representing familiar objects such as flags, traffic signs, etc. In other words, first matching may correspond to the identity of all possible pictures' properties, up to the difference of their positions in 'my sign" and "your sign" sets. Gradually proceeding, other games should have variations in respect of difficulty level. These variations are made by adding some amount of noise to "my sign" set, leaving "your sign" set unchanged. To use Gestalt jargon, while "my sign" set contains "poor" forms, "your sign" set contains "good" forms. These "poor" forms can be obtained from "good" forms by using:

- different colouring,
- changes in position,
- magnitude changes (which enlarge the classification relation to shape recognition),
- changes in orientation,
- continuous deformation (when topological classification enters).

Some examples of games, selected from the above-mentioned booklet (Marjanovich, 1975) containing about sixty models of games, are given in Figures 3-6.

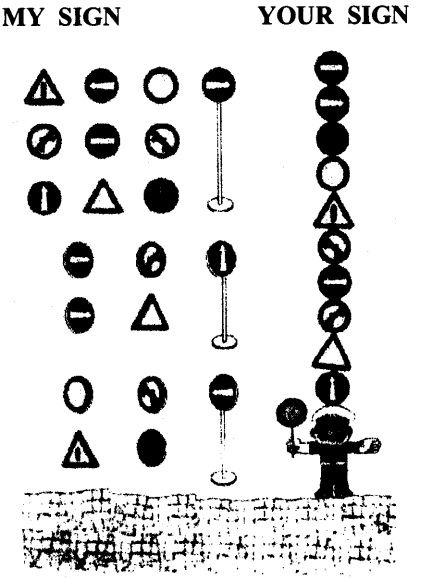
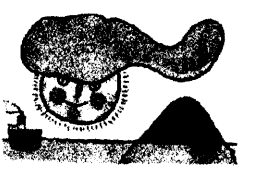


Fig. 3



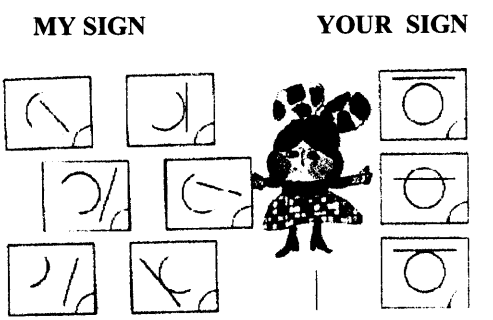


Fig. 4

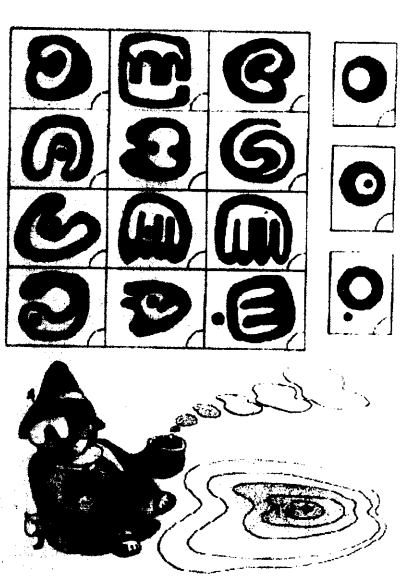


Fig. 5

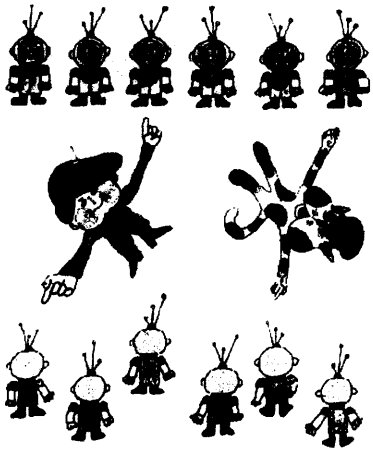


Fig. 6

Our experience suggests that children successfully discriminate picture-signs, and usually find the game clue easily. Once used to playing, a child spontaneously develops the habit of careful thinking and he/she frequently chooses his/her signs with accuracy. However, some degree of help may be needed, especially in case of complex games containing a substantial amount of noise. In such cases, to help children find what the clue is, harder games might be accompanied with some attractive tick-tack songs. Furthermore, we may use stage helpers, like in Marjanovich (1975), where Tom and Mary appear as bright characters and Dance Cat as a dull character (Fig. 7). (In case of several wrong matching, a series of simple games should be interpolated.)

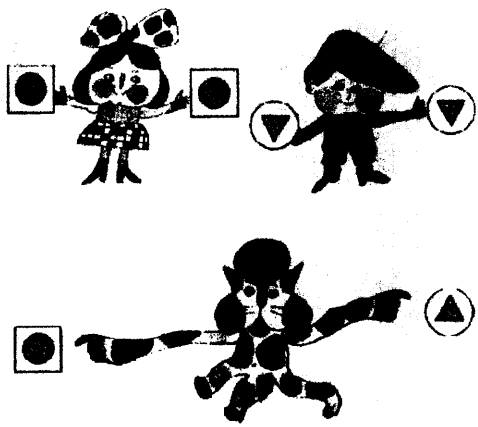


Fig. 7

"My sign - your sign" games, which presuppose the socio-constructivist nature of human knowledge (Ernest, 1991), support the constructivist representation approach (Cobb, Yackel & Wood, 1992). This is because children are not required to construct correct and accurate mental representations, mirroring mathematical knowledge built-in the game examples. Instead, they are encouraged to enrich their mental pictures and strengthen the links between the above-mentioned concept components of some not yet explicit concepts.[3] These mental pictures are realised as "good" forms from "your sign" sets. The selected "your sign" forms may be considered as spatial projections of internal mental pictures, and in that way they play the role of ideograms enabling interpersonal communication. Note that though "my sign - your

[3] "... the experienced transparency of instructional representations is a consequence of our own mathematical acculturation in the course we each actively constructed relatively sophisticated conceptions that make it possible for us to participate in the taken-as-shared mathematical practices of our society ... As long as we continue to assume that these representations are self-evident, we do not consider the possibility that they might be but one of a variety of alternatives or that [children] might not see what we see." (ibid, pp. 8-9)

sign" games are based upon classification, we do not consider concepts only as classification rules. They are rather complex clusters of procedural, declarative and inferential knowledge[4] (Kadijevich, 1993).

* * *

We recently jointly taught Didactics of Mathematics at the Teacher Training Faculty, Belgrade, occasionally using the examples of games from (Marjanovich, 1975). Our students produced many interesting variations of the games presented, and we enjoyed seeing that kind of creativity. Some years ago "my sign - your sign" games were also well-received by Kindergarten children, who willingly and successfully played them through attractive small-stage performances. We hope that our article will inspire some readers of this Journal to try out "my sign - your sign" games with children or students they teach. Note that "my sign - your sign" games have been primarily designed as parent-child mathematical games.

Some readers may wish to develop computer-based "my sign - your sign" games. To achieve this end, a number of powerful windows-based programming environments can be used. An easy implementation can be realised in Microsoft Visual Basic (http://www.msn.com). If the reader is interested in building a "my sign - your sign" game shell with some tutoring abilities, he/she may chose Amzi! Prolog (http://www.amzi.com) as its engine can easily be embedded in Visual Basic.

[4] While procedural knowledge, which induces algorithmic performance is concerned with carrying out specific procedures, conceptual knowledge (or declarative knowledge in AI), which fosters genuine understanding, deals with objects, their properties and mutual relations. Inferential knowledge, which promotes deductive reasoning, is concerned with general and particular patterns of reasoning. These types of knowledge can be fostered if children with a good language command are encouraged to explain a chosen match, give an explanation (pre-definition) of the underlying concept, and clarify the relations between signs of the same type (different types). In early mathematics education conceptual and inferential knowledge are usually poorly developed.

Concluding remarks

To summarise, "my sign - your sign" games can be successfully used to facilitate, primarily at an intuitive level, the teaching/learning of various mathematical concepts in early mathematics education. These games have been well received by both Kindergarten children and teacher training faculty students. Computer-based "my sign - your sign" games can easily be implemented. Further research may be directed toward the following goals: (a) determining, in fuller detail, the empirical values of "my sign - your sign" games, (b) implementing a "my sign - your sign" game shell (including some tutoring abilities).

References

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