TRAMES, 2005, **9**(**59/54**), 2, 192–206

https://doi.org/10.3176/tr.2005.2.06

DEVELOPING CHILD'S THINKING SKILLS BY SEMANTIC MAPPING STRATEGIES

Saule Raiziene, Bronislava Grigaite

Vytautas Magnus University

Abstract. Semantic mapping may be defined as a strategy in which information is categorically structured in a graphic/visual form. According to Lim et al. (2003) semantic mapping/webbing can be used for promoting teachers' and school principals' reflective and critical thinking skills. The present paper examines cognitive outcomes, stimulated by the teachers' use of semantic mapping as a strategy for accelerating two cognitive operations, classification and seriation, in a child's seventh year. Fifty-seven children at the age of six took part in the research. The members of the experimental group participated in the training that lasted for four months. During the training thought operations of classification and seriation were stimulated by a semantic mapping method. The changes in classification and seriation capabilities were assessed in experimental and control groups using tasks presented by Piaget and Inhelder.

Keywords: semantic mapping training, cognitive development, classification, seriation

1. Introduction

The majority of studies on teaching have explored its aspects related to the transfer of knowledge from a more proficient person to another, who is less knowledgeable (Strauss et al. 2002). In this paper we will examine teaching from the perspective of pupils' cognitive development from the point of view of the semantic mapping teaching strategy.

1.1. Concept of semantic mapping

The semantic mapping is a cognitive strategy in which information is categorically structured in a graphic/visual form. A number of similar terms can be found in literature, including semantic mapping, semantic webbing, modeling, graphic organizers, semantic networking, concept mapping, thinking maps and plot maps for labeling this concept (Fisher 1995, Lim et al. 2003, Moore 2003, Venger 1988, 1986). Of course, these terms are used to denote various strategies of graphic and visual representation of relationships between concepts and ideas. Thus, these terms are used to define similar strategies. However, some authors (e.g. Fisher) sometimes distinguish between thinking maps and concept maps: in thinking maps words/ideas are listed like in brainstorming, while in concept maps links between words and ideas are represented. In the present work the role of links is emphasized, and such terms as semantic mapping/webbing, semantic networking, concept mapping and modeling will be used interchangeably.

A semantic map, as a construction, has essentially two aspects: visual and conceptual. A visual semantic map is made up of forms, such as circles, triangles, etc. A conceptual semantic map contains "verbal information inside and between the forms, which represents relationships between words/ideas" (Fisher 1995:68).

There are various map structures that people use for representing and organizing their knowledge. A simple concept map creates a semantic web from a simple idea or a concept, while hierarchical concept mapping is a more advanced strategy to organize concepts into a hierarchy (Fisher). Information in a concept map may be organized in different ways: in a "linear" arrangement, where relationships between concepts are represented in lines and/or arrows drawn between figures. In a "spatial" form relationships between concepts are represented by a relative position of figures in space.

Semantic maps are typically organized from top to bottom. First, a more general concept (central idea) is defined. Then more specific concepts follow and a location on a map is found for each of them taking into account their interrelations and links to the central idea. A semantic map is read in the same way as it is created – from top to bottom, establishing relationships between concepts according to the lines connecting them in the linear structure of the map or according to their relative position in the spatial graphic form.

Semantic mapping as visual categorization of information serves a number of purposes. First, if one person shows to another how relationships between concepts may be represented using semantic mapping, s/he reveals the ways to categorize, relate, and organize ideas. According to Moore (2003:17), the teacher may transfer experience to children by showing them how "scientists sort and classify objects".

Fisher believes that semantic mapping is a very useful tool for teaching concept formation to children, because concept learning is a gradual process during which a child creates increasingly definite understanding of a concept by relating this concept to others. Lim et al. (2003) indicates that semantic mapping as a visual means stimulates cognitive skills of analysis, categorization, and synthesis. A study conducted by Pennequin and Fontaine (2000) using elderly subjects above 60 years of age found that semantic mapping training method may help optimize the inclusive reasoning of these individuals regardless of their level of education.

As the study by Lim et al. (2003) shows, teachers and educators can use semantic mapping/webbing to help teachers to develop reflective and critical thinking skills regarding the content and instruction of the subject matter. Semantic mapping not only allows receiving, visualizing, and organizing information, but also helps to interpret, re-think, and relate it to a person's schemes of understanding.

1.2. Semantic mapping as a training method of cognitive operations

On the stage of concrete operations (according to Piaget's theory) the most important aspect in the cognitive development is mastery of logical operations. Logical operations are internalized cognitive structures, which allow a child to formulate logical consequences. As any other cognitive structures, logical operations are constructed from earlier schemes by means of assimilation and accommodation (Piaget 2001). Logical operations are the means used by a person for organizing her or his experiences.

Operations of classification and seriation represent a sort of logical operation, and level of mastery of these operations influences the child's ability to understand and master the stimuli presented to him (Case 1985, Desprels-Fraysse and Lecacheur 1996, Halford 1982).

According to Piaget (1994), Wadsworth (1996), Souviney (1980) and Hunting (2003), operations of classification and seriation constitute the basis for child's understanding of the concept of number. The cognitive structures, enabling an individual to perform classification and seriation operations also help him in logical-mathematical reasoning.

The listed functions of the classification and seriation operations suggest that mastery of these operations in the pre-school age may be helpful for a child to prepare better for learning at school (reading, writing, narrating, calculating, etc.) (Kamii 1973, Taiwo and Toylo 2002). Thus it is justified to determine whether a special stimulation of classification and seriation operations is more instrumental in assisting a child to master these thinking operations than in the conventional conditions of development (without systematic influence on the development of these operations).

In search for an answer to this question, scientists often use a direct method of teaching of classification and seriation operations, i.e. they teach how to solve a certain problem or to answer a certain question, which they later use for the assessment of training results (Johnson 1977, Wohlwill 1973). In such cases the training effect is observed, but it is short-lived and does not help children to understand logical relationships between objects.

In the research, while giving pre-school children sets of classification and seriation tasks, conditions are created for them to systematically perform what they can. Thus, classification and seriation operations are stimulated. In these studies a positive effect on the development of classification and seriation operations is observed (Ciancio et al. 1999, Malabonga and Pasnak 1995, Pasnak and Madden 1996, Southard and Pasnak 1997). Such training also affects children's intellectual skills, measured with the help of standardized tests, e.g. Stanfort-Binet

Intelligence Scale, Wechsler Intelligence Scale for Children – Third Edition (Rhodes and Whitten 1997). The effect of training is not only short-term, observed in several months after the activities, but also long-term – observed after 15 months (Pasnak and Madden 1996).

Yet, the effectiveness of semantic mapping training on the classification and seriation operations development has not received adequate attention of researchers. In Venger's study (1986, 1988) children were taught for a year and a half, following a special program, using models in various fields. One of the fields of this educational program was representation of logical relationships between concepts using a method of semantic mapping. This study determined that 52.3% of subjects in the experimental group achieved higher level of cognitive development than the children in the control group. We may conclude that the method of semantic mapping may be used to stimulate classification and seriation operation at pre-school age. However, the results of this study do not specify the effects on the child's cognitive development of classification and seriation operations stimulation using the method of semantic mapping, because stimulation of these operations was taking place simultaneously with cultivation of other abilities (such as musical, constructional, etc.).

The purpose of the present study is to establish whether stimulation of classification and seriation operations using the semantic mapping method in the period of four months is more instrumental for mastery of these operations than in the condition of their natural development. In this study six-year-old children were chosen as research subjects, as this is the most rapid period of development of classification and seriation operations (Tomlinson-Keasey et al. 1979).

2. Research methodology

2.1. Samples

The subjects in this study were children in their seventh year, attending kindergartens in two largest cities of Lithuania (Vilnius and Kaunas). The pre-test was administered to 57 children. The subjects were randomly assigned to experimental and control groups. The control group included 29 subjects (mean age 77.7 months, standard deviation (subsequently SD): 3.9). The experimental group had 28 subjects (mean age 76.8 months, SD: 3.9). The post-test, which took place 4 months later, was taken by 53 subjects: 27 in the control group and 26 in the experimental group. Four subjects (two from each group) could not take the post-test, as they moved to another city or were ill for more than a month. Parents of each child gave their written consent for the participation of their child in the study.

2.2. Instrumentation

Before the semantic mapping training, the level of classification and seriation operations in each subject was assessed using four tasks created by Piaget and Inhelder (2002). The first two tasks – free classification and class inclusion – are intented for additive classification development, the third – for multiplicational classification development and the fourth – for seriation development research.

Stimulating material of free classification task consists of 18 cards, presenting six circles (three small circles – 3 cm in diameter and three big circles – 6 cm in diameter), six squares (three small squares– side 3 cm and three big squares – side 6 cm) and six triangles (three small triangles – side 3 cm and three big triangles – side 6 cm). Each of the corresponding figure sets is of a different color (blue, red, yellow). 18 cards were placed in front of the subject. The subjects had to classify these cards according to the shape, color, and size. This task helps to determine whether a child is able to anticipate classification schemes and to change classification criterion.

Evaluation of *the ability to anticipate classification schemes* (free classification task I) is based on three groups of criteria: (1) whether the subject is able to make a correct mental identification of the number of groups into which s/he would categorize figures; (2) whether the subject is able to name groups correctly; (3) whether the subject is able to identify correctly which figures should be assigned to specific groups. If the subject is unable to complete any of the above tasks, his/her ability to anticipate classification schemes is assigned to the 1st level (no anticipation observed). If the subject completes one or two tasks correctly, his/her anticipation ability is assigned to the 2nd level (partial anticipation). Correct completion of all three tasks warrants assignment to the 3rd level (complete anticipation). 1st and 2nd levels of classification schemes anticipation are characteristic of preoperational stage of thought, while the 3rd level is characteristic of the concrete operational thought (Inhelder and Piaget 2002, Lavatelli 1973).

The ability to switch classification criterion (free classification task II) is evaluated as follows: if the subject is able to change classification criterion not only in performing actual classification, but also mentally, s/he is in the 3rd level of classification criterion changing. If the child is able to change the criterion only when performing actual classification, s/he is in the 2nd level of classification criterion changing. Inability to change the criterion classification is characteristic of the 1st level. 1st and 2nd levels of classification criterion switching are characteristic of the preoperational stage of thinking, while the 3rd level is associated with concrete operational thinking (Inhelder and Piaget 2002, Lavatelli 1973).

Class inclusion task is designed for the assessment of the child's understanding how a specific subclass (it can be marked as A) is connected to the whole class (it can be marked as B). If the child understands class inclusion relationship, he/she is able to compare subclass A with the whole class B and to come to a logical conclusion that "all As are some Bs" when A < B. These links are defined by the concepts "all" and "some". Nine figures were placed in front of a child: 5 circles and 4 squares. These figures were in two colors – red and blue. There were only two red figures – two red squares. All other figures were blue. Each child was given 4 questions of class inclusion: "Are all the circles blue?", "Are all red figures squares?", "Are all blue figures circles?", "Are all the squares red?". The correct answer to the first two questions is "Yes", to the others – "No". The subjects received 1 point for each correct answer.

Multiplicational classification differs from the additive in the feature that during the performance of the multiplicational task two or more criteria should be coordinated instead of using a single criterion. Eight matrixes are used to establish whether the child is able to perform a multiplicational classification. Each matrix consists of 4 or 6 pictures. One picture is missing. Pictures are placed next to the matrix and the subject has to find the missing picture. In matrixes 1–4 two criteria had to be coordinated for correct classification. In matrix 1 and matrix 2 shape and color are coordinated, in matrix 3 shape and number are coordinated, while matrix 4 required coordination of color and position of a figure (in the picture the figure, e.g. a bird or a cat was rotated to the left or to the right). Matrixes 5–8 required co-ordination of three criteria. Matrixes 5, 6, and 7 required coordination of color, shape, and position of the figure, while matrix 8 required coordination of such criteria as shape, color, and size. One point was given to the subject for each correctly identified criterion. The subject could receive a total of 20 points.

Seriation task is designed to establish, whether subjects are able to anticipate seriation schemes and whether they are able to perform actual seriation. Ten sticks of different sizes and colors were placed in front of the subject. The length of sticks changed with an equal pace of 0.8 cm. The shortest stick was 9 cm, while the longest was 16.2 cm long. While looking at these sticks, the subject had to draw the series of these sticks according to their sizes and then lay them into a series. The subject's ability to anticipate seriation schemes was evaluated according to the drawing. If the subject was unable to draw sticks placed in the ascending or descending order, his or her ability to anticipate seriation schemes was judged to be of the 1st level (unsuccessful anticipation). If the graphic representation of the series by the subject was correct, but the colors corresponding to the sizes of the sticks were not properly selected, the ability to anticipate schemes is assigned to the 2nd level (global anticipation). If the subject draws the series of sticks in the order of magnitude and the colors corresponding to the sizes of the sticks are properly selected, his/her anticipation ability is judged to be of the 3^{rd} level (analytic anticipation).

The subject's ability to perform seriation is assessed on the basis of the mode of performance. If the subject is unable to seriate sticks, his seriation ability is assigned to the 1st level (unsuccessful seriation). If the subject attempts to seriate sticks using trial and error method, his seriation ability is assigned to the 2nd level. If the subject seriates sticks using systematic method, i.e. is looking for the smallest (largest) stick first of all, then for the smallest of the remaining sticks and so on, his/her seriation ability is evaluated as belonging to the 3rd level.

Apart from the 4 tasks used for establishing classification and seriation abilities, WISC-III test of general intelligence was administered to all children. WISC-III was standardized and adapted in Lithuania in 1997–2000. In this study testing procedure requirements presented in the “WISC-III Guide” (2002) were strictly followed.

In the post-test the same four tasks created by Piaget and Inhelder for assessment of classification and seriation abilities were used. To avoid the learning by heart effect, attributes (shape, color, etc.) of the means used for assessment were modified for the post-test.

3.3. Experimental training

The subjects in the experimental group participated in four months training sessions, during which development of logical operations of classification and seriation was stimulated using the method of semantic mapping. Training sessions took place twice a week. There was a total of 30 training sessions, which took place during the first part of the day. Each session took 20–30 minutes and had 10–15 children participating.

The purpose of the training sessions was to develop the ability of graphic representation of relationships/relations between objects. During sessions the children performed topological classification of objects (they did not categorize objects by size, color, or form as in the pre-test or post-test) using two forms of semantic mapping – “tree” diagram and Euler’s rings (see Figure 1). Both of these forms of semantic mapping are hierarchical as they reflect hierarchical relationship between concepts/objects. “Tree” diagram is a form of the linear semantic mapping, while Euler’s rings is a form of spatial mapping. Development of classification and seriation operations was first stimulated using semantic mapping in the

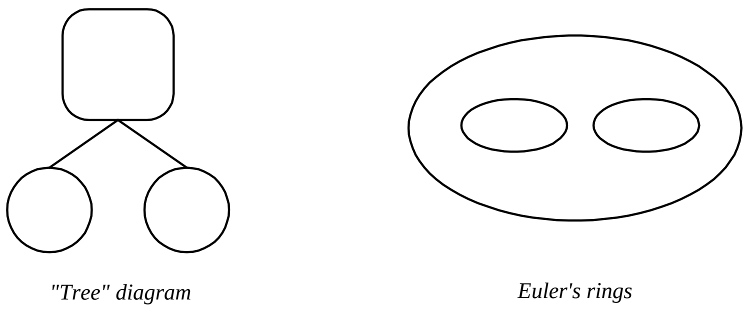

Figure 1. Forms of semantic mapping used in training sessions

form of a "tree" diagram. After the subjects mastered this method of graphic representation, Euler's ring form of mapping was used.

Sessions had similar structure of four stages:

Stage 1. A general concept was discussed. Initially the investigator presented a general concept. After some sessions the subjects were offered to present a general concept and they enjoyed it a lot. The investigator presented such concepts as people, furniture, animals, sweets, etc. Children in the experimental group suggested such concepts as space, cars, and home appliances. If no real things or things represented in pictures were used during the session, the investigator asked children to draw the objects assigned to the general concept on pieces of paper. The investigator demonstrated on a board or a large piece of paper how a "tree" diagram or Euler's rings may be used for the graphic representation of the general concept.

Stage 2. Specific concepts were discussed. These concepts were not only named, but also classified into two groups according to some selected attribute. The investigator demonstrated how a "tree" diagram or Euler's rings might be used for graphic representation of these specific concepts. If the concepts used were not real things or objects represented in pictures, the investigator asked to draw related groups of specific concepts on separate sheets of paper.

Stage 3: The investigator gave the subjects the strings, by means of which the subjects had to create a "tree" diagram or Euler's rings. The subjects placed real objects or their drawings into the created graphic structure.

Stage 4: The investigator gave to the subjects a task to represent on the piece of paper a general concept examined during the session and its relationships to specific concepts using a "tree" diagram or Euler's rings.

During the experimental training, it was noted that if at the beginning the investigator had to present rather detailed instructions, later a brief description of a task was sufficient for the subjects to be able to complete the task independently, without the help of an adult. In such cases Stage 3 was skipped. However, if any confusion concerning some general concept or its relationships to specific concepts emerged, a certain task was prepared for Stage 3 to help clear out the confusion and to promote understanding. Using this way it became gradually possible not to use real objects or their representations on paper (presented by the investigator or created by the subjects themselves) during the training session. Analysis was then conducted on the symbolic level.

3.4. Control group condition

While the subjects in the experimental group participated in the semantic mapping training sessions, the subjects in the control group attended their regular classes. During these classes the teacher presented drawing, cutting, and application tasks, fairy tales were read, or the children listened to music.

4. Results

4.1. Equivalence of groups

To establish whether control and experimental groups were equivalent, WISC-III and pre-test results of these groups were compared. Data of WISC-III, class inclusion and multiplicational classification were on interval scale, therefore the hypothesis of group equivalence was verified with the help of Independent Samples t-test. Data of free classification and seriation tasks were ordinal, therefore to verify the above-mentioned hypothesis the Chi^2-test was used. Statistical analysis revealed no significant differences between the control and the experimental group in IQ (mean value of control group 102.3 vs. mean value of experimental group 105.1, $t = -0.81$, $p > 0.05$), anticipation of classification schemes ($\chi^2 = 2.82$, $df = 2$, $p > 0.05$), change of classification criterion ($\chi^2 = 0.55$, $df = 2$, $p > 0.05$), understanding of class inclusion relationship (mean value of control group 2.2 vs. mean value of experimental group 2.3, $t = 0.22$, $p > 0.05$), understanding of relationships in multiplicational classification (mean value of control group 13.3 vs. mean value of experimental group 13.4, $t = -0.13$, $p > 0.05$), anticipation of seriation schemes ($\chi^2 = 0.53$, $df = 2$, $p > 0.05$), and seriation performance ($\chi^2 = 0.17$, $df = 2$, $p > 0.05$).

4.2. Effect of the semantic mapping training

Free classification task. Changes in anticipation of classification schemes in control and experimental groups are presented in Figure 2. When comparing the anticipation of classification schemes during the first and the second measurements in each group separately, statistically significant improvement in anticipation of classification schemes was found in both control (Sign test, $p < 0.01$) and

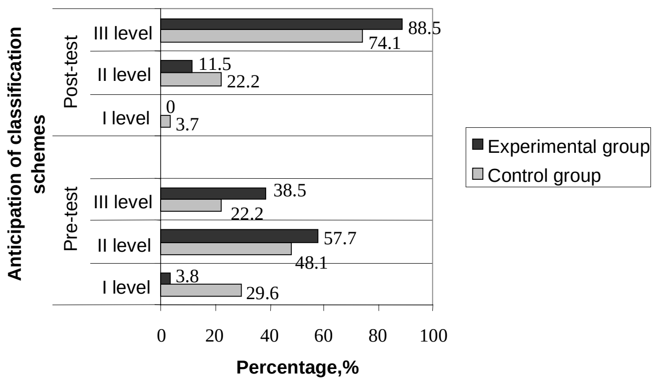

Figure 2. Indices of anticipation of classification schemes

experimental (Sign test, $p < 0.01$) groups. When the number of subjects in the experimental and the control group, whose ability to anticipate classification schemes improved or stayed the same during the four-month period (each of the groups had one subject, whose ability to anticipate classification schemes regressed. However, results of these subjects were not included in inter-group comparisons in order to achieve precise approximation of χ^2 distribution) was compared, no statistically significant differences were found ($\chi^2 = 0.01$, df = 1, $p > 0.05$, see Table 1). It may be concluded that the semantic mapping training had no significant influence on the ability to anticipate classification schemes.

Table 1. The researched subjects‘ distribution according to the assessment of changes in classification and seriation indicators

The subjects of research	The changes of classification and seriation indicators in 4 months			χ^2
	Deteriorated	Remained the same	Improved	
Anticipation of classification schemes				
Control group	3.7%	33.3%	63.0%	0.01
Experimental group	3.8%	38.5%	57.7%	
Change of classification criterion				
Control group	3.7%	74.1%	22.2%	**4.50***
Experimental group	3.8%	42.3%	53.8%	
Anticipation of seriation schemes				
Control group	3.7%	66.7%	29.6%	2.36
Experimental group	–	44.0%	56.0%	
Seriation performance				
Control group	3.7%	85.2%	11.1%	**4.43***
Experimental group	4.0%	56.0%	40.0%	

* $p < 0.05$

Pre-test and post-test results for the classification criterion change are presented in Figure 3. When comparing the change of the classification criterion during the first and the second measurement in each group separately statistically significant improvement in the ability to switch classification criterion was found only in the experimental group (Sign test, $p < 0.01$). Comparing the number of subjects in the experimental and the control group, whose ability to switch classification criterion improved or remained unchanged during the four months of the study (each of the groups had one subject, whose ability to switch classification criterion regressed; however, results of these subjects were not included into inter-group comparisons in order to achieve precise approximation of χ^2 distribution), it may be concluded that the semantic mapping training had a positive effect on the ability to change classification criterion ($\chi^2 = 4.50$, df = 1, $p < 0.05$, see Table 1).

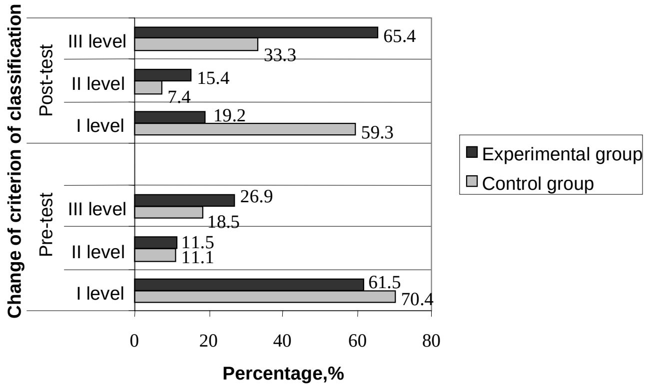

Figure 3. Indices of change of classification criterion

Class inclusion task. When comparing pre-test and post-test results in the control group, the deterioration of class inclusion results was found (pre-test mean 2.2; SD: 0.7 and post-test mean 2.0; SD: 1.0), although it was not significant (Wilcoxon Sign test Z = –1.00, p > 0.05; since the distributions of the variable's first and second measurement assessments' are not normal, this nonparametric test was used). In the experimental group improvement of class inclusion was observed (pre-test mean 2.3, SD: 0.8 and post-test mean 3.3, SD: 0.9), which was statistically significant (Wilcoxon Sign test Z = –3.33, p < 0.01). During the post-test, the subjects in the experimental group understood relationships of class inclusion better than the subjects in the control groups and semantic mapping training had a significant effect on this change (t = –4.03, p < 0.01).

Multiplicational classification task. Statistically significant improvements in multiplicational classification were found in both control (pre-test mean 13.2, SD: 2.5 and post-test mean 15.9, SD: 3.0; Wilcoxon Sign test Z = –3.37, p < 0.01) and experimental groups (pre-test mean 13.4, SD: 4.0 and post-test mean 18.8, SD: 2.0; Wilcoxon Sign test Z = –4.20, p < 0.01). Comparison of changes from the pre-test to the post-test in control and experimental group reveals that semantic mapping training had a positive effect on multiplicational classification performance (t = –2.82, p < 0.01).

Seriation task. Figures 4 and 5 represent changes in seriation scheme anticipation and seriation performance from pre-test to post-test measurements. When comparing seriation schemes anticipation and seriation performance during the first and the second measurements in each group separately, the anticipation of seriation scheme improvement in both control (Sign test, p < 0.05) and experimental groups (Sign test, p < 0.05) is observed. However, seriation performance improved only in the experimental group (Sign test, p < 0.05). Comparing the number of subjects in the experimental and the control group, whose ability to anticipate seriation schemes and perform seriation improved or remained unchanged during the four months of the study (results of the subjects, whose

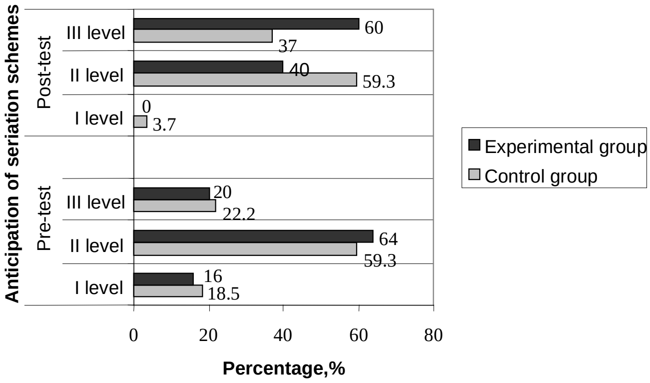

Figure 4. Anticipation of seriation schemes

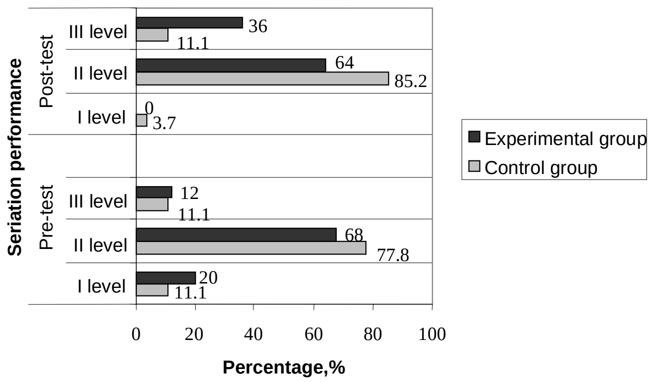

Figure 5. Seriation performance

ability to anticipate seriation schemes and perform seriation regressed, were not included into inter-group comparisons in order to achieve precise approximation of χ^2 distribution), it may be concluded that the semantic mapping training had no effect on the changes in the ability to anticipate seriation schemes ($\chi^2 = 2.36$, df = 1, $p > 0.05$, see Table 1), but had positive effect on the ability to perform seriation ($\chi^2 = 4.43$, df = 1, $p < 0.05$, see Table 1).

Discussion

The results of our study revealed that the systematic stimulation of development of logical operations by means of the semantic mapping instruction had a positive effect on such indices of mastery of classification operations as the ability to change classification criterion, understanding class inclusion relationship, and performing multiplicational classification, and on the index of seriation performance. As experimental and control groups were equivalent, we may conclude that positive changes in classification and seriation abilities in the experimental group were caused by the semantic mapping training.

The indices, on which there were no significant differences between the experimental and the control group, were the abilities to anticipate classification and seriation schemes. We may conclude that the abilities to anticipate classification and seriation schemes are rapidly changing in four months of the seventh year of life, regardless of whether or not the development classification and seriation operations is stimulated by the semantic mapping training.

The difference in changes in classification and seriation abilities indices between the control and the experimental group suggests that stimulation of development of these operations in the seventh year of life may improve understanding of the logical relationships between objects. During the seventh year of life the semantic mapping training facilitates mastery of the transformation process, which ensures mobility of schemes, i.e. ability to simultaneously anticipate two opposite processes – joining subclasses A and A' into entirety B (A + A' = B) and resolving entirety B into subclasses A and A' (B – A' = A).

The results of this study corroborate those of Venger. This leads to a conclusion that the semantic mapping training is a suitable method for stimulation of classification and seriation operations' development. The semantic mapping training influences thinking not only in adults (Lin et al. 2003, Pennequin and Fontaine 2000), but in children as well. Hence, it is not only sets of classification and seriation tasks that may accelerate the development of logic operations in the seventh year of life, but the semantic mapping training as well. It would be interesting to determine whether these methods of stimulation of logical operations development have equal effect on the development of classification and seriation abilities. This requires further studies in which the development of classification and seriation abilities would be stimulated by different methods in different groups. It would also be interesting to establish the long-term effects of the semantic mapping training on the cognitive and personality development of a child.

Address:
Saule Raiziene
Vytautas Magnus University
K. Donelaicio Str. 52-315
LT-44244 Kaunas
Lithuania
Tel.: +370 87 79506
E-mail: saule_raiziene@fc.vdu.lt

References

Cancio, D., A. Sadovsky, V. Malabonga, L. Trueblood, & R. Pasnak (1999) "Teaching classification and seriation to preschoolers". *Child Study Journal* 29, 3, 193–206.

Case, R. (1985) *Intellectual development: birth to adulthood.* San Diego: Academic Press.

Desprels-Fraysse, A. & M. Lecacheur (1996) "Children's conception of object, as revealed by their categorizations". *Journal of Genetic Psychology* 157, 1, 49–55.

Fisher, R. (1995) *Teaching children to learn*. Cheltenham: Stanley Thornes.

Halford, G. S. (1982) *The development of thought*. Hillsdale, NJ: Erlbaum.

Hunting, R. P. (2003) "Part-whole number knowledge in preschool children". *Journal of Mathematical Behavior* 22, 3, 217–235.

Inhelder, B. & J. Piaget (2002) *Genezis èlementarnyx logičeskix struktur*. Moscow: ÉKSMO-Press.

Johnson, M. L. (1977) "The effects of instruction on length relations on the qualitative seriation behavior of first- and second-grade children". *Journal for Research in Mathematics Education* 8, 2, 145–147.

Kamii, C. (1973) "A sketch of the Piaget-derived preschool curriculum development by the Ypsilanti early education program". In *Revisiting early childhood education (readings)*, 150–165. Joe L. Frost, ed., New York: Holt, Rinehart and Winston., Inc.

Lavatelli, C. S. (1973) *Piaget's theory applied to and early childhood curriculum*. Boston: A Centre for Media Development.

Lim, S. E., P. W. Cheng, M. S. Lam, & S. F. Ngan (2003) "Developing reflective and thinking skills by means of semantic mapping strategies in kindergarten teacher education". *Early Child Development and Care* 173, 1, 55–72.

Malabonga, V., Pasnak, R. (1995) "Cognitive gains for kindergartners instructed in seriation and classification". *Child Study Journal* 25, 2, 79–97.

Moore, J. E. (2003) "The art of sorting". *Science Activities* 39, 4, 17–22.

Pasnak, R. & S. Madden (1996) "Persistence of gains from instruction in classification, seriation, and conservation". *Journal of Educational Research* 90, 2, 87–93.

Pennequin, V. & R. Fontaine (2000) "Training the elderly: the example of class inclusion". *Adultspan Journal* 2, 2, 68–88.

Piaget, J. (1994) *Reč i myšlenija rebënka*. Moscow: Pedagogika.

Piaget, J. (2001) *The psychology of intelligence.* London: Routledge.

Rhodes, R. L. & J. D. Whitten (1997) "Early intervention with at-risk Hispanic students: effectiveness of the Piacceleration program in developing piagetian intellectual processes". *Journal of Experimental Education* 65, 4, 318–329.

Southard, M. & R. Pasnak (1997) "Effects of maturation on operational seriation". *Child Study Journal* 27, 4, 255–270.

Souviney, R. (1980) "Cognitive competence and mathematical development". *Journal for Research in Mathematics Education* 11, 3, 215–224.

Strauss, S., M. Ziv, & A. Stein (2002) "Teaching as a natural cognition and its relations to preschoolers' development of theory of mind". *Cognitive Development* 17, 3–4, 1473–1787.

Taiwo, A. A. & J. B. Tyolo. (2002) "The effect of pre-school education on academic performance in primary school: a case study of grade one pupils in Botswana". *International Journal of Educational Development* 22, 2, 169–180.

Tomlinson-Keasey C., D. C. Eisert, L. R. Kahle, K. Hardy-Brown, & B. Keasy (1979) "The structure of concrete operational thought". *Children Development* 50, 4, 1153–1163.

Venger, L. A. (1986). *Razvitiye poznavatel'nych sposobnostey v processe doshkol'novo vospitaniya.* Moscow: Pedagogika.

Venger, L. A. (1988) "The origin and development of cognitive abilities in preschool children". *International Journal of Behavioral Development* 11, 2, 147–153.

Wadsworth, B. J. (1996) *Piaget's theory of cognitive and affective development*. Longman.

Wechsler, David (2002) *WISC-III Guide*. Vilnius: Vilnius University.
Wohlwill, J. F. (1973) “The place of structured experience in early cognitive development”. In *Revisiting early childhood education (readings)*, 150–165. Joe L. Frost, ed. New York: Holt, Rinehart and Winston, Inc.