Effects of the Rostock model on metacognitive development of pupils

La influencia del modelo Rostock sobre el desarrollo metacognitivo de los alumnos

Ibolya Revák-Markóczi[1], Beáta Tóth-Kosztin[1], Zoltán Tóth[2], Éva Dobó-Tarai[2], Ilona K. Schneider[3], Franz Oberländer[3]

[1] Department of Teaching Methodology in Biology, University of Debrecen, Debreceni Egyetem 4010 Debrecen, Egyetem tér 1. Pf.: 85, Hungary
[2] Team of Chemical Methodology, University of Debrecen, Debrecen, Hungary
[3] Department of Education, University of Rostock, Rostock, Germany
revakne@delfin.unideb.hu

Abstract

The Rostock model is a programme based on an international cooperation, which didactic conception roots in the pedagogical theory of Wygostki, Bruner and in the theory of "conceptual change" developed by several American researchers. The primary aim of the model is to provide suitable learning surroundings to apply and understand scientific knowledge efficiently and successfully. During experimental teaching, the theme of water is dealt with from class 1 to class 4 in a longitudinal system. Dealing with the theme in a concentric way touches the significance of water, its occurrence, its states and changes of physical states, the problems of water pollution and cleaning, the ideas of water particles in the concept's of children and the circulation of water in nature. In accordance with concepts of didactics during lessons, on the one hand, there are groupworks, experiments done both by pupils and teachers, discussing, forming opinions freely, and doing several problem-solving tasks. While on the other hand, we try to improve and emphasize how to solve the problem, the exact aim of acquiring of knowledge, and improving the skills of realising shortcomings appearing in the process of acquiring knowledge. This improvment has been tested by asking students to solve a problem which is not used in teaching but requires the knowledge acquired during the experiment in class 1. Similar tests are to be done in class 2, 3 and 4. During evaluation of strategic elements, it was obvious that naming the aims, planning consciously and in detail, and proper evaluating were missing. At the same time excellent results were born in the terms of conceptions about problemsolving. The knowledge about knowledge may not be observed due to language issues, therefore while teaching, these strategies should consciously be reinforced.

***Key words**: Rostock model, learning, socialization, metacognition, problem solving*

Resumen

El modelo Rostock es un programa con una estrecha cooperación internacional, basado en las teorias pedagógicas de Wygotski, Bruner y del cambio conceptual. El modelo tiene por objeto construir el ambiente conveniente de los estudios, para que los alumnos comprendan bien el saber cientifico. Durante la enseñanza experimental el grupo de alumnos se dedicó al tópico del agua desde primero hasta cuarto año en un sistema ascendente. En las clases se analizó el tema de las cualidades del agua, de la ocurencia del agua, de la transformación del estado fisico del agua, las concepciones del alumno sobre las partículas del agua y la circulación del agua en la naturaleza. De acuerdo con este enfoque, los alumnos trabajan en grupos, efectúan los experimentos, discuten y desarrollan sus opiniones abiertamente, sin restricción; resuelven varios problemas. El modelo aplicado tiene como objetivo adquirir conocimiento, ampliar la aptitud y las capacidades de los alumnos, sus habilidadas de la metacognición y la solución de problemas. Se utilizó un cuestionario para los alumnos de primer año y adelante en segundo, tercero y cuarto grado. Durante la evaluación de esta estrategia se puso en evidencia que los estudiantes no adquirieron las capacidades para nombrar el objetivo, planificar consciente y detalladamente y evaluar congruentemente. Al mismo tiempo los buenos resultados se han obtenido con habilidades para solucionar problemas. Los conocimientos metacognitivos no se han detectado y hay necesidad de reforzar esta parte de la metodología.

***Palabras clave**: modelo Rostock, comprensión, aprendizaje, socialización, metacognición, solución de problemas.*

INTRODUCTION

The Rostock Model is based on an international cooperation philosophy (Germany, Hungary from 2004, Lithuania and Poland from 2006), a conception of didactics for helping scientific reasoning develop at primary schools which is rooted in the pedagogical theory of Wygotski (1978), Bruner (1968) and other Anglo-American researchers (Blythe, 1999; Charles, 2000; Clarke, 2001).

Wygotski's (1978) socio-cultural theory is mainly a learning theory, which centre's on levels of current development theories. According to this theory, a child who needs help can rise to a higher level of development and in this process, language plays an important role. Wygostki argues that the social and physical environment have crucial roles in cognitive development as well. He believes that the quickness of maturation varies in broad lines, within it the most important is the social cooperation which determines the development. On the basis of his theory, learning is a social cooperation and during it pupils work in different ways. Practical and theoretical instructions are given by teachers, partners and when groupwork is offered, pupils cooperate with each other, with their teachers and experts as well.

Bruner (1968) determined —similar to Wygotski— that socio-cultural environment has a crucial role so the schoolchild is confronted with problems that lies at the border of his or her horizon of experience and that lure him or her to the next developmental stage. The child's intellectual development can be cultivated by well thought-out intermediary questions. Neither easy nor difficult questions initiate learning process. As the child can answer easy questions without any help, while difficult ones cannot be answered or only with the help of others.

Bruner puts emphasis on the support coming from outside which supposes social interactions for learning.

There is another theoretical base, the theory of "conceptual change" which is in harmony with that of Wygotski and Bruner. In the early eighties, americans investigated both the concepts pupil possess about scientific phenomena and how these concepts change. American researchers developed the theory of "conceptual change", which was later applied to the primary stage by Susan Carey (1985). The theory's central assumption is that cognitive structures develop relatively continuously and in relation to specific fields. Through complex linking patterns and patterns of complex abstraction, these cognitive structures can be restructured. Therefore, formal-logical thinking is not the result of processes of development independent of the child's age, but rather the result of the structure and density of the child's knowledge.

According to Clarke (2001) understanding is important in learning process, which important tool is the connection between experiences from every-day life of the child and aquired knowledge. Such knowledge can support generative themes which help pupil's skills become transferable and interdisciplinary (Blythe, 1999). Themes like 'Water' can be dealt with in one or more subjects, which are may have interested by both by teachers and pupils. Learning these themes requires applying several theoretical and practical ideas and using problem-solving strategies. Futhermore this approach can provide an opportunity to study complex phenomena, as well.

That is why the Rostock Model emphasizes the social characteristic of learning and understanding, and interactive developmetal learning as well. Beyond that it pays attention to pupil's inidividual needs, motivation and their emotions.

Among the aims of the Rostock Model there is the improvement in problem-solving thinking and meatcognitive skills, for it applies group and individual work. In this process, reflecting and explainig experiments to understand the given phenomena must be crucial.

Metacognition is a cognitive process of improving thinking, the ability of conscious checking and controlling of cognitive process (Balogh, 1998; De Corte, 2001; Gordon Győri, 2001). Its two basic components are usually seperated. The first one is the knowledge about cognition while the other one is controlling cognition.

The first component includes the knowledge of when, how and why we do different cognitive activities. The features of knowlegde can be personal (the knowledge about our characteristics) and about the task (the cognitive knowledge of the task), futhermore it can be the knowledge of strategy (the knowledge about the use of the suitable strategy) (Flavell, 1981). The other component, the cognitive control deals with the use of the strategies which enables us to control our own cognitive efforts (like checking the results of our efforts, recognising and correcting our mistakes and controlling our learning strategies). These general problem-solving technics and the general principles of metacognition can be used in different situations and in all kinds of fields of learning (Baker, 1991). Several experts (Di Sessa, 1987, Fisher & Lipson, 1986) call attention to the importance of using metacognitive strategies in teaching science. A number of experiments were carried out to improve metacognition, though it has not often happened to class-1 pupils.

Model of "Conceptual Change" has lead to investigations of pre-school children. In these investigations, pre-school children were asked about the notions they held about scientific phenomena. Lacking proper knowledge and language, pupils use predictions to explain scientific phenomena, as shown in the precursor model (Koliopoulus, Tantaros, Papandreou & Ravanis, 2004). The base of these predictions is that the pupil explains the world around them, describes and predicts natural phenomena by the help of complex conceptions. But its system of knowledge has not been worked out properly and cannot be identified by the content of general plans or the rules of science. The system of knowlegde has to be recognized and pedagogical conditions have to be created for it to change. In this case pedagogical conditions mean forming accurate preconsumptions, forming hypothesis, teaching to plan experiments and how to put down experience and practicing basic strategies of problem-solving.

On the base of Rostock Model, we will explore several issues:

1) what effects experimental teaching had on the cognitive development of children, within it on the use of strategies;
2) an attempt to gain a clear picture about the extent of strategies of problem-solving (aim, hypothesis, etc.) appear; and
3) how much the transfer and application of the aquired knowledge from completed experiments were typical while solving the problem.

METHODOLOGY

There is a longitudinal research which follows the efficiency of the practical use of the theoretical The Rostock Model was used from class 1 to class 4 in primary schools. The chosen interdisciplinary theme is "water". Teaching happens in a concentric way. The annually repeated and expanding elements of the theme are the significance of water, its occurence and forms, its physical states and change of states, polluting and cleaning water and the characteristics of water molecule.

We devote 8-10 lessons to teach the theme each year. Before and after teaching, pre-tests and post-tests (parts of the tests are listed in Table 1) are used to evaluate and compare how much the system of concept of children has changed as the result of the applied method. There were different questions in the pre- and- post-tests (but the post-test 1 and 2 were similar) which relate to the same concept. (The second post-test followed the first three months later) We recorded answers of children on a chart. Based of these data we investigated the number of concepts' elements in pupils' answers and examined the change between pre- and post-tests.

At the end of the schoolyear metacognitive and problem-solving skills are tested by solving a problem task which needs to apply the learnt experiments to get the right solution.

About 300 pupils are examined in the countries cooperating in the programme. The pupils participating in the research remain the same, though they become older and older during the experiment. The project started in 2004. By that time the programme of class 1 and class 2 and the evaluation of class 1 had been completed as well as.

In the centre of the lessons there is defining the exact aim of acquiring the knowledge, realising it by pupils, how to get knowledge, understanding acquired knowledge and realising shortcomings as well. These aims of didactics are put into practice by consideration for teacher's instructions, discussions between teacher and pupils or between pupils, individual and group work, experiments, describing and drawing pnenomena, using experience from every-day life and the nature of thinking and language of the child (Figure 1, Table 2.)

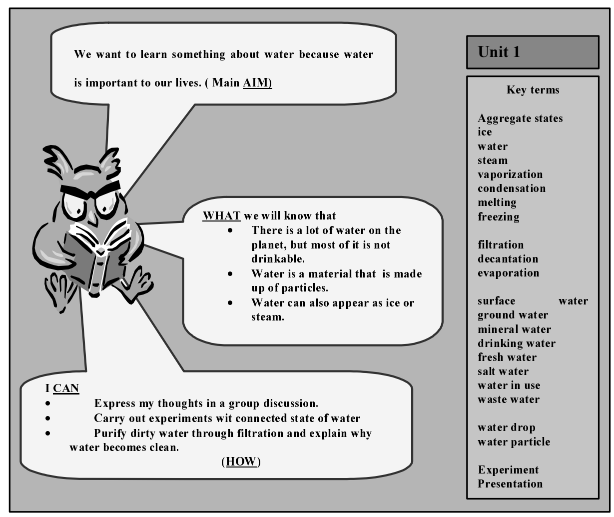


Figure 1. That help to make children aware of triple concepts (aim, what, how) of Rostock Model.

Table 1

Questions of pre-and post-tests abou state of water

<table>
<tr><th colspan="5">Field of experience: state of water</th></tr>
<tr><th>Concept</th><th colspan="2">Evaporation</th><th colspan="2">Melting</th></tr>
<tr><th></th><th>Pre-test</th><th>Post-test 1, 2</th><th>Pre-test</th><th>Post-test 1, 2</th></tr>
<tr><td>Question</td><td>The interviewer presses his wet hand on a dry table board.</td><td rowspan="3">You know water is a liquid. But water can also exist in other states of matter. What is water called in liquid or gaseous state?
Fill in the gap of text! Use the following words: water, vaporize, ice, condense, evaporate, freeze, steam, melt, boil
The water of a puddle ………………………in the sun. As a result.......................... develops.
When water is heated, it starts to................ and......................... As a result.......................................develops.</td><td>The child is showed an ice cube. What will happen with the ice cube if you take it in your hand?</td><td rowspan="3">You know water as liquid. But water can also exist in other states. What is water called in solid or liquid state?
Fill in the gap of text! Use following words: water, vaporize, ice, condense, evaporate, freeze, steam, melt, boil.
When it is very cold, water..................... As the result..........................develops. Ice ………………….. in the sun. As a result................develops.</td></tr>
<tr><td>Question</td><td>What has happened? What will happen?</td><td>The child takes the ice cube in his hand. What has happened with the ice cube?</td></tr>
<tr><td>Question</td><td>Where is the water left?</td><td>Where is the ice left?</td></tr>
</table>

Table 2
Lernmodul Unit 1 of water. (8-10 lesson)

Knowledge and Understand-ing	#1. Where do we find water? (The children know that water exists in the earth, on the surface of the earth [ponds, lakes, rives, seas], and in the atmosphere [steam, rain, snow, fog] .) #2. How can water change its form? (The children learn about and understand the aggregate states of water and realize that their occurrence depends on specific conditions.) #3. How can we purify water that has become dirty or polluted? (The children can purified soiled water by means of filtration, decantation, boiling, and condensation) #4. What is water? (The children come to see water as a material made up of particles.)	**Key Terms:** Aggregate states Ice Water Steam Vaporization Condensation Melting, Freezing Filtration Decantation Evaporation Condensation Surface water Ground water Mineral water Drinking water Salt water Fresh water Water in use Waste water Water drops Water particles Experiments Presentation
Abilitities	The children develop the ability: • to express their thoughts in a discussion • complete simple experiments	
Developing Attitudes	The children develop the need: • to work together with other children • to ask about the causes and conditions of events and processes • to try out things • to use water economically	

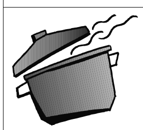
Learning Activities		**Assessment and Feedback in Productive Learning**
Lear-ing Phase	**Content**	
Introductin	The teacher discusses the significance, aims and criteria of the instruction with the pupils.	
	a. The children put together all of what they already know about water and talk about how their lives involve water (Talking in a circle--brainstorming)	The teacher offers stimulus and encourages every child to take part in discussions
	b. The children paint a picture expressing the theme: water is important (Individual work – homework).	The pictures will be hung up and discussed in a group
	c. The teacher summarizes the children's knowledge about water: There can be no life without water (Plenum: Instruction).	The children think about examples for these claim
Instructional Inquiries	d. What happens to puddles after it has stopped raining, and why?	The teacher works on the problem with the children.
	e. The children do experiments about evaporation at various room temperatures).	The teacher explains the basic features of a experiment and requires the pupils to observe carefully.
	f. The teacher does experiments on vaporization (wind) and demonstrates the evaporation of water.	The teacher requests the children to express their assumptions about where they think the evaporated water has gone and what influences the process.
	g. The teacher explains that water is comprised of particles that attract each other. He or she introduces the concepts of water particles, steam, evaporation, vaporization (Plenum: Instruction).	The teacher asks whether and how the evaporated water can be recovered.
	h. The teacher demonstrates condensation and explains the process using the participle model .	The children explain what happens when panes of glass (e.g. on a car or in the kitchen) fog up (Partner work).
	i. The partners present their explanations to their fellow students (Partner work: Short presentation).	Fellow pupils offer feedback. The teacher make sure that the pupils present information accurately and express themselves correctly
	j. The children make ice cubes (Homework) They measure the temperature of ice cubes. They heat the ice cubes and test the temperature at which they melt. They press a strip of mental onto the piece of ice and observe what happens (Partner work).	The teacher asks the children to consider why ice is so smooth that you can slide and skate on it (Partner work).
	k. The children summarize their observations (Discussion in a circle). The teacher explains the processes with the help of the particle model. She introduces the terms "aggregate states", "melting" and "freezing"(Plenum: Instruction)	The children explain why the snow melts when it gets warmer (Partner work).
	l. The children consider which conditions influence condensation, melting, and freezing (Discussion in a circle).	The teacher makes sure that the rules of conversation are maintained. She summarizes the influences: warmth, wind, pressure
	m. Homework: Where do we find water? The children bring in pictures from home on which certain forms of water are visible. Every child explains his or her picture and attaches it to an especially prepared board on the wall.	The teacher provides the lacking information on the water resources of the planet (Instruction).
	n. The teacher together with the children discusses the names for various forms of water. (Discussion in a circle)	explanations for the various terms.
	o. How can dirty water be purified? The teacher repeats the condensation process . The children do experiments on filtration and decantation (Partner work).	The teacher encourages the children to consider further means of purifying water. The teacher asks why well water is clear and clean.

Summary	p. The teacher distributes illustrated cards, on which various forms and processes of water are represented. The children receive the task of explaining the picture on their cards to the other children (Partner work; Plenum: Picture-based presentation)	The teacher gives informal tips on how to make a presentation. The illustrated cards are also available as transparencies . Feedback from the fellow pupils and teacher
	q. The teacher and the children reflect together on the aims and criteria of learning.	

It is important to mention that teaching is done with the help of similar integrated lesson plans and the system of concept. We can see the lesson unit for class 1 in Table 2 and one of the task sheets that children worked with in Table 3.

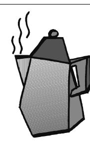
Table 3
One of task sheets for learning unit 1. "Water"

? Water evaporates	E 3
Name:	Date:



What we know:

We know that when water is heated in a kettle or a pot, it starts to boil and steam starts to rise.



What the teacher shows us:
- **She places some water in a dish.**
- **She places the dish on a tea warmer and she warms it with three tea candles.**

What will happen? We suspect
....

What do we observe? We see
....

Why does this occur? We know
....

Development of metacognitive strategies were tested after the post-test at the end of the class 1, in the autumn 2005 with a problem-solving task which required the previously acquired knowledge. Twenty-two pupils participated. The reason for not every pupil taking part in checking was that their number seemed to be enough to work out the method of studying. With the help of it, 154 cases of 22 pupils were examined.

The method of the research was personal interviews. Answers and attempts were recorded, rewritten and decoded. During interviews we allowed the pupil get to know the task and asked them to think aloud. After providing instructions to the task we did not give any help to the pupils, so we did not interfere their way of thinking. Pupils were asked to indicate when they were ready. The task was the following:

> "It is winter, the snow is falling outside and it is very cold. The water has frozen in the pot of the dog, Rexi. How can you help him?".

The following instructions were given:

> "The experimental instruments lying in front of you can help you solve the problem. There is warm water in one of the pots, and cold in the other one. You can see some cubes of ice next to it. Carry out the experiment and if you think it is necessary use your experiences to solve the problem. Think aloud. Always tell me what you are thinking about."

The correct solution was considered when the child realised that the dog could not drink because of the ice, so ice should be melted or drinking water should be provided from somewhere else. The experiment above was carried out to help the pupils recognise that melting needs heat.

Before experimental teaching pupils did not get any complex task similar to the one above. There was only one question in the pre-test which required more complex thinking.

"Drinking water we drink is clean. Do you have any ideas on how to clean polluted water?".

This task differs from the previous one as the solution of the problem is stated, namely, we want to drink clean water so it has to be cleaned. Only types of cleaning technics are asked, so forming hypothesis and planing cover each other. That's why we can investigate the existence of these two elements of problem-solving. However, in the above mentioned problem-solving task the child has to recognise the problem, namely, the water has frozen, so the dog will not have any drinking water, the problem has to be named and the aim to turn ice into water has to be pointed out. Afterwards the child has to think over the solution, how to melt ice, or any other possibilities, which lead to the process of forming hypothesis and planning. When the child solved the problem mentally, he could only make predictions. When the child evaluated and gave reasons for his ideas about melting using concepts learnt previously was considered to be an excellent solution. The child had to recognise the connection between the problem and the experiment which made the task even more difficult. It is the transfer's higher, a so-called second level. So through this task we wanted to find out whether the consciously applied metacognitive structures during experimental teaching really appear in the child's thinking.

As the above mentioned task of the pre-test contained fewer elements of strategy it was not worth comparing it to the post-test which was a complex metacognitive task with all of the elements of problem-solving. In these two tasks there were different concepts which were against comparing. too. While on the one hand, the task in the pre-test required concepts about stiring, and cleaning, and in the complex task, concepts of melting and freezing were needed. There are qualitative and quantitative differences between these two systems of concept, which are likely to end in difference between the numbers of strategical elements.

That is why we wanted to test the effects of teaching on pupils' being aware of metacognitive structures only with the help of the complex task mentioned later (drinking water of "Rexi dog").

RESULTS AND DISCUSSION

The answers of the children were evaluated in the following respects: naming the aim (conscious: direct or indirect, hidden aim) pediction, forming hypothesis, planning (within it conscious, full planning), evaluating, explanation, transfer.

During naming the aim when the child explaimed to us what he wanted to reach with the solution, it was considered to be conscious. It could be direct, when he said that the dog had to drink, so water had to be drinkable. For example: "I am thinking of melting the water for the dog so that he can drink." Or "I am doing it so that the dog can drink, because otherwise he would remain thirsty."

Another category is naming of indirect aim, when the child did not say that the dog had to drink, but he refered to it in an indirect way. For example: "I am breaking the ice and putting some water into it. I think it will be drinkable." Or "we should put the dog's pot onto the stove, lit the fire and wait until the water gets warm and the ice melts."

We speak about hidden aims when the child did not mention the above ideas, but at the same time he or she listed the possibilities of solution which meant drinking water. For example: "I am pouring hot water on the ice because it melts it." Or "The ice can be boiled or heated somehow."

The solution of the problem is considered to be a prediction when it contained explanations in addition to suggestions. For example: "I would light it with an infra-red lamp so that it gets warm, and I think it would melt too."

Thanks to the characteristic of the problem the hypothesis involved possibilities to make water drinkable, which means the same as planning. While we were evaluating planning speaking about the work in detail was considered to be conscious and real. For example: "I would put the pot of the dog into a pan and put it into the oven. I would set it to the highest. I would set the oven to 30 degrees and let the ice melt. But even 1 degree would be enough because ice melts at 0 degree."

About transfer two respects have to be taken into consideration. The first is whether the concepts of melting, freezing, ice, heat learned during teaching are used or not. The other one is that the experiment which provided help to the solution of the problem was carried out or not. According to it we can speak about a simple or a double transfer.

Table 4
Number of problem solving startegies'elements (N=22)

Number of strategies' elements	Aims			Hypothesys	Planning		Evaluating
	Direkt	Indirekt	Hidden		Conscious	Real	
	7	7	8	76	67	9	31

According to table 1 all of the 22 pupils were aware of the aim of the task, namely the dog's water has to be drinkable. Fourteen (64%) pupils spoke about it and 7 children refered to the real aim directly.

The number of mentioned hypothesis is really high. The avarege to 22 children is about three. All of the pupils had ideas to solve the problem. The most hypothesis mentioned by a pupil were six, while the least were two. Among hypothesis there were some with the same content.

For example: "I would take the pot into the house and melt it" Three from this type,

"I would put it into the micro." Two from this type,

"I would pour hot water on it" Five from this type,

"I would break the ice and spill it" Three from this type

So 63 different solutions were suggested by children out of 76, which majority was based in the concept of melting.

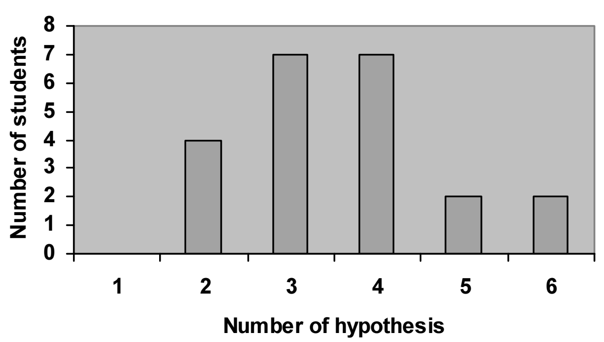


Figure 2. Number of hypothesis for one student

On the basis of Figure 2 we can make the conclusion that each pupil suggested 2 or more ideas, which coincides with the frequency of plan making (see Table 4). Most pupils suggested three or four solutions, while the number of hypothesis more than four is much less.

Plan making in harmony with forming hypothesis also assumes great dimensions. (As we have already mentioned ideas to solution were about its carrying out). We could read only nine ideas out of 76 which contained how to carry out it.

Evaluating and explaining were accepted when the pupil explained its satements and made a conclusion about the whole problem task.

For example: "...now we have spoken about melting."

The spoken evaluation is done by 29 cases.

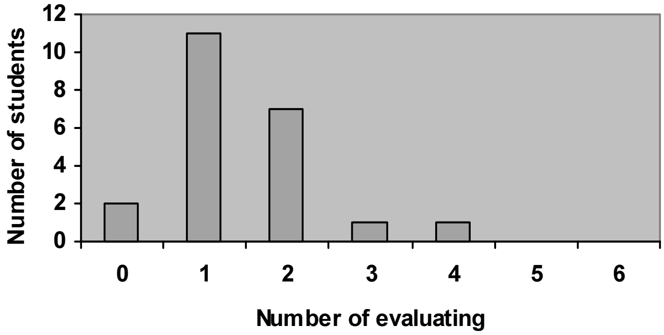


Figure 3. Number of evaluating for one children.

According to Figure 3 the majority of the pupils did one or two explanations. However, connection between explanations and the number of hypothesis have not been detected.

Considering these figures above, we can say though pupils go over some elements of problem-solving, naming the aim and conscious planning leave much to be desired. Supposingly, when the same pupils will be asked in class two and three we will get better figures, which will thank not only to the features of their age but to the Rostock Model.

As we have already mentioned, the central concept of the Model is the triple unities of aim, how, what we got to know, about which it was turned out that ideas and suggestions to solution and how to do it strengthened in pupils. Although the last one has been conscious completly. Children seem not to be able to tell what they are thinking or to finish the given idea. It cannot be accidental, as language issues and thinking skills of the pupils in this age are not in harmony, so the power of expression with respect to science is not proper (maybe because of lack of knowledge). For the sake of it it is worth making pupils speak more and more, and create such learning surroundings where they can express their own opinions freely without any anxiety. Another important idea of the Rostock Model about improving elements of strategy is that there should be the aim of learning the given knowledge, how to get them, at the end of the process what he has learned and at what level, and what shortcomings they have in front of the pupils all the time either on the board or by repeatitions done by the teacher.

Futhermore it is worth mentioning the predictions about how to solve the problem. The given hypothesis was considered to be a prediction when the child gave explanations, namely it said what would happen if it carried out the given idea. These numbers were 25, so one third of the hypothesis, which is very similar to the few numbers of evaluation. The matter of another further research canbe how the number of ideas changes during the real solving of the problem, not mentally, if predictions are refused.

The experimental teaching in harmony with the Rostock Model seemed to be successful in teaching the concept of melting as pupils could apply it to solve the problem in all of the cases. However there were seven children out of 22 who got the level of double transfer namely they carried out the experiment and used it to solve the problem.

The further aim of using personal interviews was to sum up pupils' knowledge about knowledge.

Putting aims and problems into words happened only 12 times. For example: "I am doing it so that the dog could drink." or "At the end I would like the dog not to be thirsty."

The hypothesis or rather fixing the moment of planning was mentioned once, while that of the evaluation five times. For example:" What shall I do? What shall I think about?..... What about throwing the ice out of the pot, or heating it, or taking the dog to the house as there there is running water! What would be the best to the puppy? I must think it over...".

At the same time other meditative statements about the rhythm of thinking, interest or about the solution were said 21 times. For example: "Nothing occures to me." Or "I don't know, I am tired toit now." "Well I have to find out something, but what...just a moment. Yeah, I have got it."

The number of these manifestations seemed to be really few, probably because in the period of experimental teaching pupils did no have enough metacognitive consciousness or rather as above mentioned the matutity of language skill of pupils does not let them express their thoughts clearly. This fact emphasises the significance of such learning surroundings where children can speak out their thoughts bravely.

CONCLUSIONS

The methodology applied in class 1 in primary school to emphasise one of the specific aims of the Rostock Model (aim, how, what) seemed to be efficient mostly in the development of the strategy of how. Further applying of the Model in class 2, 3 and 4 probably leads to realisation of the other elements of strategy, consequently they will appear in solution with a greater frequency. Similar conlusion can be said about the knowledge about knowledge strengthening needs more and more opportunities in real comunication in such school surroundings where pupils can express their thoughts freely by taking active part in learning.

ACKNOWLEDGMENT

This work was supported by the 'Hungarian-German exchange of scientists' programme (MÖB-DAAD project No. 28.).

BIBLIOGRAPHY

Baker, L. Metacognition, reading and science education. In: Minnick Santa, C. and Alvermann, D. E. (ed.): *Science learning. Processes and application.* International Reading Association, Newark, 2-13, 1991.

Balogh, L. *Learning strategies on basic of psychological development.* (In Hungarian) Kossuth Egyetemi Kiadó, Debrecen, 1998.

Bar, V. Children's views about the water cycle. *Science Education* **73** (4), 481-500, 1989.

Blythe, T. *The Teaching for Understanding Guide*. San Francisco: Jossey-Bass Publishe, 1999.

Brophy, J.; Alleman J. Primary-grade students' knowledge and thinking about the supply of utilities (water, heat, and light) to modern homes. *Cognition and Instruction* **21** (1), 79-112, 2003.

Bruner, J. S. *Processes of cognitive growth: Infancy.* Worcester, MA, Clark University Press, 1968.

Carey, S. *Conceptual change in childhood*. Cambridge, MA: The MIT Press, 1985.

Charles, C. M. *The Synergetic Classroom. Joyful Teaching and Gentle Disscipline*. New York, Longman, 2000.

Clarke, S. *Unkocking Formative Assessment. Practical strategies for enhancing pupils' learning in the primary classroom.* London, Hodder & Stougthon, 2001.

De Corte, E. School learning. (In Hungarian) *Magyar Pedagógia*, **101** (4), 413-434, 2001.

DiSessa, A. A. The third revolution in computers and education. *Journal of Research in Science Teaching*, **24**, 353-367, 1987.

Fisher, K. M.; Lipson, J. I. Twenty question about student errors. *Journal of Research in Science Teaching*, 783-803, 1986.

Flavell, J. Cognitive monitoring. In: Dickson, W. P. (ed), *Children's oral communication skills.* Academic Press, New York, 35-60, 1981.

Gordon Győri, J. Teaching and learning of thinking.(In Hungarian*) Iskolakultura*, **11** (2), 93-100, 2001.

Johnson, P. Children's understanding of changes of state involving the gas state. Part 1: Boiling water and the particle theory. *International Journal of Science Education* **20** (5), 567-583. 1998.

Johnstone, A. H., Mahmoud N. A. Pupils' problems with water potential. *Journal of Biological Education* **14** (4), 325-328, 1980.

Koliopoulus, D., Papandreu, M., Ravanis, K., Tantaros, S. Preschool children's ideas about floating: a qulitativ approach. *Journal of Science Education*, **5** (1), 21-24, 2004.

Osborne, R., Corgrove M. Children's conceptions of changes of state of water. *Journal of Research in Science Teaching* **20** (9), 825-838, 1983.

Russell, T.; Harlen W.; Watt D. Children's ideas about evoporation. International *Journal of Science Education*, **11** (6), 566-576, 1989.

Stavridou, H., Marinopoulos D. Water and air pollution: Primary students' conceptions about "Itineraries" and interactions of substances. *Chemistry Education: Research and Practice in Europe* **2** (1), 31-41, 2001.

Wygotsky, L. S. *Mind and Society. Cambridge*, MA, Harward University Press, 1978.

Received: 15.01.2007 / Approved: 20.04.2008

Reducing students' alternative conceptions on the reproduction and development in living things by means of conceptual teaching

Reducción de los conceptos alternativos en los estudiantes sobre la reproducción y el desarrollo de seres vivos a través de la enseñanza conceptual

Osman Cardak, Musa Dikmenli

Selcuk University Faculty of Education, Department of Science Education, Konya, Turkey
ocardak@selcuk.edu.tr, mdikmenli@selcuk.edu.tr

Abstract

In primary science education, there are different instruction methods used by science educators and teachers in order to change alternative conceptions held by students. One of the common methods used to change alternative conceptions is concept maps. The purpose of this study was to change alternative conceptions held by 6th grade Turkish primary school students in the context of the reproduction and development of living things in a primary school science and technology course. This study was completed with two 6th grade primary school science and technology classes consisting of 36 students in fall 2006. Concept maps, semantic feature analysis and conceptual change texts, and traditional science instruction were applied to the experimental and control groups over a period of six weeks. An achievement test over the reproduction and development in living things was given to both groups as pre- and post-tests to compare the two instruction methods. After analyzing the data, it was determined that students who learned reproduction and development in living things with the concept maps and semantic feature analysis showed statistically higher achievement than those students who learned the same subject material with the traditional method (P<0.05).

Key words: *reproduction and development, living things, conceptual instruction, biology, primary school.*

Resumen

*Hay varios métodos usados p*or educadores de ciencia y por los profesores para cambiar los conceptos alternativos que los estudiantes poseen sobre ciencia, en la escuela primaria. Los mapas de conceptos, por ejemplo, pueden ser utilizados para cambiar las concepciones alternativas. El objetivo de este estudio es cambiar las concepciones alternativas sobre procreación, el crecimiento y el desarrollo de los seres vivos en alumnos de una escuela primaria. Este estudio fue realizado con 36 estudiantes de sexto año de una escuela primaria durante un semestre de 2006. El grupo experimental utilizó mapas de conceptos, análisis semántico y textos para el cambio conceptual, en el grupo de control fue utilizado el método clásico. Este estudio se extendió durante seis semanas. Los dos grupos fueron evaluados al principio y al final de las actividades. El análisis de los datos indicó que el grupo experimental que usó mapas de conceptos, análisis semántico y textos para el cambio conceptual, acertó mas que el grupo de control que usó el método clásico (P<0.05).

Palabras clave*:* reproducción, conceptos de crecimiento, cambio conceptual, biología, escuela primaria.

INTRODUCTION

In recent years, many researchers in science education have focused on students' conceptual development and cognitive processes (Kwon & Lawson, 2000). It was basically accepted that each student had a different cognitive structure because of his/her different abilities, backgrounds, and attitudes (Piaget, 1969). Many studies in the science education arena deal with alternative concepts related to science subjects taught in primary and secondary schools around the world. Children learn new information daily and tend to comment this learned information in the direction of beliefs and ideas they develop through intuition before formal instruction. As a consequence, children begin to restructure scientific events. Educators now generally agree that students come to class with established ideas, but mostly different from those usually accepted by scientists. These different conceptions, generated by students, have been called alternative conceptions (Arnaudin & mintzes, 1985), children science (Gilbert, Osborn & Fensham, 1982), naive theories (Mintzes, 1984), or misconceptions (Fisher, 1985). Misconceptions, being quite widespread in formal education, are very resistant to change (Wandersee, Mintzes & Novak, 1994). Students seem to have difficulties learning concepts as well as to change preconceptions already held in science courses, including biology (Bahar, 2003; Kinchin, 2000; Treagust, 1988; Bloom, 1990). There may be several reasons why students hold on to alternative conceptions, including going back to the first years in school or even earlier (Bell, 1981; Pines & West, 1986). Alternative conceptions held by students are not easily changed throughout the school years and may adversely affect meaningful learning of new concepts and making connections with other concepts in science courses (Strike & Posner, 1982).