ANNALS OF THE POLISH MATHEMATICAL SOCIETY
5TH SERIES: DIDACTICA MATHEMATICAE 35 (2013)

DOKTORATY

Jan Amos Jelinek
Department of Early Childhood Education
Institute for Human Development Support and Education
Academy of Special Education, Warsaw
Poland

The effectiveness of educational multimedia programs in teaching mathematics to first grade primary school students[1]

Abstract: Polish and foreign scholars opinions differs in range of efficiency of use of multimedia programs for learning mathematics. On the basis of Polish researches can be concluded that the most popular program in the country „Klik uczy liczyć w Zielonej Szkole" proved to be sufficient in teaching of mathematics. This article based on the author research sheds some light on this issue.

Introduction

A study of Polish publications focussing on teaching mathematics to children with the application of (such as „Klik uczy liczyć w Zielonej Szkole" – "Click teaches to count in the Green School") leads to the conclusion that multimedia programs are effective (Kaczmarek, 2003; Watoła, 2006; Raszka, 2008).

[1]This text is the modified version of a paper presented on 29 of May 2013 at the Academy of Special Education in Warsaw, Department of Education, during a doctoral exam. The procedure was supervised by Prof. Edyta Gruszczyk-Kolczyńska. Reviewers were doc. RNDr. Jan Łaszczyk PhD., from the Academy of Special Education and doc. RNDr. Ewa Swoboda PhD., from the Rzeszów University.

Such results were achieved by applying experimental methods in parallel groups, which made it possible to compare achievements of students who used educational programmes with achievements of children who did not. Mathematical knowledge and skills were tested in order to establish effects of the learning process. The study showed that multimedia programs were effective in terms of acquisition of mathematical knowledge and skills

No publications have been identified which would discuss the learning process using multimedia programs. However, it is sufficient to observe children using the computer for a longer time in order to notice that students see educational programmes as games and an opportunity of entertainment, rather than a chance to learn.

A study conducted by an American researcher – Kengfeng Ke (2008, 539-556) confirmed that the "edutainment" only raises motivation – willingness to learn mathematics, but knowledge and skills acquired by using the programs are not translated into the knowledge and skills needed away from the computer in test situations (paper-pencil situations). One of the conclusions of this paper confirmed these reservations. Solving tasks using a multimedia programme tasks has a negligible educational influence, even if the number of tasks is by about one third higher than at school.

This paper presents the research procedure applied among Polish students who used the most popular multimedia programme for teaching math – "Click teaches to count in the Green School" (Kłosińska, Włoch, 2002). The programme is intended for children from 5 to 9 of year of age.

Methodology

The main objective of the research was to analyse the behaviour of first grade primary school students while using the multimedia programme in order to establish effectiveness of this process.

The research was conducted using the induction method, i.e. not hypotheses had been formulated at the planning stage. Instead, the author focussed on obtaining as much information about the learning process of children using multimedia educational programmes as possible. As it turned out, the choice of the road test allowed me to capture the most important issues of the problem as they were the strategies used by the students. Let me also add that the formulation of a hypothesis supposedly educational programme "Click teaches to count..." is ineffective and it would be unethical, because my intention was to create a situation in which students from the experimental group would benefit from this programme.

To isolate the factors that may had an impact on the learning process of examined students the author had to reduce conditions of research. the author had examined a class of students (N = 25, age 7 years), in which one teacher led activities, he used a training program, and children used the same educational package.

In addition, all students attended extra mathematical classes, which were ran by the same teacher. Children in the experimental group had to be able to use a computer to a minimal extent, and they were not to know the programme used in the study "Click teaches to count in the Green School". Such conditions made it possible to minimise the effects of other variables, and thanks to using the experimental method in parallel groups they made it possible to distinguish between educational effects of the programme in contrast to regular school learning.

The use of the multimedia programme "Click teaches to count..." was adopted as the experimental variable having a more or less significant impact on the level of knowledge and skills of students. To determine the impact of this variable the author had organized the pedagogical experiment described below.

Similarly to other researchers, the author planned to compare the change in the level of knowledge and math skills by conducting mathematical tests of knowledge and skills. For this reason, the author constructed a test of knowledge and skills in mathematics, in which the level of difficulty of tasks corresponded with difficulty level 17 of in the programme "Click teaches to count...". Consequently, this made it possible to compare the level of difficulty of problems solved in the programme with the level of difficulty of tasks solved in the mathematical knowledge and skills test. It turned out however that there were students who were able to solve much more difficult tasks in the mathematical knowledge and skills test than in the computer programme.

As mentioned above, by testing the level of mathematical knowledge and skills twice (pre-test – post-test) and comparing the results, it was possible to determine the effectiveness of the selected educational programme. However, the purpose of this round of research was to go beyond such information. The author intended to capture the learning process in students who used the programme "Click teaches to count...". This was necessary in order to explain its low or high efficiency.

In order to analyse the process taking place while student's used the multimedia program, it was necessary to simultaneously capture the actions of a child looking at the computer screen and the tasks presented at the screen. It was technically difficult, because observing the face of the child the author lost sight of the screen, and while the screen the author was unable to watch the facial expression, gestures, or even manipulations on the keyboard. To overcome this difficulty, the author used a camera built into the computer, which registered the behaviour of the child, as well as installed a recording programme (working in the background of the educational programmes "Click teaches to count…"), which made it possible to link information from camera to what appeared on the screen at the time. This made it possible to carefully analyse the behaviour of each student in the context of the educational situation created by the programme.

In addition, it is noteworthy that problem-solving is a characteristic feature of the math education. When a child solves tasks – it acquires mathematical knowledge and skills. If however it fails to do it, the learning process is interrupted. Thus, a good way to capture the learning process, was to capture and compare the two previously described layers of information: information recorded by the camera (facial expressions, gestures, manipulations) with the task situation created by the programme on the computer screen (and in the loud-speakers).

Referring to the organization of the learning and teaching process, the author had assumed that educational programmes were performing the role of a teacher. When authors of the programme created it, they had to adopt a certain teaching strategy[2] (its elements are: layout and structure of the task, difficulty levels, instructions and types of reinforcement). The strategy determined the selection of tasks and the methods of motivating children to overcome difficulties. However, the author noted that a description of such a strategy had not been included in the description of the programme. It only includes statements that the programme was effective and compatible with the school curriculum. Also students who used the programme applied certain strategies. For instance, they could:

- follow to the strategy of the programme and solve consecutive tasks;
- resist instructions of the speaker, stop solving tasks and instead experiment with various keys on the keyboard to see if "anything comes out of this."

By establishing the strategy of the author's programme and realising the strategies applied by students using the programme, it was possible to capture the features of the learning process of mathematics using the multimedia programme.

The students (25) had been divided into two groups:

[2]For the purposes of this paper , the term **teaching strategy – strategy of developing students' knowledge and skills** shall mean all actions undertaken by the programme (created by its authors) to control the learning process in students.

- control group of 13 students (six boys and seven girls);
- experimental group: 12 students (six boys and six girls).

At the beginning the author conducted a test of the mathematical knowledge and skills among them (both pre-test as well as post-test), which was led in a separate room individually with each of the examined students. The time interval between the first and the second test was 5 months.

A pedagogical experiment in which each student was confronted with the programme "Click teaches to count..." took place at the back of the class, behind all the students taking lessons in the classroom. At the first session, after a test of mathematical knowledge and skills, the student was confronted with the programme "Click teaches to count..." for the first time. The author asked the students to start the computer (and then independently switched on the recording programme – explaining that it was an application necessary to run the educational software), and then he allowed the students to use the computer. This part on the one hand tested computer skills (and checked if the students knew the programme), it was also the first in a series of 10 sessions with the programme "Click teaches to count...".

The following sessions differed only by the fact that the computer had already been turned on (also a recording programme was running in the background). Board with the programme was already in the station computer, and adult only asked to run a particular programme icon. From that moment the child alone carries out the instructions of the program: the appointment album for collecting stickers, launch the main map, and (optionally) a stand-alone change the difficulty of tasks in the programme. All activities of the student were recorded on the video player (without his knowledge).

After the experiment, i.e. sessions with the educational programme, a second test of mathematical knowledge and skills was conducted (post-test). The conditions and procedure were the same as in the pre-test. The only difference was that this time the children had to solve a lot more tasks. For this reason the testing of arithmetic knowledge and skills was carried out in two meetings. Each followed the same conditions.

Research results

At the beginning, by analysing the programme multiple times, the author determined who the authors intended to teach mathematics to children – this allowed him to formulate the **strategy of the programme's authors.** In the process, the author found that not all of the objectives set out in the leaflet supplied with the educational programme were actually implemented in the programme. For instance, some goals were implemented in a very superficial way through only one task (failed to make full use of the issue), other tasks would include false assumptions. It cannot be assumed that students will master a certain skill based on one task only, even if they solve it several times.

The programme is really oriented at teaching the following skills:

- counting in an expanding scope to 10 and 20;
- simple calculations: adding and deducting as well as multiplying and dividing in an expanding scope 10, 20, 100, 1000 (including crossing the decimal and the centimal thresholds);
- use numeracy and numeracy skills for solving descriptive tasks.

In addition, other elements included in the strategy of the authors of the "Click teaches to count in the Green School" are:

- Selection and arrangement of tasks aimed at achieving the previously mentioned goals. The author observed that numeracy-related and counting-related tasks had been developed to correspond with difficulty level 17 (arranged form the simplest ones to the most difficult ones). Creating degrees of difficulty authors adopted two criteria: the expansion of the scope of counting and numeracy, and the presentation of the tasks on the screen. Apart from the fact that programme independently adapted the level of difficulty of tasks to abilities of students, also students had the opportunity to select the level of difficulty. An analysis of their behaviour showed that they often used this possibility to gain easy rewards in the programme;
- A way to encourage students to solve tasks of increasing difficulty. The authors found that students want to deal with the programme for longer time if after solving a tasks the following items appeared on the screen: a short video of nature, an animation showing the main character, static images (e.g. pirate treasure), or a verbal praise. In addition, authors used the album with stickers to encourage children to perform the tasks (it was a form of reward). For the purposes of this research, it is important to note that the authors did not inform the student clearly what prizes can be expected if they solve the task. It was a way to force on the students to solve the tasks;
- Barriers within the programme to prevent students from solving tasks by the hit-and-miss method. Students were not aware of any barriers in the programme so establishing the result by the hit-and-miss method they tried to overcome the barrier by changing the pace of writing numbers. This action let students work around the barrier.

In the next part, the strategies of students using the programme "Click teaches to count..." will be discussed. During the research, the author amassed 48 hours of footage. This material allowed to establish what strategies students took in situations created by the educational multimedia programme. At the beginning it is necessary to note that during the experiment students from the experimental group solved as many tasks as they wanted (no pressure was applied). They also decided about the difficulty level of task they wished / or did not wish to solve.

As for the relationship between the difficulty level of tasks and the number of tasks solved by all students in the experimental group (Figure 1), the author found that up to Level 4 (tasks for the addition and subtraction up to 20) there was a growing trend in the number of tasks solved by students. Then, the number of solved tasks considerably decreased as the difficulty increased to Level 7 (tasks for addition and subtraction up to 100). Above Level 8 children were often confronted with tasks for multiplication and division, which the majority of students decided not to solve. As for the following tasks, the students would only solve those which involved addition and subtraction again (Levels 11 and 12).

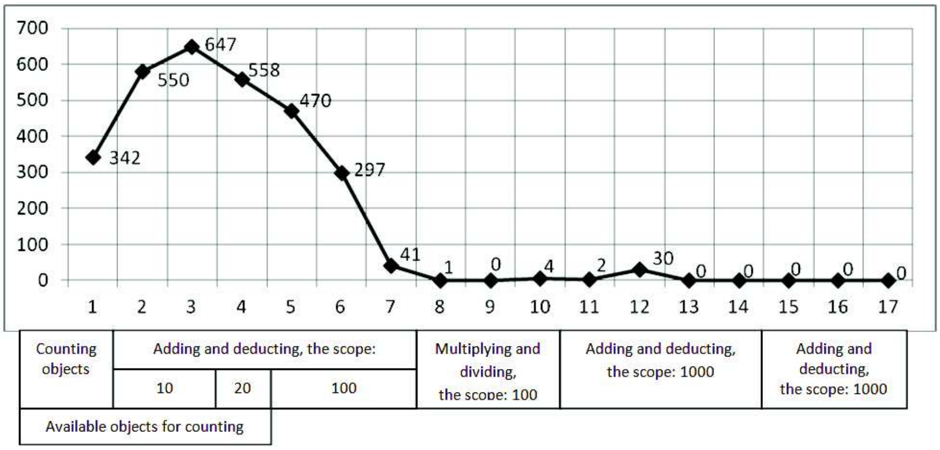

Figure 1. Summary of the total number of completed tasks at each level of difficulty (1-17) for all students in the experimental group. Own study

The vertical axis represents numerical values of solved tasks (up to 100, from 1 to 700). The horizontal axis represents seventeen levels of difficulty. Below them, the author informs about the types and extent of calculations which the students had to perform to solve the tasks.

At the time when the experiment using the programme was conducted, the teacher worked on developing arithmetic skills in children in terms of adding and deducting the second ten with crossing the decimal threshold (which is Level 4 in terms of difficulty of tasks defined by the authors of the programme “Click teaches to count in the Green School”). This explains the growth trend marked on diagram 1 (these tasks were easy for the students because they had the necessary skills)[3]. The fact that students in the experimental group (Czarek, Oliwia and Marta) managed to solve four tasks at Level 10, two tasks at Level 11 and 30 tasks at level 12 can be explained by the fact that these students applied the hit-and-miss method, writing consecutive numbers in the box (with the exception of Oliwia who solver easier tasks in memory[4]). When tasks appeared on the screen and students realised that they involved adding and subtracting they were willing to spend more time on these tasks because they had the feeling that they were able to add and subtract. Because the calculations turned out to be difficult they then went for an easy solution – writing numbers at random. Based on that the author concluded that (except Oliwia) students in fact did not solve problems at these levels of difficulty.

If in the course of using “Click teaches to count...” students solved tasks, they followed the instructions given by the software (what the speaker said, and what was shown on the screen) and in this way gathered useful experience to improve their calculation skills. If however they stopped to follow the instructions given by the programme (words of the speaker and displayed on the screen) and started to behave as they were pleased, their learning process planned by the authors was interrupted.

The fact that a child no longer followed the instructions, did not mean, however, that it ceased to learn. It still accumulated experiences but other than those that the authors have planned. This lead the author to the following conclusions:

- If a student follows the instructions (solves the consecutive tasks given by the program), he or she submits to the authors’ strategy;
- When a student stops to follow instructions of the programme, he or she switches to their own strategy, which has little to do with learning mathematics;

[3]As the results from the conversation with the teacher (and analyses of the educational package which he used) it turned out results that pupils didn’t know tasks of multiplying and dividing. It is explaining why children didn’t start to solve tasks for multiplying and dividing recognizing them as to much difficult.

[4]Both in the evaluation from the teacher as well as from the conducted of the mathematical abilities tests which results that Oliwia is displaying mathematical abilities over averages.

- Students switch to their own strategies also in a situation when they apply other methods than intended by the authors to solve the tasks (e.g. hit/miss approach).

An analysis of the behaviour of students using the programme "Click teaches to count..." indicates that at the beginning students submitted to the strategy of authors of the programme, then switched to their own strategies which were inconsistent with those of the authors. The time in which students followed the authors' strategy varied among different individuals – some worked longer in the way foreseen by the authors, other only briefly. However, no single child followed the instructions of the authors from the beginning to the end of the session. In the final part of the session, every one of them would apply their own strategy. Every in the final part of classes passed on personal strategies Analyzing the behaviour of students registered by the camera (frame by frame), the author distinguished four major strategies described below:

- **Strategy dominated[5] by counting objects rather than calculating on the symbolic level:** When the task was to calculate the result of a given mathematical operation, instead of trying to calculate it in the memory, the students would establish the result by counting (e.g. they would used the cursor to count circles on the screen and enter the result, this applied to tasks as simple as $4+3$ or $3+2$). This strategy dominated among children who were at the stage of counting using fingers (as a way of solving tasks). They ignored objects and used substitute objects. To them it was quicker and simple to use their fingers to count rather than laboriously touch consecutive circles with the cursor. The few cases of counting in one's head (students who entered the result immediately) were probably the result of intense practice.

- **Strategy dominated by the hit/miss approach rather than trying to solve the tasks logically:** Students would choose any number (at random) and repeatedly enter it in the box ignoring to the error signal (They did it in the hope that the programme would yield and approve the selected result for the task) or they entered in the box a randomly selected number and if the programme rejected it, they would

[5]In this place author is explaining that what is understand under the notion **"strategy in which dominating is..."**. Behaviors ranked among the strategy didn't appear in the separated way, but one after second. For example when the pupil ineffectively tried to set the result counting on their fingers had most often proceeded to establish the solution on hit or miss approach. Similarly when the pupil didn't manage to set the solution by the hit or miss approach escaped from the objective pressing the icon of the exit.

try another one[6]. It is significant that students often applied the hit/miss method to tasks in which there were no objects to count were displayed on the screen – only to illustrate mathematical operation. These were the tasks above the fifth level of difficulty. The authors predicted the possibility the applying the hit/miss approach to solve the problems, and for this reason they installed a blocking system in the programme (It is impossible to enter an incorrect, randomly selected number in the box[7]). The block is activated when a child enters several wrong answers at short intervals and the programmes prevents the uses from entering numbers for about 2 seconds. Some students noticed the block and tried to bypass it. They managed to do it by experimenting with the manner of entering numerical values (as it turned out it was enough to type more slowly).

- **Strategy dominated by the use of "lifeline" rather than trying to solve the problem by oneself:** The authors predicted students might have difficulties with solving certain tasks and introduced the "lifeline" option, in which the programme automatically entered the correct result. However, in order to use the "lifeline" option, the student had to try out all the buttons available under the bottom margin because the programme did not include information about what the "lifeline" was. It turned out that students treated the "lifeline" as a regular way of finding the solution and avoided intellectual effort.

- **Strategy dominated by ceasing to deal with the programme (escape) and experimenting with the keyboard instead:** "Escape as a way of getting out of a difficult tasks and looking for an easier one" – All examined students preferred this kind of behaviour. The only difference concerned the level of difficulty: Some students applied it already when crossing the first decimal threshold was crossed, others when more difficult tasks were presented. The escape strategy had two varieties: (1) exit and look for a simpler task (the difficult task disappeared from the screen), or (2) exit, lowering the level of difficulty, and then return to the task and solve in on a lower level.

[6]The first form is regarding writing solutions down without taking previous errors into account (is unreflective and mechanical), second is regarding taking made errors into account (reflective). Differences between these forms concern the effectiveness. In the reflective method students more quickly came to the solution of the task.

[7]A blocking of the programme is specially a security which was applied by authors of the programme in the objective of counteracting for mindless writing down results. This security wasn't described in the instruction attached in the package of the programme "Click learns to count..."

The research has shown that students apply their own strategies when the task is difficult and submit to suggestions of the authors when the task is easy (according to their subjective view). Exercise of the previously developed task solving strategies does not lead to the effective development new strategies.

In tasks in which it was possible to arrive at the result by counting objects, counting them was the prevailing strategy. The second most popular strategy implied counting substitute objects, and mental calculation – the educational strategy. A less frequent method was the hit/miss strategy to find the solution or the "lifeline" strategy (pressing the button which made the programme enter the correct answer automatically). Details are presented in Table 1.

		Czarek	Damian	Domini	Kacper	Konrad	Malwina	Marcin	Marta	Martyna	Oliwia	Tosia	Wiktoria
Author' Strategie	Counting objects	**81**	**109**	**206**	**237**	**139**	**158**	**203**	**76**	**186**	**94**	**100**	**167**
	Mental calculation	33	17	16		20		42	12	2		16	1
	Lifeline	2										12	
Students' Strategie	Finger countin	41		9		20		5	7	34			
	Hit/miss approac	11		21				1					
	Escape	Using the escape did not solve the tasks											

Table 1. Application frequency of five problem-solving strategies observed in simple tasks – on the first four levels of difficulty (from 1 to 4), and tasks with a plot. Own study

In tasks in which it was impossible to arrive at the result by counting objects – as was the case in more difficult tasks (from level 5 to level 17) – in most cases students would apply the mental calculation strategy. The use of this strategy in higher level tasks largely depended on a child's skills[8]. Students who could not cope with the difficult tasks would more often apply other strategies. These strategies were: counting substitute objects or establishing the result with hit/miss approach. The "lifeline" strategy was used exclusively by Czarek, Kacper and Tosia. Details are presented in Table 2.

Application frequency of four problem-solving strategies observed in more difficult tasks – on difficulty levels from 5 to 17, and in tasks with a plot.

Strategies used by students for solving tasks with a plot were found to be similar to those used for solving arithmetic problems. Based on an analysis of the video footage, the author observed that when students failed to cope with mental calculation they would use another way which was easier to them: finger counting or counting objects shown in the task. If this strategy failed,

[8]They are: Malwina and Wiktoria. The author is reminding that the scope of counting began from full tens of adding and deducting, as well as deducting a one-digit number up to full tens from a two-digit number.

the students would press numerical keys on the hit/miss basis or give up completely and abandon the task.

		Czarek	Damian	Dominik	Kacper	Konrad	Malwina	Marcin	Marta	Martyna	Oliwia	Tosia	Wiktoria
Author' Strategie	Mental calculation	11	**12 6**	1		**31**		**87**	**63**	**17**	**4**	**166**	
	Lifeline	7			8							3	
Students' Strategie	Finger countin	11	1		2			37	21	5	2		
	Hit/miss approac	**29**	25	**20**				25	14			4	
	Escape	Using the escape did not solve the tasks											

Table 2. Application frequency of four problem-solving strategies observed in more difficult tasks – on difficulty levels from 5 to 17, and in tasks with a plot. Own study

The following part includes a **comparison between strategies applied by authors of the programme "Click teaches to count. . . " and personal strategies in order to understand the reason why the children gave up solving tasks**. It is important to bear in mind that the process of knowledge and skills acquisition in students who used "Click teaches to count. . . " was determined by comparing the authors' strategy with strategies applied by students using this programme.

It was possible to determine that all children who had used the multimedia programme followed the speaker's instructions only up to a certain point. From then on they would apply their own strategies. The time which passed between turning the computer on and switching to one's own strategy was different for each session and each child.

Children who preferred the finger counting strategy did not pay attention to rings, circles or numbers presented in the task. They concentrated on the problem and solved it by finger counting. Whenever a problem presented in symbolic form (arithmetic operation) could not be solved through finger counting (above 10), they dealt with it by counting substitute objects, e.g. keys on the keyboard. Counting such substitute objects took a long time and so such children would solve considerably fewer problems. Then, probably because it made them tired, they would pass on to other own strategies, for example they started playing with the program, guess the result at random, etc. They behaved similarly while solving tasks with the plot.

The relevant factor in children who tried to find the result by the hit-or-miss method was the subjective feeling of difficulty. If they were unable to determine the result immediately (e.g. by counting objects or through mental calculation), they started experimenting with the computer, i.e. started to play with the numeric keypad in the hope that random numbers would be accepted by the programme. If this way failed, they either stopped dealing with the task and proceeded to the next one or closed the programme. All children used this strategy in the end, the only difference was that some of them did it sporadically and others at the first feeling of difficulty.

Children who realised that the "lifeline" icon made the programme enter the result automatically no longer tried to solve the tasks and instead focussed on clicking on the "lifeline" and enjoying the "gift" (In addition, this made the programme lower the difficulty level of tasks, which further encouraged them to use the "lifeline").

Children who preferred to escape rather than solve the tasks were also guided by their subjective feeling of difficulty. It was characteristic that they assessed the level of difficulty by looking at a task and not by trying to solve it. The time which passed between starting the computer and the first escape varied (sometimes it happened after a few minutes, sometimes after almost twenty). It is worth adding that all children used this strategy,the only difference was that some of them did it more frequently (as their dominant strategy), and others rarely or only as an expression that they no longer used the programme after a certain task cost them too much time.

It was noted that children would follow the authors' strategy for as long as the learning process organised by the programme corresponded with their skills. Otherwise they would ignore suggestions of the programme and try to deal with the programme on their own. The author observed **four main causes why students would abandon the strategy of programme's authors:**

1. The authors incorrectly assumed that children would want to solve difficult tasks. They assumed that the children would be aware how solving difficult problems contributes to improving their mathematical skills, while the children only wished to solve the problems to confirm the skills they already had. This was reinforced by awards in the form of videos, animations, pictures or praise without clear specification for what the child received them.
2. The authors misinterpreted one of the important stages in the formation of arithmetic abilities – level of counting on substitute sets. In tasks up to Level 3, they illustrated symbolic problems by adding substitute sets and silently assumed that it would be understandable without additional clarifications. So in the screen the children would see the equation accompanied by circles and numerical figures, without any suggestion that they can use them to solve the equation. For this reason they treated

the circles or numerical figures as decoration.

3. The authors drew up tasks with the plot in a way which did not require the students to carry out many mathematical operations to solve them. They had to perform the most simple steps in solving such a task, and the programme would follow with the rest of the steps. When children did not receive basic instructions what to do, their activity focussed on: watching the animation without seeing it as a task. Only when the animation was accompanied by instructions given by the speaker, e.g. Count!, they would interpret it as a task. If such an instruction did not appear in the animation, it would lose its meaning as a challenge.
4. The authors would use vague ways of motivating children. They assumed that if short information that a sticker is granted or a video, animation or picture are shown for the correct solution is given at the beginning, children will remember about it and solve consecutive tasks. However, the children forgot about this promise already in the second or third task. They no longer expected prizes after solving the following problems. Therefore, prizes which appeared on the screen came as a surprise, or the children thought that a video, an animation or a picture is something they get to see for clicking.

For these reasons, the effectiveness of the learning process by means of the "Click teaches to count in the Green School" programme was astonishingly low.

Analysing the mathematical education process organised by the teacher for students from the experimental group and the control group, the author estimated that within 5 months (research period), both in the classroom and during extra math classes, students would solve about 600 tasks (about 440 tasks during regular classes and 60 tasks during extra classes). According to a conversation the author had with their teacher, the children did not solve tasks which would require calculations above 20, which corresponded with Level 4 (out of 17) created by the authors of the "Click teaches to count..." programme. The author estimated that the children would solve such a number of tasks (600) in 75 school days. Based on a footage analysis, the author determined that the average number of tasks performed on the "Click teaches to count..." programme was 247. This number is impressive bearing in mind how much time the students spent at the computer solving them – 4.5 hours on average. It shows that students from the experimental group solved about 250 tasks more than students from the control group.

Comparing the results of the pre-test and the post-test, the author stated that despite the fact that all children who used the "Click teaches to count..."

programme solved a significant number of additional tasks, only in three cases could one observe some improvement of the ability to count and calculate as an effect of using the multimedia programme. For five students the impact of the programme on the ability to solve tasks q was negligible. Any positive changes in numeracy development were mostly the result of studying at home or attending extra math classes. In other three students a positive change in their abilities could to a small degree have been caused by using the programme.

These results point to the conclusion that using the programme "Click teaches to count in the Green School" and solving about one third more tasks on average have a negligible educational influence. It seems that solving between a few dozen and a few hundred additional tasks using the programme only for some students constitutes a sufficient portion of learning to bring about measurable changes in their numeracy and calculation skills. Detailed information[9] is summarised in Table 3.

Possible impact of the programme on mastering the knowledge and skills:

- None – In cases when in spite of solving the number of tasks named in the table in the multimedia programme, the author did not observe any significant increase in the level of mathematical knowledge and skills of the children (from the experimental group). There were four such children (Martyna, Konrad, Wiktoria and Dominik);
- Hardly any – When the number of tasks had little influence on the increase in the knowledge and mathematical skills. The author considered the fact that at the same time the children learnt the subjects at school. There were four such children (Kacper, Malwina, Marcin, Tosia);
- Present – In cases when the impact of the multimedia programme was distinct. There were three such children (Czarek, Damian, Marta).

[9]In the first column the author described the 17 levels of difficulty. Next columns contain name of students from the experimental group. the author am writing results of tests with Roman numerals: and test results first (of pretest) – conducted before the accession of students from the experimental group for using the computer; the II test results second (posttest) – of cycle conducted after the completion of using the programme by students from the experimental group. For the more legible image the author darkened these fields of the table which are presenting results first (with light colour) of both the second test of the message and mathematical abilities (with dark colour). With Arabic numbers in the central part of table the author am putting the number of tasks down on the specific level of the problem each of students solved which while using the program. In the last line of the table the author am describing the possible impact of the programme "Click learns to count in the Green School".

Difficulty level	Martyna	Czarek	Damian	Kacper	Konrad	Malwina	Marcin	Wiktoria	Dominik	Oliwia	Marta	Tosia
17												
...												
14					(II)							
13												
12		22								(II) 5	3	(II)
11		2										
10		4			(I)							
9												
8		1										
7	(I) (II)	(II) 8	(II) 28				(II)			(I)	(II) 5	
6		19	(I) 58		4		(I) 95	(II)	7		20	94
5	6	12	64		47	(II)	159	1	15		(I) 78	(I) 88
4	117	(I) 75	54	(II) 9	43	(I) 29	83	(I) 14	(I)(II) 70		23	41
3	72	51	40	(I) 40	49	91	71	112	48	14	39	20
2	60	34	40	61	63	32	20	40	118	58	20	34
1		25		140	20	13	20		39	32	20	33
Possible influence of the programme on mastering the skill	**No**	**Yes**	**Yes**	**Rather not**	**No**	**Rather not**	**Rather not**	**No**	**No**	**No**	**Yes**	**Rather not**

Table 3. Number of tasks performed by every student from the experimental group divided according to 17 difficulty levels, including results of the first (I) and second (II) mathematical skills test. Own study

It was also stated that the **time of using the computer or the number of sessions which students spent using the educational computer programs did not have any significant influence on the increase in the mathematical knowledge and skills**

A comparison of the difficulty levels of tasks solved by girls and boys from the experimental group between the pre-test and post-test showed that changes in the difficulty levels were similar. Based on this, the author **failed to notice any correlation between the sex of students who used the**

educational computer programmes and changes in the acquisition of mathematical knowledge and skills measured in the tests.

Results of mathematical knowledge and skills tests show at the same time that the authors' statements about the effectiveness of their educational programme are hardly reliable and have a purely advertising character.

It is also untrue that children with a low level of mathematical knowledge and skills benefit more from using the programme because they can work through the tasks included in it many times. This study shows that such children switch to their own strategies very early and simply do not use the programme properly. In their case using the programme is just a pastime. Students with a relatively high level of mathematical knowledge and skills switch to their own strategies much later, i.e. they learn longer, which is contrary to the general opinion.

Summary

Comparing the research procedure applied in this study to methods applied in hitherto studies (concerning computer-based learning of children), the author stated that considering the way children learn pointed to exactly opposite results. Taking into account only results of mathematical knowledge and skills tests (disregarding the levels of difficulty), one may draw the conclusion that multimedia programmes are effective because a considerable change in the level of knowledge and skills was observed in the case of 10 tested students (Czarek, Damian, Kacper, Konrad, Malwina, Marcin, Wiktoria, Oliwia, Marta and Tosia – see Table 3). Therefore, it is not surprising that the hitherto results were optimistic.

Also observing a child using the computer programme in question may point to its high educational effectiveness. The author determined that within 4.5 hours (total time in which the children used the computer programme during 10 sessions), the students solved a total of 247 tasks on average. Thus, watching children solving tasks in the programme and comparing the number of such tasks with the number of tasks completed at school (during 75 school days students solved about 600 tasks), one can conclude that using in is effective. However, the research presented in this paper has shown that if the quality of the process is taken into account, it turns out that the children's involvement with the programme is very superficial.

This research has also shown that students with a lower level of mathematical knowledge and skills, who need to experience more task situations in order to gain logical experience, benefit from multimedia programmes the least

because they switch to their own learning strategies at the earliest stage. In consequence, they waste time playing with the programme as if it were a toy. The situation is different for gifted students – they do not give up early and follow the authors' strategy for a long time, which favours learning to count and calculate.

The reason for the programme's low effectiveness lies in the fact that students abandon the authors' strategy, which is caused by the authors' lack of knowledge about the learning processes in children and emotional mechanisms governing their behaviour during tests. If it was possible to create a programme without substantive errors, probably its educational impact would be higher. If however any errors are committed it should extected that sooner or later children will abandon the learning strategy. Probably, the more errors there are, the sooner they will abandon the authors' strategy.

The author proved that children who use the educational programme "Click teaches to count…" treat it as a game and seek entertainment rather than an opportunity to learn. Comparing the educational programme to an educational computer game, it turns out that the author's results confirm the findings of Kengfeng Ke: Using a computer-based multimedia programme is not reflected in results of mathematical knowledge and skills tests. If by using the programme students acquire mathematical knowledge and skills, it is not shown in paper and pencil situations.

References

K a c z m a r e k, Z.: 2003, *Komputer na zajęciach korekcyjno-wyrównawczych*, Wydawnictwo Państwowej Wyższej Szkoły Zawodowej, Wałbrzych.

K e n g f e n g, K.: 2008, *Computer games application within alternative classroom goal structures: cognitive, metacognitive, and affective evaluation*, in: *Education Tech Research Dev* **56**.

K ł o s i ń s k a, T., W ł o c h, S.: 2002, Kształcenie wczesnoszkolne wobec oferty multimedialnych programów edukacyjnych, in: *Edukacja Medialna* **3**.

R a s z k a, R.: 2008, *Komputerowe wspomaganie procesu zintegrowanej edukacji matematycznej uczniów klas pierwszych w zakresie arytmetyki*, Wydawnictwo Adam Marszałek. Toruń.

W a t o ł a, A.: 2006, *Komputerowe wspomaganie procesu kształcenia gotowości szkolnej dzieci sześcioletnich*, Wydawnictwo Adam Marszałek., Toruń.

Uczenie się matematyki przez uczniów klasy pierwszej podczas korzystania z programów multimedialnych

S t r e s z c z e n i e

Zdania polskich i zagranicznych badaczy różnią się w zakresie efektywności korzystania z multimedialnych programów do nauki matematyki. Na podstawie polskich badań można dojść do wniosku jakoby najpopularniejszy w kraju program „Klik uczy liczyć w Zielonej Szkole" okazał się wystarczający w nauczaniu matematyki. Niniejszy artykuł w oparciu o badania autora rzuca nieco światła w tej kwestii.