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CAN INFORMATION TECHNOLOGY CHANGE ATTITUDE OF THE STUDENT IN THE TEACHING OF MATHEMATICS?

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Abstract

The article shows a specific example of extracurricular activities conducted in secondary school, how the graphing calculator helped the first class student in learning mathematics to solve a very difficult task (math problem): *How many elements has the equation*: $a^x = \log_a x$. The article describes the reasoning and attitude of the student who voluntarily of his own accord, inspired by other students to experiment, putting, generalizing and verifying hypotheses coped with the solution of this task. It describes the impact of this teaching mean that triggered activity and aroused student's interest with the task on the degree of knowledge and skills in mathematics, the student's skills in the use of mathematical language, self-reliance in solving a mathematical problem.

1. Introduction

Currently in the teaching and learning of mathematics increasingly used information technology (computers, graphing calculators, tablets) noting the great advantages of these teaching aids. Using them helps students to understand mathematical concepts, provides an opportunity to explore the claims, provoking hypotheses and results that the student is able to solve the unusual task, which without this tool on your level of knowledge and skills would not be able to cope. However, there are doubts whether after using a computer or a graphing calculator series of empirical tests and putting the hypothesis, the student will want to even verify and justify them? This raises the question whether the use of this tool does not fail the proportionality between the empirical inference and reasoning formal? Teachers today are wondering: what the consequences might bring the teaching of mathematics, in which, a teaching aid will permanently be woven into your

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computer, tablet or graphing calculator? For me, it is particularly interesting question: Can the continued use of information technology change the attitude of the student in the teaching of mathematics?

The term attitude has a lot of meanings and it is difficult to clarify or even define the term. Anna K. Żeromska [2004] in the article: "The attitude of the conceptual category on the example of attitudes towards mathematical tasks". Cited several terms of definition of the term, commented on the differences between them and considered the definition of the main features that make up each posture. Here are a few examples cited by her attitude definitional terms: "*Attitude – this is the probability of occurrence of a particular behaviour in a given situation*" – W. M. Fuson (Mika, 1982, p. 112).

"*Attitude – this is the amount of the positive or negative feelings associated with some object*" – L. L. Thurston (Mika, 1982, p. 113).

"*Attitude – a structure composed of cognitive elements, i.e. the set of beliefs concerning the possibility of implementing some of the values of the subject posture and affective feelings caused by this item*", (Rosenberg, 1962).

"*Attitude – is formed in the process of meeting needs in specific social conditions, relatively stable organization: knowledge, beliefs, feelings, motives, certain forms of behaviour and entity expressive reactions associated with a particular object or class of objects*" (Mądrzycki, 1977, p.18).

According to Żeromska the concept of attitude can point to some elements repeated in most of the theoretical thinking and forming a common core of meaning of the term. In the concept of attitude, there are three interrelated components:

(1) cognitive – meaning the overall knowledge and beliefs relating to the subject
(2) emotional – including feelings about a particular subject
(3) behavioural – relating to behaviour, reactions and actions aimed at target responding to the question: what is the attitude of the body relative to the object?

The study psychological M. Morady [1976] trying to create a tool for measuring and evaluating, testing attitudes. What should examine, measure, observe to infer about the attitude. The term attitude is also used in the teaching of mathematics to describe and explain the behaviour of the student in situations related to the teaching and learning of the subject, e.g. M. Legutko [1984], M. Czajkowska [2002, 2003], M. Ciosek [1976, 1988, 1992, 1995]. The teaching of mathematics also explores issues of students' attitudes towards same mathematics e.g. Ruffell, Mason, Allen [1998]. I would like to examine how forms, grows and changes the attitude of the student under the influence of such a factor as the continued use of information technology in teaching and learning mathematics. My researching has a long lasting character. They have to investigate and describe the impact of the constant use of TI (graphing calculators) in the teaching and learning of mathematics in shaping the attitudes of students towards mathematical tasks which means checking pupils' progress in science and showing the results of learning (taking into account all three components of attitudes that manifest themselves in any posture, but in different proportions).

In Contemporary Problems of Teaching Mathematics in the article: "*The role of graphing calculators in solving mathematical problems*" I have presented a specific example conducted lessons in grammar school, how a graphing calculator can help solve very difficult for middle school students the task (a mathematical problem): How many elements has the equation: $a^x = \log_a x$. In this article, I described the reasoning of students occasionally using information technology in the classroom mathematics who inspired to experiment, putting, generalizing and verifying hypotheses coped with the solution of tasks using a graphing calculator. In this article, I have attempted to describe the attitude the student (applying IT in the learning of mathematics) to the contents of the attitude this above math task is examined.

2. Description of experiment

Description of the experiment:

For extracurricular activities reported to me first class student who wanted to try to solve this problem task. Due to the different way of solving that has not occurred in the work of older pupils with whom I conducted an experiment is worth presenting. The student – Nathan math lessons program made at a basic level and was familiar by the day of solving the problem with the following material: real numbers, the function and its properties, linear function, vectors, transformation of graphs of functions, quadratic function (without the task of parameter) trigonometry (acute angle). Nathan is a student who frequently uses technological innovations. He can take advantage of: laptop, tablet, and smartphone-pad for presentation his solution, explain the present problem, its visualization. He often uses i-pad at school and has installed a number of mathematical applications that are used in solving the tasks of school. Attends extracurricular activities, taking part in the project: "Development and implementation of compensatory course in mathematics using ICT for secondary school students" project entitled "Mathematics Re@ktywacja" within the Operational Programme of the European Social Fund. The initiators and executors of the project are employees of Wrocław University of Technology and coordinator of the project is Ph.D. Jędrzej Wierzejewski of the Institute of

Mathematics and Informatics, Wrocław University of Technology. “Mathematics Re@ktywacja” uses a support system of teaching, in which advanced technologies are closely linked with the active participation of teachers and students. Students receive through the Internet remote access to comprehensive lecture materials and a vast number of dynamic interactive exercises and tests of the entire range of mathematics covered in the curriculum in secondary schools. Lecture materials and exercises are intertwined in such a way that the student getting to know a new issue or a method could immediately proceed to independently solve problems. Project: “Mathematics Re@ktywacja” complements the academic program for secondary schools in the field of interactive math remedial classes. Material e-learning can be a substitute for lessons, but its principal advantage is the possibility of individualized pace of acquiring knowledge, practising multiple tasks in different sets.

In an interview with the student I learned that he had heard from older friends from school about an interesting task which solved using a graphing calculator. This student without any pressure from outside, without coercion, without waiting for the reward of his own accord showed great desire and commitment to try to cope with the task. It was evident in his positive attitude to the experiment, interest, intrinsic motivation to solve this task.

Before attempting to solve the task the student was asked for news of graphs and properties of exponential and logarithmic function. He stated that all the messages he met while working alone on the platform: “Mathematics Re@ktywacja”. He made the platform: e-test with exponential functions and logarithmic at 92% scored 46 points out of 50. In an interview said that the unusual task solved by using a calculator or a computer. He had sufficient mathematical knowledge and fluent ability to use graphing calculator TI-83.

The research material only represent the student’s notes-draft and completed card work on the task. Running classes not taped because the classes were not pre-planned and I was not prepared for it, however my conclusions, observations of the conversation with the student are provided in the text below.

I introduced the student to solve the problem:

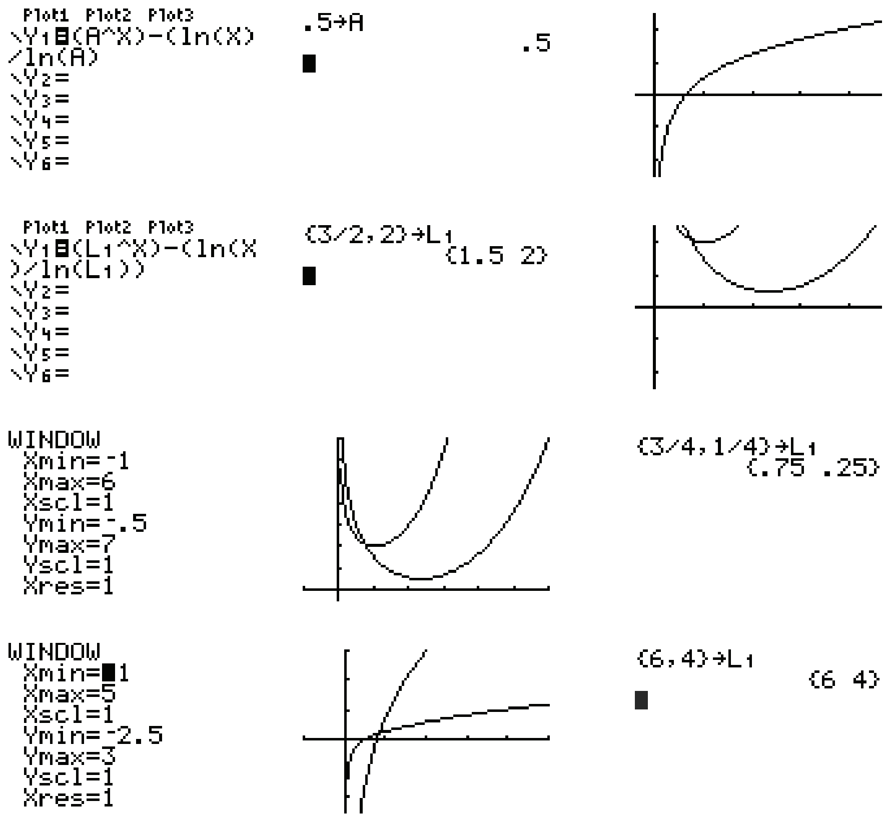
How many elements has the equation: $a^x = \log_a x$.

Presenting the draft and work card, I asked to publish his proposals for solutions, observations, notes, charts, and left him with the problem. Nathan asked for a graphing calculator. For a long time I did not pay attention to his work. I watched only his gestures, facial expressions, glances, I noticed only that he was working on a calculator and drew notes.

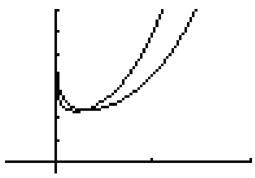
Then I looked at the note prepared by him, and in the conversation I asked for explanation of the records. Nathan explained that the properties from the equation functions: exponential and logarithmic, you can specify the domain of the equation $x > 0$ and the value range of the parameter $a \in (0;1) \cup (1;+\infty)$. He could not solve such equation algebraically at the level of his knowledge . The task of this type meets the first time. This task seems to him to be very difficult to solve.

He took, however, the following strategy:
He moved everything to one side, turning the output equation for the equation of the form: $a^x - \log_a x = 0$.

On the left side of the equation given functions: $f(x) = a^x - \log_a x$. He explained $f(x) = 0$ means that the zero of the function $f(x)$ is the root of the equation: $a^x = \log_a x$. Thus, the number of elements of our equation is equal to the number of zeros of functions $f(x)$ and the number of zeros of functions $f(x)$ can be read from the graph. Reported for selected values of a, the following graphs on the calculator:



```
WINDOW
 Xmin=-.5
 Xmax=2
 Xscl=1
 Ymin=-.5
 Ymax=7
 Yscl=1
 Xres=1
```



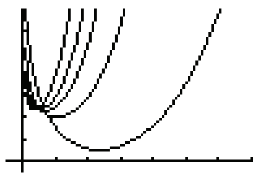
On the job card moved graphs drawn from the Calculator functions.

Nathan explained that in order to solve tasks considered cases for fixed values of the parameters a and based on observations formulated by the above hypothesis. Without giving proper solutions jointly analysed again drawn up by the charts. Discussion on the choice of the parameter value a and deeper analysis prepared charts and look at the shape of the curve being the graph of a function has raised doubts for the student about the hypothesis. Intuition caused reanalysis and observation and the shape of chart dictated to, that might be two zeros. Nathan looked at the field of functions $x > 0$ once again, as well as the range of values of the parameter $a \in (0; 1) \cup (1; +\infty)$. Convinced of the need to verify the hypothesis pondering the solution of the task, planned that must be more to look at the graphs of functions for value of the parameter a in the various ranges $a \in (0; 1), a \in (1; +\infty)$. This demonstrates the ability of the student to observe, analyse, process and use of the information received. He decided to read from prepared charts the number of zero will be applied to the axis of the numerical values of this parameter a.

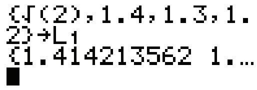
He began work from the value of the parameter: $a \in (1; +\infty)$

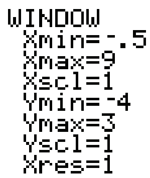
```
{1.5,2,2.5,3,4}→
L1
 {1.5 2 2.5 3 4}
```

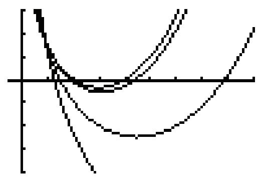
```
WINDOW
 Xmin=█.5
 Xmax=7
 Xscl=1
 Ymin=-.5
 Ymax=7
 Yscl=1
 Xres=1
```

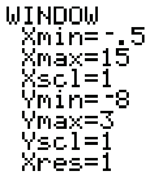


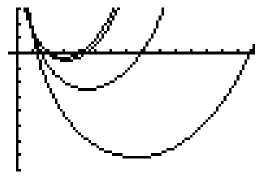
Under the influence of observations drawn graphs of functions on the calculator screen noted that when: $a \geq 1,5$ there are no number of zero.
Next came the observation charts for: $1 < a \leq 1,5$
Working function graphs showed that in this range can be found a value for which there are one or two zeros.



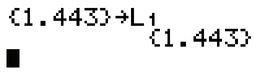


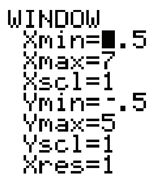


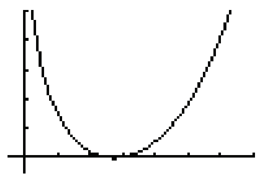


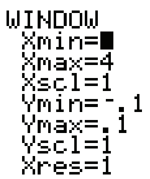


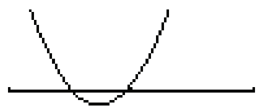
Observation charts led him to the conclusion that in the interval $(1,4;1,5)$ it must be such and such value for a function: for example $a = B$ where function: $f(x)$ has one number of zero and for $a \in (1; B)$ there will be two zero seats. I asked him for the appointment of the value of the parameter a.











In this graphic, method Nathan saw a chance to search, narrowing, bisecting the interval searches. Throughout the work critically approached the information read from the windows calculator. By varying several times of parameters of the chart window, yielded to verify his results. He noted that these attempts fail and determine the exact same value graphically even using a calculator is not possible however in his work was very persistent. He marked it by B and estimated that approximately is: $1,444$.

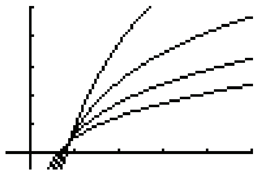
On the job card moved graphs of the Calculator window:

On the axis number for the parameter a he noted the number of zeros and wrote a proposal:

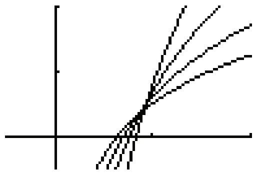
Next came the parameter values: $a \in (0; 1)$. Reported charts:

```
{.8,.7,.6,.5}→L1
   {.8 .7 .6 .5}
```

```
WINDOW
 Xmin=■.5
 Xmax=5
 Xscl=1
 Ymin=⁻.5
 Ymax=5
 Yscl=1
 Xres=1
```

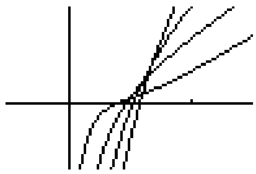


```
WINDOW
 Xmin=⁻.5
 Xmax=2
 Xscl=1
 Ymin=⁻.5
 Ymax=2
 Yscl=1
 Xres=1
```



```
{.4,.3,.2,.1}→L1
   {.4 .3 .2 .1}
```

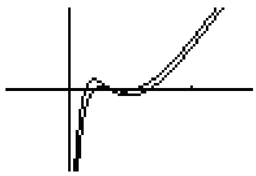
```
WINDOW
 Xmin=■.5
 Xmax=1.5
 Xscl=1
 Ymin=⁻.2
 Ymax=.3
 Yscl=1
 Xres=1
```

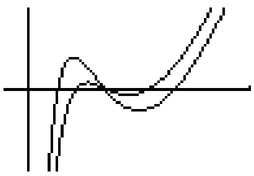


As Nathan argued that this range has only one solution I suggested to make a chart for: $a = 0.05$ or $a = 0.06$.

```
{.06,.05}→L1
        {.06 .05}
■
```

```
WINDOW
 Xmin=⁻.5
 Xmax=1.5
 Xscl=1
 Ymin=⁻.1
 Ymax=.1
 Yscl=1
 Xres=1
```





```
WINDOW
 Xmin=⁻.1
 Xmax=1
 Xscl=1
 Ymin=⁻.03
 Ymax=.03
 Yscl=1
 Xres=1
```

The resulting graph surprised the student. On the number axis for the parameter a noted the number of zeros:

Exercising many graphs on the calculator for the value close to $a = 0.06$ and analysing the number axis line for the parameter a, the student noticed that up to certain parameter values and the function has three numbers of zeros and from that only one. Nathan tried to determine the value of the parameter. For this purpose, performed on his calculator many graphs for different values of the parameter. The whole time he was focused on finding the value choosing the division range method. Examining these charts stated that it is difficult to determine the value. He marked it by A.

On the job card presented chards from the Calculator window:

He formulated a proposal.

Then I gave the student mysterious values: $A = e^{-e}$ i $B = e^{\frac{1}{e}}$. Student asked about the number of: e, boasted remaking the lesson forum: logarithms, read the book: Bogdan Miś, *Tajemnicza liczba e i inne sekrety matematyki*, WNT, 04, 2008.

Once again, we analyzed together the entire job giving the correct solution to the problem:

How many elements has the equation: $a^x = \log_a x$

$1 < a < e^{\frac{1}{e}}$ $\quad a^x = \log_a x$ – equation has two solutions
$a > e^{\frac{1}{e}}$ $\quad a^x = \log_a x$ – There is no solution
$a = e^{\frac{1}{e}}$ $\quad a^x = \log_a x$ – There is one solution
$0 < a < e^{-e}$ $\quad a^x = \log_a x$ – equation has three solutions
$e^{-e} \leq a < 1$ $\quad a^x = \log_a x$ – There is one solution

At the end Nathan made a function of the amount of solutions depending on the parameter a and set approximations of numbers: A and B.

3. Conclusions

The described experiment shows how the graphing calculator helped the student in solving the tasks of the problem, and served an important role in its termination at the level of knowledge and skills of the student. Shows how work with it develops skills and abilities to verify the hypotheses through a mathematical experiment. Reveals the ability to perform different experiments gave the converter, which observation and analysis of matched cases, allowed not only to explore certain regularities, formulate hypotheses about the problem being solved, but also gave the opportunity to verify these hypotheses, justifying the choice of the appropriate direction of research and finding a solution to the problem. After observing the student's involvement in the work can be seen as it increases the student's interest in the problem under consideration, so that the student understood it well and wanted to solve, produces an increase in excitement, satisfaction with work. Working with the calculator let the student find himself in the situation similar to the work of creative mathematics by giving satisfaction, self-confidence, increase self-esteem.

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