INFORMATION TECHNOLOGIES
(EQUATION GRAPHER) IN TEACHING OF LINEAR
AND QUADRATIC FUNCTIONS

JANA BALÁŽOVÁ

Abstract. The aim is to summarize all possibilities of Information Technologies (IT) using
in teaching of mathematics in the didactic situation of acquirement. I depict a contemporary
state of IT use in teaching in Slovakia and in foreign countries. I further acquaint the
reader with the results of the experiment, the goal of which was to use the Equation Gra-
pher program in teaching of linear and quadratic functions.

Résumé. Le but est de synthétiser les possibilités d'utilisation de la technologie informati-
que (TI) dans l'enseignement mathématique, plus particulièrement dans le domaine de l'appropriation didactique. Je décis l'état actuel de l'utilisation de IT dans l'enseignement en Slovaque et à l'étranger. Je précise notamment les résultats d'une expérience qui por-
tait sur l'application du programme Equation Grapher lors des révisions sur les fonctions affines et les polynômes de degré deux.

Zusammenfassung. Das Ziel ist eine Summierung aller Möglichkeiten vom Gebrauch der
elektronischen Datenverarbeitung (IT) im Mathematikunterricht in der didaktischen Situation
des Anlernens. Ich beschreibe die gegenwärtige Situation des Gebrauchs der IT in dem
Matheunterricht in der Slowakei sowie im Ausland. Ich habe vor den Leser mit den
Ergebnissen des Experiments, wessen Ziel war das Programm Equation Grapher in dem
Unterricht den linearen und quadratischen Funktionen zu benutzen, bekannt zu machen.

Riassunto. Lo scopo è riassumere tutte le possibili Tecnologie di Informazioni (IT)
utilizzate nell'insegnamento delle matematiche nella situazione didattica di acquisizione. Illustro un uso contemporaneo dell’IT nell’insegnamento in Slovacchia ed in paesi stranieri.
Informo inoltre il lettore dei risultati dell’esperimento, il cui scopo era quello di usare il
programma Equation Grapher per l’insegnamento delle funzioni lineari e quadratiche.

Abstrakt. Cieľom je zosumariovať všetky možnosti použitia informačných technológii
(IT) vo vyučovaní matematiky v didaktickej situácii osvojovania. Opisujem súčasný stav
používania IT vo vyučovaní na Slovensku aj v zahraničí. Blížšie oboznámim čitateľa
s výsledkami experimentu, ktorého zámerom bol použiť program Equation Grapher pri
opakovanej učiva o lineárnich a kvadratických funkciách.

Key words: Information Technologies, Equation Grapher, student, teaching, linear function,
quadratic function
1 INTRODUCTION

Since ancient days what differ the human from the rest of the animal kingdom is the continuous and never-ending hunger for knowledge. The knowledge goes hand in hand with the imagination and fantasy. But unfortunately this human quality hadn’t been granted to all of us in the same extent. Therefore there is space for reduction of these differences, namely by suitable widening of existing teaching methods through something quite common in developed cultures, through Information Technologies, especially graphic software.

I can confirm from my experience, that exactly this human attribute was not assigned to all the people identically. Because I believe to the possibility of minimizing these differences, I highlight the advantages of broadening the teaching methods with something, in the advanced world entirely obvious, namely with Information Technologies, especially graphic software.

In the article I deal with some possibilities using IT in basic didactic situation, illustrations of applets, graphic calculators and notably Equation Grapher. Thanks to these programs are graphs of functions deeper in pupils’ memory, because the knowledge based on experience is more durable. This “draw program” enables to plot on up to twelve function graphs into one picture where the graphs differ only with the value of some parameter. Thus the student gains the ability to imagine the meaning of the word “parameter”.

As the task of a teacher is to mediate the access to the knowledge to the student, I applied software during the exercise, revision of the knowledge about linear and quadratic functions, equations and inequations. Didactic situation affects also as a “milieu” that activates the processes of acquirement/teaching in relationship “knowledge – student – teacher – didactic situation”. (Spagnolo, 2003)

I used the software during the exercise, revision of the knowledge about linear and quadratic functions, equations and inequations. I state the subsequent hypothesis: Information technologies, or more precisely Equation Grapher, can be effectively used in the phase of exercise and revision of taught theme.

2 COMMUNICATION IN MATHEMATICS SUPPORTED BY COMPUTER

In this chapter I will deal with some matters of communication in mathematics supported by computer. I’ll try to resume all available technologies, which could be used in the process of teaching.

The didactic software offers the students the interface, tool for cognition, investigation and modelling. It is developed to support learning, cognition and progress of information literacy. Its fundamental properties and criterions are:
didactical goal, suitable user interface, development of information literacy and information culture, it provides feedback, develops associatively learning, has the form of a game, applies visualization and multimedia, it is interactive, open, oriented, concentrated, provides severity levels, offers individual approach to the person who learns (i.e. respects his tempo, provides interface adjustability, various ways to work with, the order of activities. (http://209.85.135.104)

**Applets** are programs created in the Java programming language and are appointed only for inclusion in web pages. Their animation is most frequently caused by movement of some point or bigger figure. In many of these web pages is included subsidiary text as mathematical theoretical base, formulas, derivations, guidance tasks, repetitive questions, exercises… (Koreňová, Jodas, 2002)

Applet on the web page http://www.ies.co.jp can serve us as an example. Author explains on the example of inflowing water the principle of direct proportion and thus the linear function graph too. The amount of water in the vessel before turning the tap on is the Y-Intersection. The faster the water flows in, the bigger is the angle of the line with x-axis.

Applet on the web page http://64.233.183.104 web page is also suitable for understanding the quadratic functions drawing problems. After applying the function expression the function graph \( y = a \cdot (x + h)^2 - k \) whose parameters \( a, h \) and \( k \) are changing by moving a button. Program calculates coordinates of the vertex.

**Graphic calculators** belong to contemporary society. They can be used in different mathematical activities. They can help by solving of mathematical problems in the cases when numerical and graphical solutions of students are not completely successful. In education process can be usefully used also projection graphic calculators. They have video-output or LCD-output which can be projected through beamer. (Koreňová, Jodas, 2002)

Graphic calculator is a combination of advanced graphics, tables and data analysis with basic mathematical functions. They are perfect for mathematically oriented high schools. They offer unbelievable speed and versatility. (Bereková, 2004)

**Teleproject** is a distance project on which two or more schools are cooperating. Together they solve some problem in given theme. Rich source of telepro-
jects of Slovak School is on the web page http://www.infovek.sk. (Slavíčková, 2006)

**EBeam** belongs to the latest possibilities of using IT. It is an interactive board, which soldered the tradition of board writing with information technologies. With the assistance of this system not only prepared lectures can be presented, but there is also the possibility of writing own comments into the projected matter, all teaching programs may be controlled from the board and the like. (Slavíčková, 2006)

Other new ways of teaching includes also **e-learning**. This method is based on computer network using in making the self-study educational courses accessible. These courses provide interactive teaching environment using multimedia operation of information as well as continuous evaluation of the teaching approach by means of dialogues, exercises, tasks. (Slavíčková, 2006)

### 2.1 The contemporary conditions of IT using in the Slovakia

In the contemporary society full of different technical conveniences computer prove to be a natural motivation of students. It is satisfying that more and more computers begin to be used at our schools. The Infovek project brought the biggest contribution to the expansion of computer launch in the education in Slovakia. From year to year the number of schools connected into this project increases. The task of these projects is not only the integration of computers into the teaching but also help to change Slovakia to a modern information society. (Kalaš, 2002)

There were a lot of authors engaged in the theme about teaching by means of IT in the last couple of years. In the next chapter I’m going to present the endings of particular experiments which were made in connection with using IT in Slovakia.

Brisudová (2004) realized a research on a sample of teachers from different parts of Slovakia, which do not teach informatics. Answers on some questions from the survey are introduced in the next lines.

*How often do you use didactic software in lessons in the class?*

![Bar chart](image)
From the graph it is evident that most the teachers do not use didactic software (37%) or use it only minimally (32%). Another graph explains the reasons of this phenomenon. Hardly any teacher (10%) uses didactic software several times a month.

**What could help you to use the didactic software in teaching more frequently?**

- 30% worksheets
- 21% books counting the PC using in the lesson
- 19% better computer equipment at the school
- 16% more supportive materials to improve the PC and peripherals skills of the teacher
- 9% support from the side of school management
- 5% nothing, my interest in PC using is constant at the moment
- 19% nothing, my interest in PC using is constant at the moment

The answers show explicitly that teachers want to use didactic software in teaching but they are short of the peripherals skills, support from the side of school management and most importantly all suitable tools in teaching (worksheets, books...). Only 5% of asked teachers have no interest for using PCs in the teaching now.

Simonka in his article pointed out the three-dimensional graphic depictive abilities of MS Excel as a teaching aid. The presented graph was applicable by making illustrative vision of graph of two variable functions on basic contour lines. This simplified teacher’s work significantly but also improved the final effect of explanation leaving deeper impression in the listeners. (Simonka, 2000)

Bereková occupied the using of graphic calculator in different mathematical activities, which can be often implemented more effectively without routine mathematical operations. The research results showed that teachers in the future will be interested to work with this form of IT too. (Bereková, 2001)

With the research, if the teaching with assistance of computers really assists to better understanding of the curriculum about compound goniometric functions graphs dealt Kraslanová. The author created worksheets in given theme. (Kraslanová, 2004)
Unequivocal result appeared in the work from the field of constant inquisitional knowledge with the assistance of IT (Mathematica®, Cabri geometria II, MS Excel) in comparison with traditional method. In the opinion of the author IT is an important part of the pedagogic educational process. (Žilková, 2004)

From a research connected with using of e-learning courses in teaching process followed that this form is not convenient for one third of students (extern form of study on Pedagogic Faculty at the University in Trenčín, Slovakia). It was because of inaccessibility to the Internet at home or in the job. Approximately one quarter of students would prefer CDs and round one fifth would like to use scripts or textbooks. 90 % of respondents would try to print the content of courses. (Pokorný, 2006)

Author of constructivist pedagogical software in negative numbers, fractions and percentages verified its influence on students. She found out that this “game-some“ form of mathematics represents contribution, students are looking forward to mathematics classes, they have long-term knowledge and reach minimal equivalent results to the students not using graphic software. (Slavíčková, 2006)

Sandanusová also dealt with the implementation of the Equation Grapher program to the educational process. She analyzed written test and compared its results in the class with assistance of the Equation Grapher program with the class where IT hadn’t been used. (Sandanusová, 2006)

Another work includes a collection of alternative worksheets, where solving students (with assistance of Cabri Geometria II Plus) develop creative thinking and they reach the knowledge through their own efforts. (Bestrová, 2006)

### 2.2 The contemporary state of IT using in foreign countries

European Commission Information Society and Media released on the web page [http://ec.europa.eu](http://ec.europa.eu) results of the research of IT using in teaching in year 2006. In the following graph Europe union countries are aligned by the extent of IT using in teaching.

**Percentage of teachers who have used computers in class in the last 12 months (2006)**

![Graph showing percentage of teachers using computers in class](https://via.placeholder.com/150)

*Source: LearnInd CTS 2006; Base: All teachers; Question: Q7. See questionnaire for exact wording*
Among the countries of the European Union the best results were achieved in the **United Kingdom**, where 96% of teachers used computers in class in the last 12 months. All British schools use IT in classes and have Internet access. British teachers are very frequent and intensive ICT users. A majority (65%) of teachers using computers use them in more than a fourth of their lessons, of which there are 21% using it in more than half of their lessons.

In **Denmark** there is a similar situation. All Danish schools use computers for teaching and have Internet access. There are 95% of schools connected to the internet through broadband. More than 90% of teachers use computers and the internet integrated into the teaching of most subjects, including foreign languages, as well as teaching pupils with special needs or handicaps.

**Sweden** ranks at number 3 of the 27 countries. All Swedish schools use computers for teaching and have Internet access. 89% of them use the internet via broadband connection. Only 11% of teachers in Sweden do not use computers in class. 43% of them state a lack of computers in their schools as the most important barrier. In spite of this fact a large majority of Swedish teachers are satisfied with the technical access means at their schools.

Best place among the neighbouring countries attained **Austria** where 88% of teachers used computers in class in the last 12 months. Austria is followed by the **Czech Republic** with 78% and **Slovakia** with 70%. **Poland** tails away with 61%. The worst results from Slovak neighbouring countries achieved **Hungary** with 43%.

The last but one place took **Greece** with 36% closely followed by **Latvia** with 35%. It is about a half in comparison with the 74% **European Union** average.

On the web page [http://www.euractiv.sk](http://www.euractiv.sk) is published an essay. It demonstrates that only 67% of European elementary and high schools have access to the Internet via broadband connection. For example 90% of elementary and grammar schools in Scandinavia, Netherlands, Estonia and Malta have fast Internet via broadband connection. On the opposite end of the succession appear Greece, Poland, Cyprus and Lithuania with 35% schools with Internet via broadband connection. Not even Slovakia according to the study velvet to the intent: it counts among the poorest, because only 40% of elementary and grammar schools have Internet via broadband connection. For the confrontation the essay states that in the USA 95% of all schools had Internet via broadband connection in 2003.

Since just fast Internet via broadband connection is really applicable for teaching, are these data alerting. For the future we have to believe that attention will be paid to this problem and that the teaching on schools by means of IT will head towards radical improvement.
3 EQUATION GRAPHER

We can distinguish between few programs that make the function graphs drawing possible. Equation Grapher belongs to one of them. It is a 15-days shareware from MFSoft International. Further information about this program can be found on the company’s web page.

One may take advantage of this program at mathematics lesson in teaching linear and quadratic functions. Apart from quick drawing of random functions, it has also an additional big plus in confrontation with the blackboard or exercise book – the possibility to enlarge or shrink the screen where the function graph is plotted on. Through this we can focus only on selected part of the screen. This program enables to draw up to 12 function graphs into one picture.

Only a few teachers’ skills are sufficient for effective work with the PC and it only depends to his creativity how he will take use of this program to diversify the mathematics lessons... (Koreňová, Jodas, 2002)

In this chapter I will try to describe the work with this program a little bit closer.

There is a main menu with following offer in the program:

In the main menu one can find the whole commands overview. There is no need to use it because the program can be manipulated only by means of windows and icons.

Icons serve to hasten the work with Equation Grapher. Simple click executes for example these functions: swell, decrease, determinate the intersection with coordinate axis, maximum, minimum, two graphs intersection...

The command line serves to type the expressions. We shouldn’t forget to type correct parentheses.

The Equation Grapher program works on windows base:

- Graph window with coordinate system selected by us,
- Function Pad window with buttons for typing of functions,
- Range window for changing the range values,
- Log window with mathematical and numerical buttons.
In the Range window we can change an interval represented in the Graph window namely on the x-axis and y-axis. By plotting of goniometric functions special device through the upper marked icon must be chosen and the lower marked icon “Re” has to be pushed.

The graph as a whole or its marked part can be increased or decreased by using zoom. In the Range window the current interval setting visible on x-axis and y-axis always turns up.

By typing expression the icon or directly the Function Pad window can be used. There are buttons like sinus, cosine, tangent, power, root, unknown $x$, number pi, absolute value. From numerical buttons are presented classic operations $+$, $-$, $\cdot$, $:$ and DEL for deleting of incorrect typed expression and EXE for submitting the plot of the function graph.

By means of these buttons we can determine the intersection with x-axis, y-axis, maximum, minimum, intersection between two graphs, or calculate second coordinate, value of which will picture in the Log window.

4 EXPERIMENT

4.1 THE REALIZATION OF THE EXPERIMENT

I executed the experiment during repetition of the curriculum about linear and quadratic functions in two fifth classes of 8-yearlong grammar school. I will call these classes X and Y for better orientation. In both classes I applied one lesson curriculum about linear functions and linear functions with absolute value as well as curriculum of quadratic functions. I prepared a Power Point presentation containing questions and exercises for each lesson. The exercises were compiled by Rybak, 2001. Every student had a worksheet at his disposal. On the third lesson students have written a test and have filled the questionnaire. I fulfilled the analysis a priori and analysis a posteriori.
The units of the material milieu in didactic situation (Spagnolo, 2003) were:

- **material** – computer, projector, blackboard, chalk;
- **cognitive** – linear functions, function graph \( y = ax + b \), linear function with absolute value, quadratic function, function graph \( y = ax^2 + bx + c \);
- **social** – teacher, students.

### 4.2 A-PRIORI ANALYSIS OF DIDACTIC SITUATION

The exercises in test were similar to the exercises on repetition lessons. Consequently it was old knowledge. The exercises were clearly formulated. I have not expected any subsidiary questions. The students had 30 minutes to solve 4 exercises. Every student got a paper with entered tasks.

**I assumed following solutions in class X:**

1. Draw two linear function graphs that crosses the point \([0,3]\). Write relevant expressions to these graphs.

   **Solution:**
   \[ f : y = ax + b \]
   \[ b = 3, a \in \mathbb{R} \]
   \[ f_1: y = x + 3 \]
   \[ f_2: y = -x + 3 \]
2. Draw a graph of function \( y = x^2 - 2x - 3 \), plot intersections with \( x \)-axis, \( y \)-axis, find out the coordinates of vertex, domain, range.

Solution:

\[
D = b^2 - 4ac = (-2)^2 - 4 \cdot 1 \cdot (-3) = 16
\]

\[
x_{1,2} = \frac{-b \pm \sqrt{D}}{2a} = \frac{-(-2) \pm \sqrt{16}}{2 \cdot 1} = \frac{2 \pm 4}{2} \Rightarrow x_1 = \frac{6}{2} = 3, x_2 = \frac{-2}{2} = -1
\]

intersections with \( x \)-axis:

Intersections with \( y \)-axis:

\( y = 0^2 - 2 \cdot 0 - 3 = -3 \Rightarrow [0, -3] \)

vertex:

1. method: \( x^2 - 2x - 3 = x^2 - 2x + 1 - 1 - 3 = (x - 1)^2 - 4 \Rightarrow [1, -4] \)

2. method: \( V[p, q], p = \frac{-b}{2a} = \frac{2}{2} = 1 \Rightarrow q = t^2 - 2 \cdot 1 - 3 = -4 \Rightarrow [1, -4] \)

\[
\text{domain } D(f) = R
\]

\[
\text{range } H(f) = (-4, \infty)
\]
3. Solve the equation $3 - x = | -2x |$ graphically and write a result.

Solution:

Intersections are $[-3, 6], [1, 2]$ $\Rightarrow$ the equation has two solution, namely:

\[ x_1 = -3, x_2 = 1. \]

4. Martin has 50,- Slovak crowns. He would like to save for long-wished-for encyclopedia worth 950,- Slovak crowns. Weekly he gets 150,- Slovak crowns pocket money from his parents. In how much time (in weeks) he can afford to buy it? Create graph and write the result.

Solution:

Martin can afford to buy the 950,- Slovak crowns worth encyclopedia in 6 weeks.
In class Y I assumed following solutions:

1. Draw two linear function graphs that crosses the point \(0,-3\). Write relevant expressions to these graphs.
   Solution:
   
   \[
   f : y = ax + b \\
   b = -3, \ a \in R
   \]
   
   \[
   f_1: y = -x - 3 \\
   f_2: y = x - 3
   \]

2. Draw a function graph \( y = x^2 + 2x - 3 \), intersection with x-axis, y-axis, learn coordinate of vertex, domain, range.
   Solution:
intersections with x-axis:
\[ D = b^2 - 4ac = 2^2 - 4 \cdot 1 \cdot (-3) = 16 \]
\[ x_{1,2} = \frac{-b \pm \sqrt{D}}{2a} = \frac{-2 \pm \sqrt{16}}{2 \cdot 1} = \frac{-2 \pm 4}{2} \Rightarrow x_1 = -\frac{6}{2} = -3, x_2 = \frac{2}{2} = 1 \]

intersections with y-axis:
\[ y = 0^2 + 2 \cdot 0 - 3 = -3 \Rightarrow [0, -3] \]

vertex:
1. method: \( x^2 + 2x - 3 = x^2 + 2x + 1 - 1 - 3 = (x + 1)^2 - 4 \Rightarrow [-1, -4] \)
2. method: \( V[p, q], p = \frac{-b}{2a} = -\frac{2}{2} = -1 \Rightarrow q = (1)^2 + 2 \cdot (-1) - 3 = -4 \Rightarrow [-1, -4] \)

\[ \text{domain } D(f) = \mathbb{R} \]
\[ \text{range } H(f) = (-4, \infty) \]

3. Solve the equation \( 3 - x = -2x \) graphically and write a result.

Solution:

Intersections are \([ -3, -6 ], [1, -2] \) \( \Rightarrow \) the equation has two solution, namely:
\[ x_1 = -3, x_2 = 1. \]
4. Martina saved 200 Slovak crowns. She would like to buy MP3 player in a bazaar but it cost 900 Slovak crowns. In how many weeks she can afford to buy it? Create graph and write the result.

Solution:

She can buy the MP3 player in 7 weeks.

I assumed that following mistakes will occur by solving exercises (E1, E2, E3 and E4):

E 1-1: incorrect marking of the point in the coordinate system,
E 1-2: correct graph but incorrect expression of the function,
E 2-1: numerical mistake and following incorrect defined vertex and incorrect range,
E 2-2: numerical mistake during calculating the intersection with x-axis,
E 2-3: numerical mistake during calculating the intersection with y-axis,
E 2-4: incorrect defined domain,
E 2-5: confusion of the domain and range notion,
E 2-6: incorrect oriented graph,
E 3-1: incorrect plotted function graph with absolute value,
E 3-2: incorrect plotted graph of the other function,
E 3-3: exploring only one intersection between the graph of functions,
E 3-4: incorrect numerical solution of the equation,
E 4-1: misinterpretation of the task context,
E 4-2: incorrect starting point of the graph,
E 4-3: numerical mistake during adding the weekly pocket money.
4.3 A-POSTERIORI ANALYSIS OF DIDACTIC SITUATION

In following chapter I will bring up the evaluation of the experiment hence the mistakes done by students while solving the exercises. The mistakes I haven’t assumed but they appeared, are following:

- N1 incorrect function graph (exercise no. 1),
- N2 incorrect range (exercise no. 2),
- N3 incorrect solution (exercise no. 3),
- N4 incorrect answer (exercise no. 4).

From the executed analysis of the results follows that four most frequently incident mistakes were:

- E1-2: students plotted correct function graph with absolute value but they assigned incorrect expression of function. This mistake occurred in 21 cases what represents 48 % of all solution of the first exercise.
- E3-1: 16 students plotted incorrect function graph with absolute value. This mistake comprises 36 % of all solutions of the third exercise.
- Following two mistakes appeared in 10 cases, hence in 23 % of all solutions of the second and fourth task:
  - E2-1: the students calculated the parabola vertex incorrectly and thus they wrote the range incorrectly.
  - E4-2: the students plotted incorrect starting point of the graph hence they didn’t take the money saved before saving into consideration.

I also have expected the mistake E4-1 of misunderstanding the exercise by students leading to not solving it. This mistake didn’t happen. The mistake E2-6 (confusion of the domain and range notion) and N1 (incorrect function graph or more exactly the line \( x = 0 \) which is not a function) appeared once and represented approximately 2 % of mistakes in the given exercise. From mistakes that occurred I expected 15 and I didn’t await 4 of them. The awaited mistakes comprised 87 % and not awaited mistakes formed 13 %. The representation of awaited and not awaited mistakes is summarized in the following graph:
Following the total number of points obtained I can say that students were most successful by solution the verbal exercise No. 4 with 83 % successfulness. Something less students attained by solution the exercise No. 1 with 66 % successfulness. In exercise no. 2 students obtained 49 % success in average. The solutions in the exercise no. 3 were with 36 % successfulness the least successful.

The successfulness of students by solution of this written exam was 55 %. The sciential grade as well as the approach to solving in both classes was remarkable different therefore I confronted the successfulness of these classes in solution of particular exercises.

The total successfulness of the class X was 44 % and 64 % of the class Y. That is a fundamental difference, which is due to different grade of knowledge of students in particular classes.

My expectations of successfulness (50 %) were fulfilled in the average. When I evaluate each class separately then the successfulness in the class X was about 6 % less and the successfulness in the class Y was about 11 % more than my projection.
4.4 The survey

At the end of the last lessons I gave survey to the students. Respondents had approximately 10 minutes to accomplish this survey. From the analysis I executed on the solution basis came out interesting results. Following graph discusses the answers on the first questions:

How difficult was to learn to work with Equation Grapher in your opinion?

74% of students answered positively (very easy and easy), 19% of students were indifferent and 7% of students answered negatively (difficult and very difficult). This means that the program is very easy to use and well arranged. An interesting point is that none of the students marked the answer “very difficult”. It is quite simple to learn to use this program and it doesn’t take a lot of time in the lessons.

The answers on the second question are composed in another graph:

Did the Equation Grapher program help you to understand the repeated curriculum?

I believe this result to be success, because the revision by means of Equation Grapher program helped more than a half of all students (58%).
Answers to the question No. 3 are shown in the following graph:

Can you imagine also the lecture of new curriculum by means of Equation Grapher?

I noticed propitious answers with 60 % of students, 23 % of students were indifferent and 17 % of respondents answered negatively. The answers on the question No. 2 and 3 are comparable. Approximately identical values were achieved there (58 – 60, 19 – 23, 23 – 17). I suppose that this was caused because the students who the program has helped to during the revision would welcome it also in the new curriculum lectures and those who were dissatisfied with this program would rather not meet it in the new curriculum again.

The question No. 4, 5 and 6 wasn’t answered by all respondents, because these were open ended questions that required meaningful answers, not only to put a cross in. For better imagination of the ideas I attach some answers from those who answered these questions.

Answer to the question No. 4:

*The program helped me to better understand how the graphs look like. At last I am able to imagine graphs of functions as well as what a, b, c parameters are causing.*

Answer to the question No. 5:

- Advantages:
  *It’s faster, more comfortable and more accurate.*
  *It’s represented better graphically and more transparent than on the blackboard or in the exercise book.*
  *It’s good for improving imagination...*

- Disadvantages:
  *The solving procedure isn’t evident.*
  *I don’t have it at school and can’t work with it.*
  *Every student should have its own computer in the lesson.*
Answer to the question No. 6:

It's a variegation of the lesson.

It was fine.

Good way to revise the curriculum.

It was refreshing.

5 Conclusion

At the end of the experiment I am going to resume the didactic analysis of students’ solutions. The goal was to find mistakes students are making during solving linear and quadratic functions, equations and inequations exercises and to destroy or confirm the hypothesis framed in the introduction.

The most frequently occurred mistake was the wrong expression of the graph of the function. I think it’s caused exactly because exercises of this sort are usually not solved at the schools. Students mostly know to plot the graph of the function on the ground of expressions (intersection with the x-axis and y-axis, vertex...), that they memorize, but they are not able to apply this knowledge in reverse direction.

The second most frequent mistake was incorrect plotted graph of linear function with absolute value. Only a few of the students is conscious of the coherence between the linear function graph \( y = 2x \) and the linear function with absolute value \( y = |2x| \).

The third most frequent mistake was the numeric mistake during the editing to square. The students don’t teem with enough experience with this editing, because during the lesson it comes across as simple and they don’t pay attention to this topic at home.

Nonetheless also the mistake in the verbal exercise often occurred. The students plotted the graph of the function with the starting point zero hence they didn’t take the money that was at disposal already before saving into consideration.

When I compare the students’ knowledge before and after the revision through the use of Equation Grapher, it clearly follows that working with this program has helped them. They became conscious of what role play parameters, how the graphs shift, how they change their position, slope. In so far my hypothesis was confirmed and on the ground of my lesson acumens, solution analysis and survey results I can say that “IT, namely the Equation Grapher program can be used effectively in the phase of review, strengthening or revision of the curriculum.”
Students enjoy such lessons, they find them interesting. The PC using alone is motivating for them, the students demonstrate unusual interest for mathematics and they show more efforts to cooperate.

Last but not least in this article I looked for possible modelling of phenomenon in didactic situations, where the milieu is strongly impacted by micro-world like Equations Grapher.

REFERENCES


http://www.ies.co.jp/math/java/geo/in_line/in_line.html
http://www.infovek.sk/ projekty/archiv_skprojekty.php
http://www.mssoft.com/equationgrapher
http://209.85.135.104/search?q=cache:NSaroWjgNnYJ: user.edi.fmph.uniba.sk/kalas/Vyucba/TPS1/prednaska04.doc+didaktick%c3%bd+cie%c4%be+vhodn%c3%a9+u%c5%be+c3%advate%c4%be+sk%c3%a9+rozhranie&hl=sk&ct=clnk&cd=1&gl=sk&client=firefox-a
http://64.233.183.104/search?q=cache:ftxJsK0QvIJ:members.shaw.ca/ron.blond/QFA.CSF.APPL/ET/+applet+function&hl=sk

Jana Balážová, Department of Algebra, Geometry and Didactics of Mathematics, Faculty of Mathematics, Physics and Informatics, Comenius University, 842 48 Bratislava, Slovakia
E-mail: jana.balazova@gmail.com