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STIMULATION OF THE DEVELOPMENT OF INQUIRY SKILLS IN TEACHING FUNCTIONS

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Abstract

High quality mathematics and science education can induce further acceleration of scientific and technological development of society. Despite the efforts to implement modern approaches to science education, reducing the level of students' knowledge and skills is observable in some areas. The skills focused on the interpretation of data from tables and graphs and the ability to apply functions to solve problems were an important area for testing mathematical literacy in The OECD's Programme for International Student Assessment (OECD PISA) 2012. Lack of skills in the use of different mathematical functions causes problems in mathematical modelling of real situations. Our research is currently aimed at developing inquiry skills of students in mathematics and diagnosing the level of their development. Inquiry based science education (IBSE) could bring improving conceptual understanding of mathematical knowledge and could increase the activity of students in learning. In the paper, we present our first experience with testing the level of development of selected students' inquiry skills. We focus on the evaluation of tasks requiring working with different representations of data and understanding of linear functions. The paper presents also interactive learning activities that are part of our innovative methods based on applying inquiry approach to teaching linear and quadratic functions. The interactive learning activities for the investigation of the properties of functions are implemented in the dynamic geometric system Geogebra and in the spreadsheet MS Excel.

Keywords

inquiry skills, mathematics teaching, linear function, quadratic function, modelling, interactive activities

Introduction

The ability to apply the acquired knowledge to solve problems is an important mathematical competence. The development of students' abilities to solve problems requires the use of different representations of data and various types of models to express relationships between variables. Acquisition of skills in the use of simple arithmetic and graphical models is the first step in developing students' ability to use modelling in problem solving. Working with simple models provides students with skills to understand and use algebraic models, which requires identifying the variables and expressing the relationships between variables using equations, inequalities and functions.

Simple functional dependencies, such as direct and inverse proportion, are already included in teaching mathematics in the primary school. The direct proportion is a special type of linear dependence between quantities. Solving problems on linear relationship should also include the creation of tables and graphs through which various real life situations could be modelled. Suitable topics are for example tasks on motion and tasks from financial mathematics. Lack of experience in designing and interpreting charts and graphs can cause problems in understanding of symbolic representations of functional dependencies between variables. These simple models are the basis for understanding and using more complex algebraic analytical models for problem solving.

Selected results of testing mathematical skills in PISA 2012

The monitoring of mathematical literacy is the aim of several international assessments, for example TIMSS (Trends in International Mathematics and Science Study), OECD PISA. An important area of testing within PISA 2012 was solving tasks focused on the use of functions. The results from PISA 2012 show a reduction in the level of students' mathematical literacy in Slovakia (NÚCEM, 2013). Slovakia has for the first time since 2003 fallen significantly below the OECD average. Selected results show that Slovak students have gaps in working with tables and graphs and have difficulties in understanding and using functional dependencies.

Students should use the knowledge of linear function, for example, to solve tasks in the area of finance. As an example, we chose the task DVD Rental (OECD, 2013): *Jenn works at a store that rents DVDs and computer games. At this store the annual membership fee costs 10 zeds. The DVD rental fee for members is 2,50 zeds for one DVD and the fee for non-members is 3,20 zeds for one DVD.*

Question 1: *Troy was a member of the DVD rental store last year. Last year he spent 52,50 zeds in total, which included his membership fee. How much would Troy have spent if he had not been a member but had rented the same number of DVDs?*

To solve this task students can use two linear functions f: $y = 2{,}5x + 10$ and g: $y = 3{,}2x$, where x represents the number of borrowed DVDs. The function f represent the total fee for borrowed DVDs for members and the function g represent the total fee for borrowed DVDs for non-members of the DVD rental store. Using the function f students should calculate the number of DVDs that Troy borrowed last year. The function g enables the students to determine the rental fee for calculated number of DVDs, if Troy had not been a member of the DVD rental store last year. The average percentage of successful students within the OECD countries in this task was approximately 40 %.

Question 2: *What is the minimum number of DVDs a member needs to rent so as to cover the cost of the membership fee?*

Students can solve this question using several methods. The comparison of the functions f, g allows to find the value of x, for which the values of both functions are equal. The calculated value of x is approximately equal to 14,29. Therefore a member should borrow at least 15 DVDs to cover the membership fee. Students can also use logical deduction to solve the question 2. A member of the DVD rental store saves 0,7 zed on one DVD. The use of direct proportion allows to determine how many DVDs a member should borrow to cover the membership fee 10 zeds. The average percentage of successful students within the OECD countries in this task was approximately 17 %.

Students also have difficulties in understanding the symbolic representation of the relationships between variables. As an example, we chose the task about drip rate of infusion. A formula for the calculation of the drip rate, D, in drops per minute for infusions is:

$$D = \frac{dv}{60n}$$

d is the drop factor measured in drops per millilitre (mL), v is the volume in mL of the infusion, n is the number of hours the infusion is required to run.

29,6 % of Slovak students calculated the value of the variable v for the specific values of the variables D, d, n correctly. Only 18,1 % of Slovak students solved the task focused on a verbal description of the relationship how D changes if n is doubled but d and v do not change correctly.

The project focused on inquiry approaches to teaching of mathematics, physics, and informatics

Lack of skills in the use of mathematical knowledge in solving problems can be caused by students' lack of experience with the use of simple models for the acquisition of mathematical concepts and relationships. The low level of development of the modelling competence is often evocated by passivity of students in a memory-oriented transmissive approach to education. The innovation of "Science and Mathematics Education" is emphasized in recent documents of the European educational agencies, such as Eurydice (Eurydice, 2011).

Efforts to implement the inquiry based science education (IBSE) to school practice is reflected in a wide range of international projects supported at the level of the European Commission, or in smaller projects supported by national research agencies. In 2013, we obtained a project supported by the Agency for the promotion of research and development focused on the research on the efficiency of innovative teaching methods in mathematics, physics and informatics education. The main objective of the project is testing of innovative teaching strategies and methods in mathematics, physics and informatics education and to assess their impact on the development of students' inquiry skills and conceptual understanding.

The first phase of the project solving was devoted to design innovative lesson plans for applying inquiry approaches to the teaching of selected topics in the 1st and 2nd year of secondary school. Teachers at partner schools tested the prepared methodological and teaching materials in real school conditions in the school year 2014/2015. The teachers were given a possibility to try out the prepared teaching and learning materials based on IBSE and to test the usability of the materials for supporting the active learning. The pedagogical experiment is planned to be conducted in the school year 2015/2016.

Creating conditions for the application of inquiry approaches to learning involves also designing and implementing a stimulating learning environment in which students can experiment and explore the properties of objects and relationships between quantities. Teachers are faced with a challenge of how to use ICT to support students' inquiry. ICT provide advanced tools for visualization of functions and for the use of different modelling activities in mathematics teaching. They offer new ways of solving mathematical problems and assessing their solutions from different perspectives. ICT can facilitate independent student's inquiry or inquiry in small group but also in whole class discussion using screen projection (Goos et al., 2003). Teacher's role is to support students in using ICT in meaningful and purposeful ways. ICT can help students to explore, conjecture, construct and explain mathematical relationships. Student's inquiry is enhanced as student can, for example, drag a point in a figure or change the parameters of models (Hähkiöniemi, 2013).

In our project, we produced a variety of motivational tasks, interactive demonstrations and worksheets which should stimulate an exploration of mathematical patterns. ICT are used in learning activities to solve partial tasks from worksheets focused on investigation of mathematical relationships which students then develop and justify using logical considerations. ICT are also used to implement more complex interactive learning activities containing the sequence of tasks which enable students' active work with data and different models and which provide feedback on their learning results. To implement these learning activities, we used mainly the dynamic geometric system Geogebra and spreadsheet MS Excel.

An important indicator of the effectiveness of innovative methods is their effect on the development of inquiry skills of students. There are several classifications and schemes characterizing inquiry skills. As a convenient basis for classification and development of inquiry skills in mathematics, physics and informatics, we have chosen the scheme of inquiry skills (Van Den Berg, 2013) which issues from classifications created by Tamir, Lunetta (Tamir, Lunetta, 1981) and Fradd, Lee, Sutman, Saxton (Fradd et al., 2001). This scheme characterizes two basic methods of developing inquiry skills based on experiment or work with a model. Creation and use of models are important factors for application of inquiry approach to learning in mathematics.

This scheme contains five basic categories which are further elaborated in specific inquiry skills. We present the selected inquiry skills associated with modelling.

1. Determining the problem and planning the experiment/model:

- to formulate a question, hypothesis;
- to propose a model;

- to develop a procedure to test the hypothesis.

2. Carrying out the experiment/modelling:
   - to construct a model;
   - to record results.

3. Analysing and interpreting the experiment/model:
   - to transform the results into transparent tables, graphs;
   - to interpret results and discuss the suitability/limitations of the modelling process;
   - to express relationships between variables.

4. Sharing and presenting results:
   - to present results;
   - to find appropriate arguments to justify relations.

5. Applying and further exploiting the results:
   - to make hypotheses for further investigation;
   - to apply modelling procedures to new problems.

We plan to give a pre-test in experimental classrooms at the beginning of our pedagogical experiment to assess the level of development of selected inquiry skills of students. The first trial version of the pre-test has already been given in a classroom in which the prepared lesson plans and teaching materials have not been used before. It was focused mainly on diagnosing the inquiry skills from the first and third category of the above shown scheme and on testing the clarity of the tasks and formulation of options for answers.

The first version of the pre-test contained thirteen tasks. We tried it in one classroom with 22 students in the first year at a secondary school. All tasks contained five possible answers, of which just one was correct. For illustration, we present two tasks from the pre-test focused on the application of the knowledge of linear dependence. The first task was used to diagnose the skills to interpret the relationships expressed in the form of symbolic notations.

Task 1: Given are the functions $f(x) = x + 3$ and $g(x) = 2x + 3$ defined on the set of real numbers. Choose the correct statement for given functions f, g.

a) All the values of the functions f, g are rational numbers. (0)

b) There is a real number a, for which the equality $f(a) = g(a)$ is true. (11)

c) All the values of functions f, g are positive. (2)

d) For each real number x the value of $f(x)$ is less than the value of $g(x)$. (8)

e) For each real number x the value of $f(x)$ is greater than the value of $g(x)$. (1)

The numbers written behind the individual choices for answer represent the number of students that chose the given answer. 50 % of students solved this task correctly. It can be assumed that the selection of the choice d) is induced by the incorrect idea that $2x$ must be more than x for each real number x.

The second task was used for diagnosing the rate of skills development to express relationships between variables using symbolic notations.

Task 2: Peter pays 18 € per night in camp on a trip to the mountains. Last year, he camped on average 4 nights per month. This year he bought in a national park season-ticket for 70 €, which allows him to obtain a 50 % discount for 24 nights in the camp for the entire year. Let x be the number of nights that he spent in the camp this year. Which of the following equations could we use to calculate x, given that we know the total paid by Peter for overnight accommodations at the camp?

a) $0{,}5 \cdot 18x = 862$ (0)

b) $0{,}5 \cdot 18x + 70 = 862$ (4)

c) $18x - 0{,}5 \cdot 24x = 862$ (4)

d) $18x - 0{,}5 \cdot 24x + 70 = 862$ (9)

e) $18x - 0{,}5 \cdot 18 \cdot 24 + 70 = 862$ (5)

Only 22.7 % of students solved this task correctly. The most students selected the incorrect answer d). These students intended to subtract 50 % discount from the full total amount of overnight accommodations at the camp. They did not notice that amount per one night is replaced by the variable x in the calculation of discount.

The average score in the pre-test was 45.98 %. This relatively low score points to the fact that some students' inquiry skills are developed on a low level. Our testing has pointed out the difficulties of students with interpretation and creation of symbolic notations expressing the relationships between variables, with making hypotheses and with finding the appropriate arguments to justify the validity of their hypotheses.

Interactive learning activities to investigate the linear dependence

Lack of skills and students’ misconceptions, which we specified using the results of international measurements and research studies (for example Marshall, 2013), have been taken into consideration in designing appropriate activities and lesson plans enabling the application of inquiry approaches to teaching mathematics. We found out that students are often not able to characterize the properties of linear dependence and cannot correctly interpret the relationship between variables expressed in the form x/y = const. Therefore, we have tried to propose learning activities to explore connections between data, graphs and algebra. ICT enable students to work with tables of numbers, graphs and formulas and to link readily different representation of data. Teachers at six partner schools tested the prepared methodological and teaching materials in real school conditions in the first phase of the project solving. Proposals of teachers to reformulate questions and tasks were taken into account in the final editing of teaching materials. Teachers have highlighted the use of dynamic models to better understand the dependencies between variables and to develop the ability to use different types of models to solve real-life problems. We chose several interactive learning activities to illustrate the proposed inquiry approaches to learning linear and quadratic functions.

An interactive activity to the uniform linear motion is used to investigate direct proportion which is a special case of a linear dependence between variables. Students have the experience with uniform motion from real life and also from physics. The applet available on the address https://phet.colorado.edu/en/simulation/moving-man allows to simulate the movement of a man. A man can be moved to the house with a mouse or by running simulations of uniform motion. Figure 1 shows a simulation result for the velocity $v = 2$ m/s.

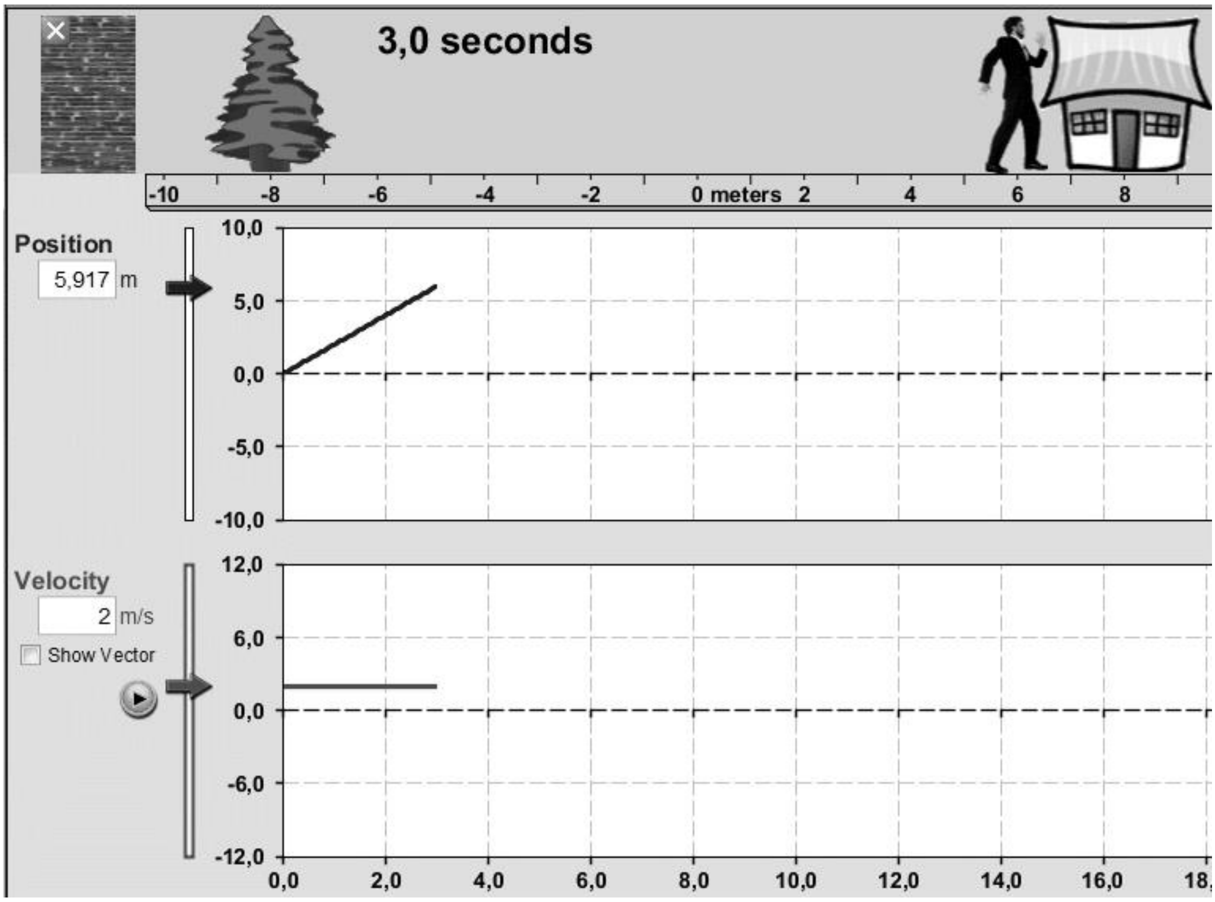


Fig. 1: The simulation of uniform motion

The simulation of the motion of the man is accompanied by drawing graphs of dependence of the distance moved and the speed over time. Horizontal lines in the Figure 1 represent time in seconds. The teacher would require students to create a table with the values of the distance moved for the selected time intervals. Student should verbally describe the relationship between distance and time and express it also using symbolic representation in the form $s/t = 2$. Then, using the applet, they could further investigate how the graphs will change for other values of the speed of a man and generalize the symbolic notation of the explored relationship.

The following activity enables students to model a linear relationship between quantities and investigate connections between different representations. The basis of the activity is a dynamic construction created using GeoGebra. To explore the linear dependence, we used a theme from real life based on the accumulation of work pieces produced in a workshop during a week. At the beginning of the week 36 work pieces have already been made in the workshop. The initial number of work pieces can be changed using the slider *a*. Workmen produce some number of work pieces each working day. The numbers of work pieces manufactured in different days of the week determine the values of the sliders *b*, *c*, *d*, *e*, *f*, *g*.

The created graph (see Figure 2) shows a dependence of the total number of work pieces produced in the workshop on time. In order to better understand the graphical representation of the modelled situation, students should create a table with data from the graph and solve two simple tasks displayed above the graph. If students enter correct numbers in the text fields they obtain information about the correctness of their answers. Then students have to set the values of sliders *b*, *c*, *d*, *e*, *f*, *g*, so that the number of work pieces in a workshop at the end of each day grows linearly over time.

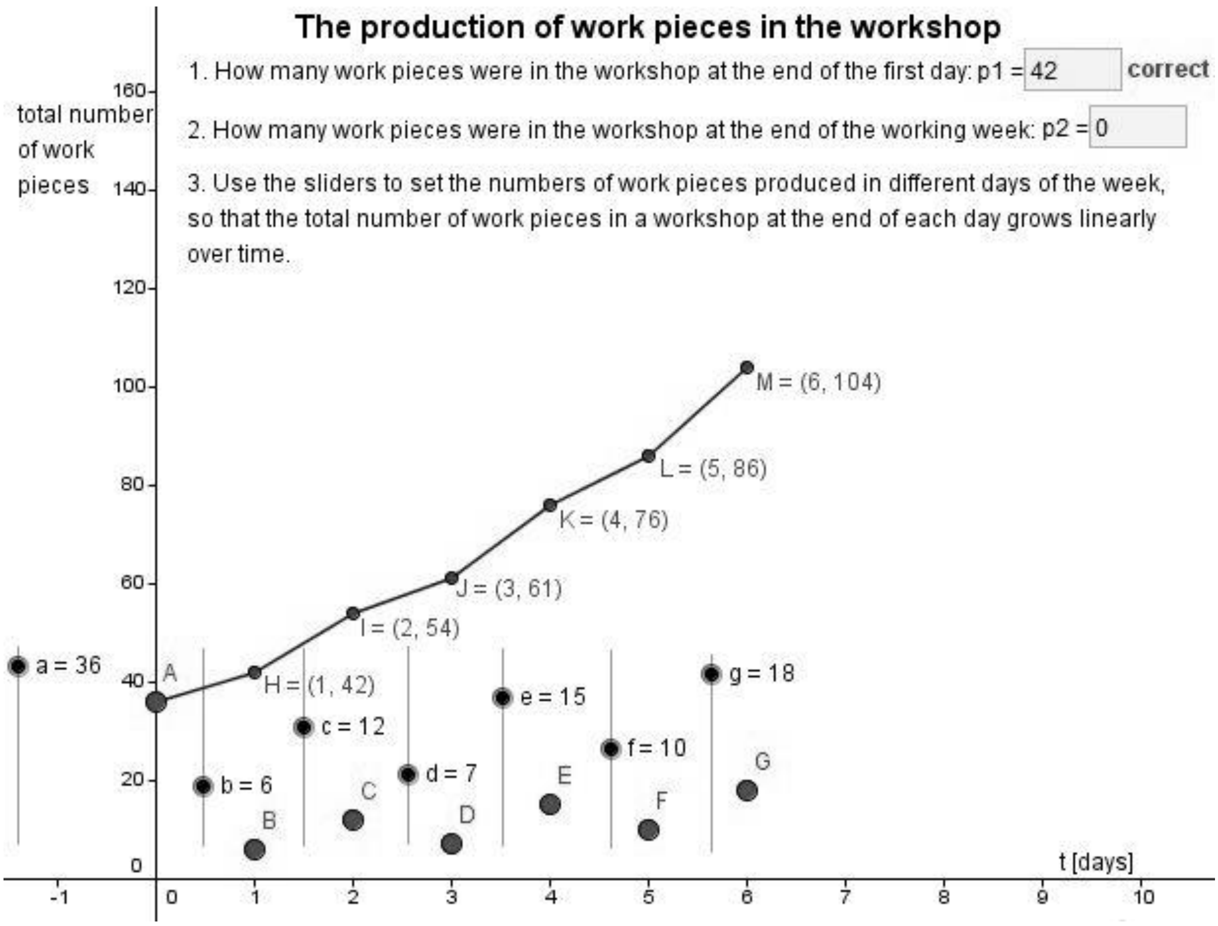


Fig. 2: The modelling of the linear dependence

Setting the same values for sliders *b*, *c*, *d*, *e*, *f*, *g* causes that the polygonal line straightens out to one straight line. Students can also change the value of the slider *a* and observe how it influences the graph of the linear dependence. After understanding the basic property of the linear dependence students can express the relationship between quantities using the formula $n = a + b.t$, where n is the total number of work pieces produced in the workshop in time t, and the variable b represents the same number of work pieces produced in different days of the week. The linear function can be generally written in the form $y = ax + b$, $a \neq 0$.

A teacher can focus students' attention to the growth rate of a linear function. If workmen produce a greater number of work pieces daily, the linear function grows faster and a line will form a larger angle with the x axis. The slope a is an important characteristic of the linear function and it can be determined using the difference $f(x+1) - f(x)$.

The proposed lesson plans include also tasks supporting formative assessment, solving of which could also provide students with self-reflection. After using the above mentioned interactive activities, we recommend to give students a task containing parts of a dialog between two boys. One boy is trying to explain to another boy that a linear function expresses direct proportion. Students have to choose one of the options: Always, Sometimes, Never and justify their choice using appropriate examples.

After modelling real life situations, we recommend to use an activity for exploring graphs of linear functions. A dynamic construction containing a graph of a linear function could be used to improve the understanding of linear functions. In accordance with the classification of the inquiry skills, this activity allows to develop also the skills associated with reasoning and generalization of discovered relationships. Students could change the values of coefficients a, b in the formula of the linear function using sliders. Students could solve the following tasks:

a) How does the graph of a linear function change if we decrease the value of the coefficient a to 0,5; –0,5; -1; ...?

b) What is the relative position of graphs of linear functions f: y = 2x – 5 and g: y = 5x + 3?

c) What is the relative position of graphs of linear functions with the same slope a?

d) Determine the coordinates of the intersection point of graphs of all linear functions given by the formula y = ax – 2, where a is any real number different from 0.

e) Find a linear function whose graph passes through the point [0, 2] and is parallel to the graph of the linear function f: y = x – 1?

f) Is there a linear function whose graph is perpendicular to the x axis?

Models for the investigation of the quadratic functions

A problem focused on triangular numbers could be used to encourage students' attention to investigation of a quadratic dependence between variables. The problem could be given to students in the form of a game. *Children were building block stairs (see Figure 3). Find out with how many blocks the stairs in few next steps are built.*

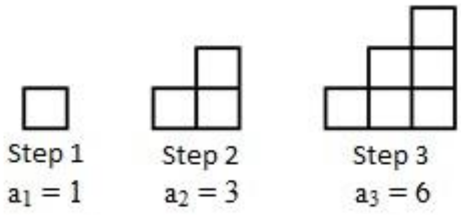


Fig. 3: The first three steps of a building of stairs

Finding the number of the blocks stairs in few following steps is an easy task. More complex problem is to identify the type of dependency between the explored variables. Students can use numerical and graphical representation of the data for problem solving. A table and mainly a graph show that the explored dependence is not linear. It cannot be expressed even by a basic quadratic function.

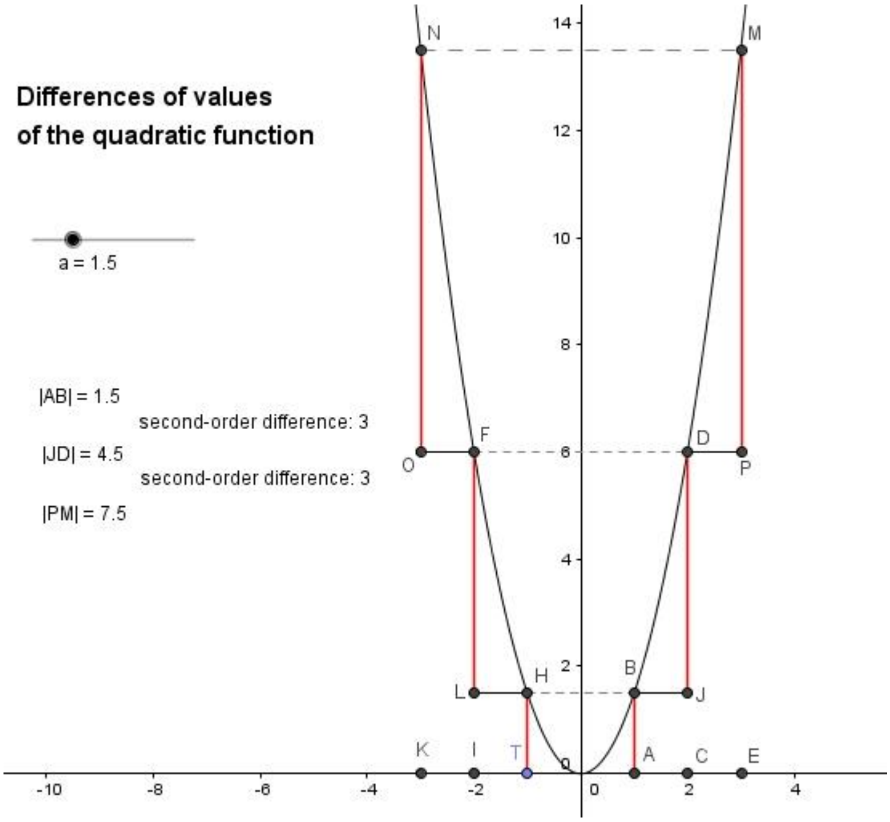


Fig. 4: The graphic model for investigation of the quadratic function

Investigation of the growth rate of selected types of functions could help students in finding a suitable type of a dependency. Teacher should focus students' attention to the growth rate of the basic linear, quadratic and cubic functions for non-negative integers. Students would create tables and graphs of functions $f: y = ax,\ g: y = ax^2,\ h: y = ax^3,\ a \in R^+$ for consecutive non-negative integers x. Students could find out that if the variable x changes by the same amount, then differences of values of the quadratic function create a linear function. A graphical model for investigating the growth rate of the quadratic function g would be given to students after formulating hypotheses. Figure 4 shows a graph of the quadratic function g for a = 1,5 and the growth rate of this function by changing the variable x by the same amount 1. The first and second order differences are calculated on the left from the graph of the function g. Students can use slider a for changing the value of the quadratic coefficient and for observing how the first and second order differences of values of the quadratic function change.

After investigation of the growth rate of the basic quadratic functions for integer values of the variable x, the teacher should focus students' attention to the changes for the values of the variable x which are not integer. The arithmetic model can be used to generalize the discovered findings. The model is implemented in a spreadsheet environment. It enables students to easily change an initial value of the variable x and the value s by which the variable x increases in each step. A part of the created table is shown in the Figure 5.

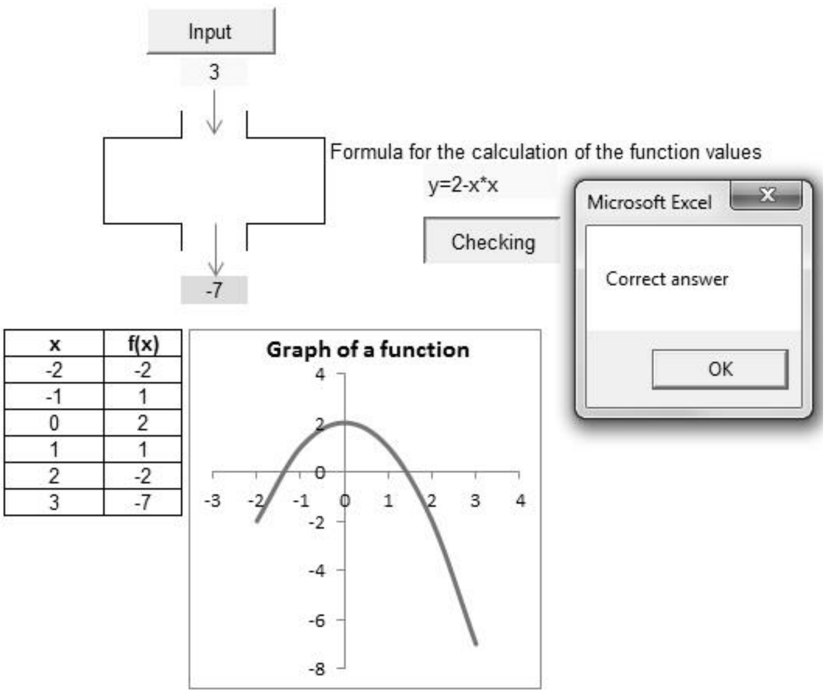
	A	B	C	D
1	Investigation of the quadratic function:			$y = ax^2 + bx + c$
2				
3	a	b	c	s
4	5	0	4	0,25
5				
6	x	f(x)	f(x+s)-f(x)	second-order difference
7	0	4		
8	0,25	4,3125	0,3125	
9	0,5	5,25	0,9375	0,625
10	0,75	6,8125	1,5625	0,625
11	1	9	2,1875	0,625
12	1,25	11,8125	2,8125	0,625
13	1,5	15,25	3,4375	0,625
14	1,75	19,3125	4,0625	0,625
15	2	24	4,6875	0,625
16	2,25	29,3125	5,3125	0,625
17	2,5	35,25	5,9375	0,625
18	2,75	41,8125	6,5625	0,625
19	3	49	7,1875	0,625

Fig. 5: The arithmetic model for investigation of the quadratic function

Using the model students can find out that if the variable x increases by the same value then differences of the quadratic function grow linearly. The growth rate of the quadratic function is influenced only by the quadratic coefficient a. Since the graph of the quadratic function is symmetrical about the axis of the parabola analogous situation occurs for decrements of the values of the quadratic function in the part of the domain in which the quadratic function is decreasing. The reasoning of the discovered properties of the quadratic function $f : y = ax^2 + bx + c$ may be based on calculating the difference $f(x + 1) - f(x)$. The result of this subtraction is the expression $2ax + a + b$ which allows to determine the linear function with the slope $2a$. Therefore, if the values of the variable x are consecutive non-negative integers, the differences of the quadratic function grow uniformly by the value $2a$. In the initial motivational problem about building block stairs the number of new blocks grows in the next step uniformly by the value 1. The number of blocks depending on the ordinal number of steps can be expressed by the quadratic function with the quadratic coefficient 1/2. The substitution of ordered pairs (0, 0) and (1, 1) into the equation of the quadratic function allows to determine the values of coefficients b, c. The searched quadratic function is $f : y = \frac{x^2}{2} + \frac{x}{2}$.

Modelling functions using the black box

An interactive activity about a black box representing an unknown formula to calculate the function values is included at the end of the part oriented on the work with different representations of linear and quadratic functions. The black box processes the input number and brings out a function value. We used a spreadsheet environment to model the black box. The interactive activity contains a sequence of eight tasks focused on finding the formula to calculate the output values of linear and quadratic functions. The formula for the calculation of the linear function values includes in some tasks the absolute value too. The last three tasks are aimed at finding formulas for the calculation of output values of the quadratic functions.



Black box representing the quadratic function

Using the Input button, students enter a value of the variable x to the box input and they receive the output value of the variable y. Students can gradually write the obtained data in the table and use it to create a graph of the explored function. Entering the correct formula and its confirmation provide access to the next sheet with a new task. Figure 6 shows the solution of the seventh task together with an additional table and a graph.

Results and Discussion

After using the prepared lesson plans, teachers filled in forms in which they expressed their subjective views on the proposed teaching and learning materials, as well as the students' reactions and their learning outcomes. The first experience shows that the use of arithmetic and dynamic graphical models helps students to interpret information from graphs correctly and to better understand the symbolic representation of relationships between variables. Most teachers highlighted the inclusion of tasks for formative assessment at the end of the selected learning activities. These tasks allow to diagnose early student's errors and misconceptions and to correct them using appropriate follow-up questions and tasks.

In the forms, teachers often emphasized that many students have difficulties with formulation of mathematical statements, with reasoning and generalization of discovered findings. Finding and using appropriate arguments to justify the mathematical statements often required a large help from the teacher. The above mentioned skills require conceptual understanding of the educational content and critical thinking.

The preparation of teachers to use innovative lesson plans in mathematics teaching and the finalization of teaching materials were carried out at the summer school for teachers. Teachers also evaluated the tasks of the pre-test and assessed the usability of tasks for developing students' inquiry skills and the complexity of tasks. The five point scale from -2 (of absolutely unsuitable) to 2 (of very suitable) was used for assessment of the tasks. Teachers' suggestions and our experience from pilot testing were taken into account when editing some tasks. For illustration, we chose the task focused on testing inquiry skill level of expressing relationships between variables using a symbolic notation (task 2). The average values of teachers' assessment of the usability and the complexity of the origin task were 1.8 and 0.6. We present the modified task 2.

Task 2: Peter pays 18 € per night in a camp on a trip to the mountains. Since he often camps out in a national park, this year he bought a season-ticket for 70 €, which allows him to obtain the 50 % discount for 24 nights in a camp for the entire year. Let x be the number of nights that he spent in the camp this year. Which of the following equations could we use to calculate the total amount s of overnight accommodations at the camp for the entire year, if we know that Peter spent in camp more than 24 nights in this year?

a) $s = 0{,}5 \cdot 18x + 70$

b) $s = 0{,}5 \cdot 18 \cdot 24 + 18(x - 24) + 70$

c) $s = 18x - 0{,}5 \cdot 24x$

d) $s = 18x - 0{,}5 \cdot 24x + 70$

e) $s = 18x - 0{,}5 \cdot 18 \cdot 24 + 70$

Students should find and express the relationship between the total amount s and the number x of nights spent in the camp. A more detailed analysis of individual answers reveals that two answers are correct (b, e). The example shows that the new version of the pre-test also includes tasks in which more correct answers are listed. Students are reminded of this fact in the introductory text at the beginning of the pre-test. Our aim is to restrict the selection of the correct answers through eliminating the false claims.

An important research question will focus on the investigation, whether the innovative lesson plans based on IBSE contribute to improving conceptual understanding. A post-test for evaluation of the effectiveness of innovative methods will be given in experimental classrooms at the end of the pedagogical experiment. The post-test will be divided into two parts. The first part will contain modifications of selected tasks from the pre-test. We will try to assess the impact of innovative approaches to teaching mathematics to develop selected inquiry skills of students. The second part will include conceptual tasks to measure the level of understanding of the educational content.

Our plan is to evaluate the learning performances of students quantitatively and also qualitatively. Quantitative analysis of the pre-test and post-test results in experimental classes of six partner secondary schools will be based on paired tests. We will evaluate whether innovative teaching methods induced a significant improvement in selected inquiry skills. Using analysis of variance (ANOVA), we will compare three groups of students with respect to their specialization: general classes, classes focusing on mathematics and classes focusing on languages. We will try to find out if potential improvements in these three groups are comparable (identical or different). In case, that ANOVA will show significant differences among the groups, Scheffe's or Tukey's method will be used to identify significant differences in pairwise comparisons.

Conclusion

Solving word problems is a convenient resource for developing the ability to apply skills of functional dependencies. The linear and quadratic dependencies can be found in real life problem solving situations that provide opportunities for creating connections between mathematics and other science subjects. Although these dependencies represent the simple types of dependencies between quantities, their understanding is necessary for acquiring more complex types of dependencies between quantities. Interactive demonstrations supplemented with asking the appropriate questions and interactive activities for students' individual investigation can assist in the implementation of the inquiry approach to teaching mathematics and science. Their contribution to teaching mathematics can be reflected in an increased student's motivation, in a development of inquiry skills and critical thinking, which is important in finding the right arguments to justify discovered relationships and their generalization.

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