Computer Supported Teaching of Mathematics at Secondary School

PaedDr. Ingrida Kraslanová
(inka.k@orangemail.sk)
Comenius University in Bratislava,
Faculty of Mathematics, Physics and Informatics
Mlynska dolina, 842 48 Bratislava, Slovakia

At present is very often discussed a problem concerning the use of computers in education. We became a part of some "informatics society" where the existence without computers is next to impossible. Computer technology is used not only by adults but also by students, pupils and children as well.

Teaching supported by computers is for students more interesting, they are better motivated and also have a possibility to excel during lessons. Computer is very good school aid which helps students with solving many problems, e.g. with drawing schemes, graphs of various functions, solving equations etc. When we are talking about implementation computers into schools, teaching, we have to be cautious and to prevent undesirable phenomena like metacognitive shift.

We made an experiment at a technical school in Bratislava and chose two classes - one experimental and the second one control. The subject matter we were teaching was: Graphs of goniometric functions, in control group we taught by traditional approach methods and in experimental group using computers and mathematical software Derive.

Aims of our experiment:

- to go through the subject matter Graphs of goniometric functions y=a*sin(bx+c)+d, y=a*cos(bx+c)+d with both groups,
- to prepare the test and give it to the students of both groups, to evaluate the test and compare the results of two classes,
- to find out if computer supported teaching is more effective than the traditional.

Hypothesis:

- H1: Students of secondary schools have problems with drawing graphs of goniometric functions; they don't know how each parameter influences the graph of function.
- H2: Students of experimental group have due to use of computers the opportunity to see more graphs of various functions and so they obtain more precise idea about influence of parameters a, b, c, d.
- H3: Computer supported teaching improves the instruction and makes it more effective.
- H4: Students are due to computers more interested in mathematics.

To achieve our aims, we taught in:

- control group (32 students, 16-17 years old) 4 lessons,
- experimental group (30 students, 16-17 years old) 5 lessons, because we needed one more lesson to let the students be familiar with software Derive.

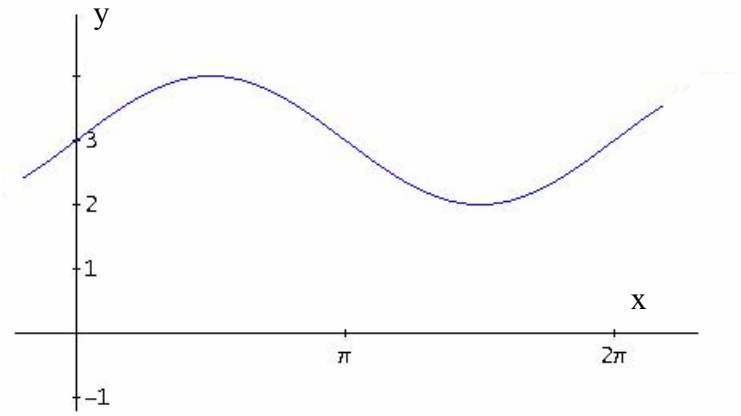
On the next experimental lesson students wrote the test.

Before giving the test we prepared Analysis a priori of the test where we tried to foresee the students thinking. We quoted the right solutions as well as expected solutions, strategies and also some mistakes that could the students do.

Thereinafter we introduce the one of two versions of the test:

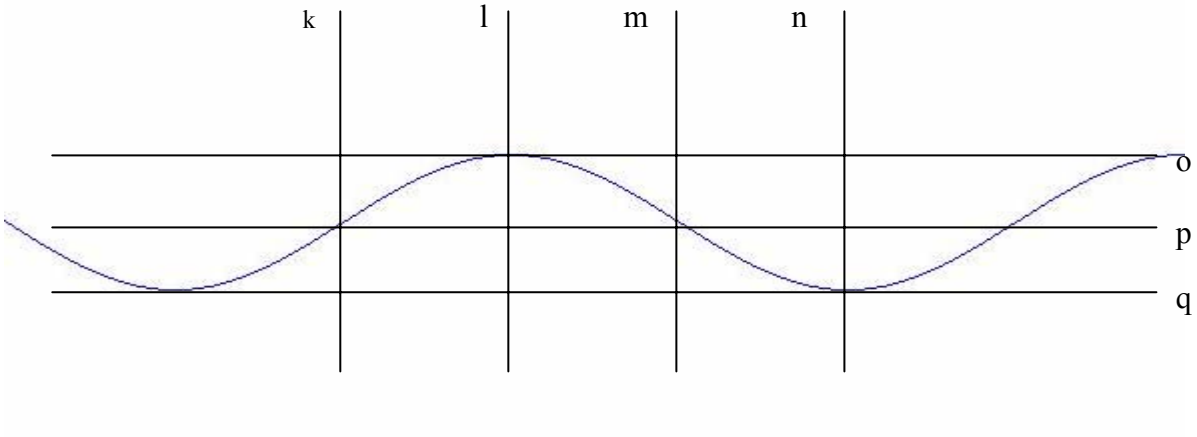
TEST A

1. Draw a part of graph of function $y = \sin x$ on interval $\left\langle -\frac{3}{2}\pi; \pi \right\rangle$.
2. Graph of which function is drawn in the picture below?

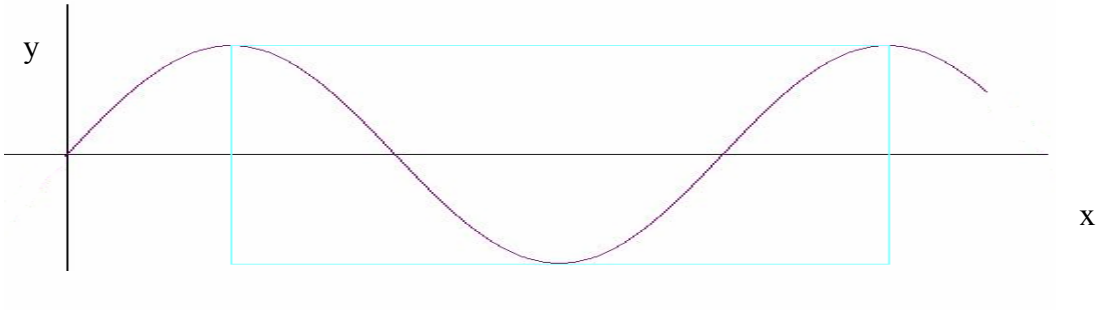


(A) $y = 3 + \sin x$ (B) $y = 3.\sin x$ (C) $y = \sin(3x)$ (D) $y = \sin(x + 3)$

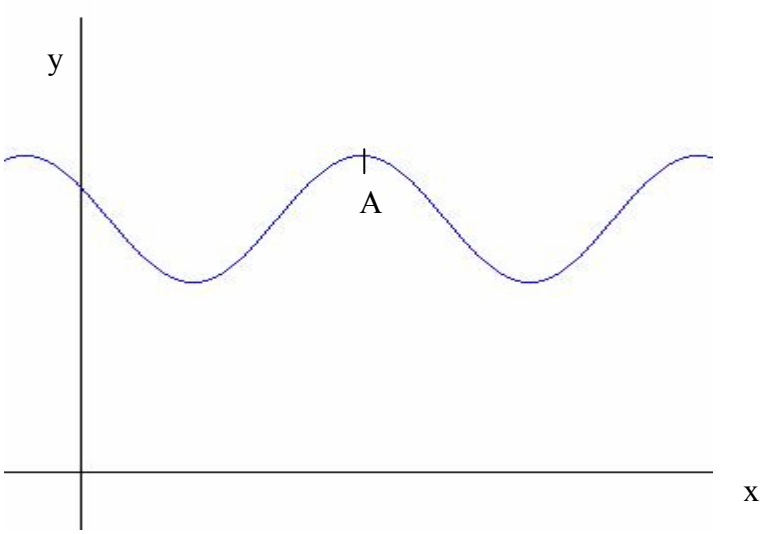
3. Draw one period of graph of the function $y = -2.\cos x$.
4. Draw one period of graph of the function $y = \sin\left(x + \frac{\pi}{4}\right)$.
5. In the picture is drawn graph of function $y = 1 + \cos\left(x - \frac{\pi}{2}\right)$. Which one from seven given straight lines *k, l, m, n, o, p, q* is equivalent to axis x and which one is equivalent to axis y?



6. In the picture is drawn graph of the function $y = 3.\sin\frac{x}{2}$. Calculate the area of the marked rectangle.



7. In the picture is drawn graph of the function $y = 4 + \cos\left(2x + \frac{\pi}{3}\right)$. Specify the coordinates of marked point A.



In Analysis a posteriori we evaluated the test qualitatively, quantitatively and also statistically. In analysis we found out the following:

- Students of the control group made unexpected mistakes in solving of the first task, because they didn't know how to draw the graph of given function on selected interval. This problem didn't appear in experimental group.
- The success of second task in the test was in both groups the best. We suppose this happened because this task was with four options and the students could easy choose the correct formula.
- The third and fourth tasks have been focussed on drawing graphs with one parameter. The difference between two compared groups is significant (see the table below). The reason could be that students of experimental group had the opportunity to see more graphs, which have been correctly and precisely drawn and also marked by different colours.
- The fifth task was for students unusual, because they have never met with such an exercise. Some of the students didn't use neither the pictures nor auxiliary tables, that's why we presume that these students guessed the correct answer. From the table below we can see that students of experimental group achieved better results than the students of control group, who weren't taught by using computers.

- In the sixth task the students had to awake, that the range of value and period of function depend on parameters in the formula of given function. Many students mainly from the control group automatically conceived that the period of function is 2π.
- The most difficult task for both groups was the last one because the students solved this type of problem first time. We supposed students don't see connections between acquired knowledge and don't know how to use them effectively in solving problem.

Percentage success of two groups in single tasks of the test:

Task	Experimental group	Control group
1	85.00%	35.94%
2	90.00%	93.75%
3	73.33%	57.81%
4	61.67%	40.63%
5	56.67%	42.19%
6	35.56%	19.79%
7	13.33%	12.50%

From listed points is ocular that the computer supported teaching influences the success of the students in the test in the positive way as well as the knowledge of the students of experimental group. We were interested in if these results aren't only accidental. That's why we decided also for statistical analysis - for Students' t-test. From the data in the following table we counted the value of the t:

	Number of the students	Arithmetical average	Empirical variance
Control group	$\mathbf{n_1 = 32}$	$\overline{X}_1 = 5{,}3125$	$s_1^2 = 8{,}5536$
Experimental group	$\mathbf{n_2 = 30}$	$\overline{X}_2 = 7{,}7667$	$s_1^2 = 6{,}3270$

Empirical variance: $s = \sqrt{\dfrac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}} = 2{,}7345$

Random variable: $t = \dfrac{\overline{X}_1 - \overline{X}_2}{s\sqrt{\dfrac{1}{n_1}+\dfrac{1}{n_2}}} = -3{,}5316$

$$\mathbf{-t\,(n_1 + n_2 - 2;\ \alpha) = -t\,(60;\ 0{,}0005) = -3{,}460}$$

Our calculating shows that the absolute value of the random variable t is: $|t| = 3{,}5316$. This high value implies that the results of our experiment are not accidental. It is a statistical very significant difference between two compared groups.

Results of the realized experiment helped us to validate the four defined hypothesis. In the future we are planning to work out and prepare some worksheets for students and teachers and to make a proposal of effective use of computers in the mathematics.

Literature:

[1] Bereková, H. – Földesiová, L. – Regecová, M. et al. (2001): Slovník teórie didaktických situácií, 1. časť. In: Zborník bratislavského seminára z teórie vyučovania matematiky, No 4, Bratislava: Vydavateľstvo UK, 2001, s. 95-98

[2] Bereková, H. – Földesiová, L. – Regecová, M. et al. (2003): Slovník teórie didaktických situácií, 2. časť. In: Zborník bratislavského seminára z teórie vyučovania matematiky, No 5, Bratislava: Vydavateľstvo UK, 2003, s. 113-121

[3] Černochová, M. – Komrska, T. – Novák, J. (1998): Využití počítače při vyučování, Praha: Portál, 1998

[4] Kerlinger, F. N. (1972): Základy výzkumu chování. Pedagogický a psychologický výzkum, Praha: Academia, 1972

Author:

PaedDr. Ingrida Kraslanová (inka.k@orangemail.sk)
Comenius University in Bratislava,
Faculty of Mathematics, Physics and Informatics
Mlynska dolina, 842 48 Bratislava, Slovakia