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The Use of ICT in Teaching Mathematics - A Comparative Analysis of the Success of 7th Grade Primary School Students

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Abstract

Information and communication technologies (ICT) are an integral part of everyday life including the teaching process. The level of teaching equipment in Croatian schools ranges from chalk and board to the latest smartboards and other equipment. High level of ICT is foreseen as a prerequisite for successful teaching and, as such, an integral tool of contemporary schools. The purpose of this study was to examine the impact of the application of ICT tools in teaching primary school mathematics. The students' success in mathematics exam, in the Linear function unit, was evaluated in two groups of 7th grade students of the primary school Josip Juraj Strossmayer in Zagreb, based on their test scores. The first group, 90 students, attended mathematics classes without ICT tools in teaching (school years 2008/2009 and 2009/2010). The second group, 110 students, (school years 2012/1013 and 2013/2014) attended mathematics classes with an extensive use of ICT in the teaching process. The first group of students successfully solved 48±26% of the Linear function test, while the second group successfully solved 58±26% of the same test. The results showed a significantly higher solving rate in the group of students who attended classes in mathematics where ICT was used in teaching (p=0.005). ICT supported mathematics classes, in the example of Linear function unit, significantly improved students' results in written exams. The results of this study support the hypothesis that using ICT in teaching leads to better learning and knowledge acquisition in primary schools.

Key words: *information support; mathematics; teaching; teaching process.*

Introduction

Contemporary technologies, specifically information and communication technologies today are considered a key factor of quality education system success, especially because the educational process is based on the collection, processing and presentation of information (Eisenberg, 2008). The education system has not changed fundamentally over 100 years and the usual way of teaching is still based on teachers presenting information to "passive" students (usually in the form of the so-called frontal instructions). Furthermore, it is considered that using contemporary technology is not a prerequisite for successful teaching. Information era students are considering teaching with intensive use of technology as motivating and a necessity (Passey, Rogers, Machell, & McHugh, 2004). Therefore, students find teaching without the use of technology obsolete and boring. It is necessary to emphasize that technology does not solve all the problems of education and that the process of teaching can be very successful without the use of the same. In other words, technology cannot be used as a shortcut for knowledge and skills acquisition (Toyama, 2011).

Expectations of teachers, students and parents must be taken into consideration while applying technology. There are numerous examples where, due to the influence of ICT, learning some of the skills is considered a relic of the past. For example, learning cursive script is increasingly being considered as a waste of time (Boone, 2013; BBC, 2014) thus many people advocate that learning cursive script should be omitted in compulsory education. Although such an approach seems unreasonable, there are many examples where some skills are omitted from the curricula due to technology development. For example, teaching the process of calculating the square root of a positive integer was once an integral part of the elementary mathematics curriculum, but nowadays is considered obsolete due to the invention and everyday use of calculators.

It can be concluded that contemporary technology, especially ICT, enables us to substitute obsolete contents with new ones, in accordance with the perceived need for the improvement of information literacy related to elementary and high school curricula. The bottom line is that contemporary technologies in the teaching process are used to improve students' acquisition of new knowledge and skills, as prescribed by the teaching plan and program.

The purpose of this study was to examine the impact of ICT in teaching the unit *Linear function* in the 7th grade mathematics curriculum. The Linear function unit is one of the six chapters in the math curriculum, selected because it is appropriate for the use of ICT, as shown in practice.

Methods

The results of the Linear function unit written exam of 4 generations of students in the Josip Juraj Strossmayer primary school in Zagreb were collected.

In the 2008/2009 and 2009/2010 school years, whiteboard, projector and computer with mathematical software were not used. The unit was taught exclusively using the blackboard and chalk, geometric accessories, worksheets and literature.

The results of the written exam were collected for 90 students, i.e. the entire population of seventh grade students for those school years. These data make the first group (ICT not used).

In the 2012/2013 and 2013/2014 school years, ICT was extensively used in teaching. The collected results of the written exam of the entire 7^{th} grade population, 110 students, make the second group (ICT used). Technology used consisted of whiteboard Interwrite with driver Workspace 02.09.97, software for mathematics Sketchpad 4.7 and 4.2 Geogebra and Microsoft Office.

Both groups had the same test and the test score percentage was compared. In both groups, the teaching was performed by the same two teachers (Teacher 1 and Teacher 2). Results of the students whose teaching was performed by Teacher 1 in relation to the Teacher 2 were analyzed. The test results of male students compared to female students were also analyzed.

Statistics

Data were entered into a spreadsheet and analysed by the software Statistica 9 (StatSoft, Inc., Tulsa, OK, USA) with a level of statistical significance $p<0.05$. The basic methods of descriptive statistics were used and standard indicators of mean and scattering calculated.

The normality of the sample was tested by Kolmogorov-Smirnov test. Significance of the arithmetic means difference was tested by a parametric test (Student's t-test). Analysis of variance (ANOVA) with two independent variables tested interaction for Teacher 1 and Teacher 2 with respect to students' gender.

Results

The arithmetic mean and standard deviation of test score percentage in the first group (ICT not used) was 48±26%, while in the second group (ICT used) the test score percentage was 58±26%. Students exposed to the intensive use of ICT in teaching the selected unit obtained significantly better results ($p=0.005$, two-sample Student's t-test) (Table 1).

Secondly, the achievement differences by students' gender were analysed (Table 1). Although the percentage of test score was higher for the female population 55±25% compared to the male population (52±27%), the difference did not show statistical relevance ($p = 0.394$, two-sample Student's t-test).

The comparison of results regarding different teachers is shown in Table 1. Although Teacher 1 shows higher percentage (55±29%) relative to Teacher 2 (51±19%), the difference did not show statistical relevance ($p = 0.384$, two-sample Student's t-test)

Table 1

Test score percentage regarding the observed parameters

Parameter		N (%)	Test score percentage Arithmetic means ±SD	Degrees of freedom	t value[1]	p value[1]
Gender	Male	105 (52.5)	52±27	198	-0.86	0.394
	Female	95 (47.5)	55±25			
Teacher	1	148 (74)	55±29	198	-0.87	0.384
	2	52 (26)	51±19			
ICT	Not used	90 (45)	48±26	198	-2.87	0.005
	Used	110 (55)	58±26			

SD – standard deviation; ICT- Information and communication technologies;
[1] Student's t-test

Furthermore, we analysed whether there was a statistically relevant connection between teacher-student's gender on test score percentage. That is, whether there were significantly better results of each of the two teachers in relation to male or female students. No statistically significant difference ($p > 0.05$) was found in the results due to the interaction of variables teacher-student's gender before the introduction of ICT and even after the introduction of ICT in education (Table 2).

Table 2

Analysis of variance with independent variables gender and teacher for the dependent variable test score percentage

Parameter		Degrees of freedom	F value[2]	p value[2]
ICT not used N=90	Gender	1	1.460	0.230
	Teacher	1	1.139	0.289
	Gender*Teacher	1	2.538	0.115
ICT used N=110	Gender	1	0.776	0.380
	Teacher	1	0.894	0.346
	Gender*Teacher	1	1.708	0.194

ICT- Information and communication technologies;
[2]ANOVA with two independent variables

Discussion

Today, contemporary technology significantly affects the everyday life and, therefore, the teaching process. The tendency of ICT integration in teaching is unambiguous and there is a general consensus on the importance of such integration. The research of the contemporary technology impact on the educational process has an important role in the integrating process.

For this purpose, the presented study was conducted. The results of the research showed a positive effect of using contemporary technology with respect to the results of the written exam on the Linear function unit. The use of ICT significantly reduces the time required to master new teaching materials. By changing the coefficients of linear function, the influence on the line position in the coordinate system, the flow of linear functions, parallelism and perpendicularity, etc. can clearly be shown.

Previously, to comprehend such influences, students would have to re-draw, or study from the literature, which often resulted in the loss of student's concentration. As a consequence, it was necessary to spend more time studying With the new approach we gain time for training, repetition and classification of materials.

The limitation of this research is the inability to achieve ideal experimental conditions; an essential factor contributing to these results may be, for example, educational differences and 'better' or 'worse' generation students. Large samples, which include a complete generation of students attempted to reduce this impact to a minimum.

The research results presented in this paper are in accordance with the results of the research conducted in mathematics and natural sciences by Delen and Bulut (2011), which showed a positive correlation in the use of ICT in the results of the PISA tests in Turkey. A step further is presented in the research by Kubiatko and Vlckova (2010), which analyses the correlation between the use of ICT and the results of the PISA tests on the population of students in the Czech Republic. Students who generally used ICT had better results than those who did not use ICT. Furthermore, students who use ICT in their education showed better results than students whose use of ICT is not related to education (Kubiatko & Vlckova, 2010).

The opposite results in mathematics were presented in the research by Machin, McNally, and Silva (2006), which analysed students' success after a large financial investment in ICT in primary and secondary schools in England. The observed results were of 1,243 primary schools and 1,524 secondary schools, and have shown improved success in the field of English language and science, but not in mathematics.

One should not ignore the importance of students' motivation. A student's positive attitude toward new technologies and modern teaching approaches affects the positive attitude toward the teaching content, thus resulting in better success (Räihä, Tossavainen, Enkenberg, & Turunen, 2014).

Conclusion

Professional development of mathematics teachers in Croatian schools, which would contribute to the quality of teaching in terms of the use of ICT, is not systemic but depends on a teacher's personal involvement. Investments in ICT in schools are becoming more visible, improving the overall condition of equipment and infrastructure. The teacher's role is crucial in motivating students for the teaching content. Teacher's imagination and enthusiasm can overcome potential deficiencies in equipment and resources. This paper has shown that the use of ICT leads to better results in seventh grade mathematics in Linear function unit, regardless of individual differences of teachers and the impact that different teachers can have on student success.

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Primjena informacijsko-komunikacijske tehnologije u nastavi matematike – komparativna analiza uspjeha učenika 7. razreda osnovne škole

Sažetak

Informacijsko-komunikacijske tehnologije (IKT) sastavni su dio svakodnevnice pa tako i nastavnih procesa. Razina opremljenosti u hrvatskim školama varira od krede i ploče do najsuvremenijih pametnih ploča i opreme, no može se očekivati da će uskoro visoka razina IKT postati standard u svim školama te neophodan dio nastavnih procesa. Svrha je ovog istraživanja ispitati utjecaj primjene IKT u nastavi matematike na uspješnost učenika na pismenom ispitu iz matematike, u nastavnoj cjelini Linearna funkcija. Za potrebe ovog istraživanja analizirani su rezultati pismenog ispita dvije skupine učenika 7. razreda osnovne škole Josipa Jurja Strossmayera iz Zagreba. Prva skupina sastoji se od 90 učenika u šk. god. 2008./2009. i 2009./2010. koji su pohađali nastavu matematike bez upotrebe IKT. Druga je skupina od 110 učenika u šk. god. 2012./1013. i 2013./2014., uz intenzivnu upotrebu IKT. Postotak riješenosti kod učenika prve skupine bio je (48±26) %, a kod druge je skupine bio (58±26) %. Rezultati su pokazali statistički značajno bolje rezultate testa učenika koji su pohađali nastavu matematike s intenzivnom upotrebom IKT-a u nastavi (p=0,005). Primjenom IKT-a u nastavi matematike, na primjeru nastavne cjeline Linearna funkcija, poboljšan je uspjeh učenika na pismenim ispitima, što govori u prilog boljem usvajanju nastavnih sadržaja uz primjenu nastavnih pomagala podržanih IKT-om.

Ključne riječi*: informacijska potpora; matematika; nastava; nastavni proces.*