INTERACTIVE ELEMENTS FOR ALGORITHMS OF ADDITION, SUBTRACTION, MULTIPLICATION AND DIVISION

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Abstract: The paper deals with efficient utilization of modern information and communication technologies in mathematics teaching at primary schools. The author characterizes interactive elements that are primarily designed for teaching algorithms of addition, subtraction, multiplication and division. The elements, that are suitable for 9 to 15 years old students, can be utilized in classrooms in a combination with interactive whiteboards, as well as for voluntary activities of students at school clubs or as a part of their homework.

Key words: algorithm of addition, algorithm of subtraction, algorithm of multiplication, algorithm of division, ICT in education, interactivity, interactive whiteboard

1 Introduction

Modern information and communication technologies are widely used in the modern world. Nowadays, these technologies can be operated not only by adults, but also by students at primary and secondary schools. So it is absolutely natural to utilize the potential benefits of technologies to improve teaching and learning environments. It is generally known that the integration of ICT into education was recommended by Papert in 1980.

ICT infrastructure investments in educational institutions have been one of the key priorities of education policy during the last decade. Most countries have invested (and still are investing) considerable amounts of public resources in ICT equipment such as computers, whiteboards, connectivity, software, etc. (De Witte & Rogge, 2014). For example, in our country, official state institutions pay attention to integrating ICT into education. This process started with the project *INFOVEK. Digipedia 2020*, which is a new policy document on the conception of integration of ICT into education till 2020, defines the needs of Slovak schools in this area. One of the aims is to increase the amount of the digital content available for kindergartens, primary schools, secondary schools and universities.

There are many ways how to use technologies in education. At many universities, e-learning has become quite popular. E-learning has been defined in a range of different ways and definitions of e-learning, online learning, technology enhanced learning and distance learning often overlap (Moore et al., 2011). For example, Khan (2005) defines e-learning as an innovative approach for delivering well-designed, learner-centered, interactive, and facilitated learning environment to anyone, anyplace, anytime by utilizing the attributes and resources of various digital technologies along with other forms of learning materials suited for open, flexible, and distributed learning.

However, in the literature we can find both advantages and disadvantages of e-learning. The list of disadvantages often contains difficult and expensive preparation of multimedia materials or students' feelings of isolation in virtual classrooms. Blended learning, defined as the combination of traditional face-to-face learning and asynchronous or synchronous e-learning, has grown rapidly and is now widely used in education. Concerns about the effectiveness of blended learning have led to an increasing number of studies on this topic. (Liu et al, 2016) Findings of Jeffrey et al (2012) reveal that students showed a strong liking for blended modes of learning and that blended learning may offer a richer learning experience than either online or traditional modes of learning. Current

literature indicates that a blended learning environment, rather than being a compromise between two extremes of traditional and fully online learning, offers the student a wider range of affordances to enhance the learning experience.

As for mathematics teaching, there are several studies that proved the efficiency of blended learning. For example, Cheung and Slavin (2013) found that ICT applications produce modest but positive effects on mathematics achievements in comparison to traditional methods. The study of Híc (2012) proved that blended learning of the subject Arithmetic is a good alternative to classical way of teaching, which enables to increase the level of knowledge of students and their ability to pass the final exam. It is clear that the importance of ICT in teaching mathematics is frequently growing. According to Klenovčan (2004) nowadays we can observe a huge expansion of teaching methods supported by computers and different net systems. These methods should stop the decrease of the education level. However, utilization of blended learning does not automatically assure the improvement of teaching process. We have to agree with Žilková (2014), who states that the quality of electronic education is primarily determined by the accurate e-content.

One of the key advantages of ICT utilization is interactivity, which can differ e-learning materials from traditional textbooks. There are several studies that proved the need for integration of interactive applications into e-learning courses. Žilková (2009) in her summarizing study about mathematics teaching using ICT underlines the need for creation of interactive environment and for utilization of dynamic activities in mathematics teaching. Unfortunately, the majority of applications that can be found on Internet and used in mathematics teaching have only low level of interactivity. These applications usually check the correctness of students' answers, but if the answers are wrong, they do not analyse reasons and do not help students to find the correct solution.

In the following part of the paper we characterize our interactive applications for teaching algorithms of arithmetic operations.

2 Interactive elements for teaching algorithms of arithmetic operations

By Klenovčan (2013), utilization of modern technologies put higher demands on teachers than a traditional way of teaching. It is especially the need to operate rapidly developing technologies. It is not possible to anticipate that teachers will prepare their own interactive electronic materials.

At Slovak schools, the number of computers and interactive whiteboards has permanently growing. However, the teachers feel the lack of proper interactive applications that can be used at mathematics lessons. One of the sources of these applications is Internet. Although there are thousands of applications for teaching mathematics, it is really difficult to find those with high level of interactivity and didactic quality. This motivated us to prepare the set of ten interactive applications for teaching addition, subtraction, multiplication, division and computation of the square root.

Let us focus on teaching the algorithm of addition of two natural numbers. In a traditional way of teaching, a teacher explains the algorithm and demonstrates its rules on several examples. Then students try to practice. However, all students in a class solve the same problem as the student who solves it on the blackboard. There is a considerable amount of students who only passively copy the solution from the blackboard into their notebooks. However, proper combination of traditional approach and our interactive elements can make all students to be active in practising the addition algorithm.

We have created the collection of ten interactive elements, which can be efficiently used in practising of arithmetic operations algorithms. These elements allow students to:

1. add two 3-digit numbers,
2. add two 4-digit numbers,
3. add three 4-digit numbers,
4. subtract two 3-digit numbers,
5. subtract two 4-digit numbers,
6. multiply a 3-digit number by a 1-digit number,
7. multiply a 3-digit number by a 2-digit number,
8. multiply a 3-digit number by a 3-digit number,
9. divide a number by a 1-digit number,
10. calculate a square root of 5-digit or 6-digit number.

The main difference between our interactive applications and applications from Internet is in the level of interactivity. We will demonstrate it on the application for addition of two 3-digit numbers. The application is depicted on Figure 1.

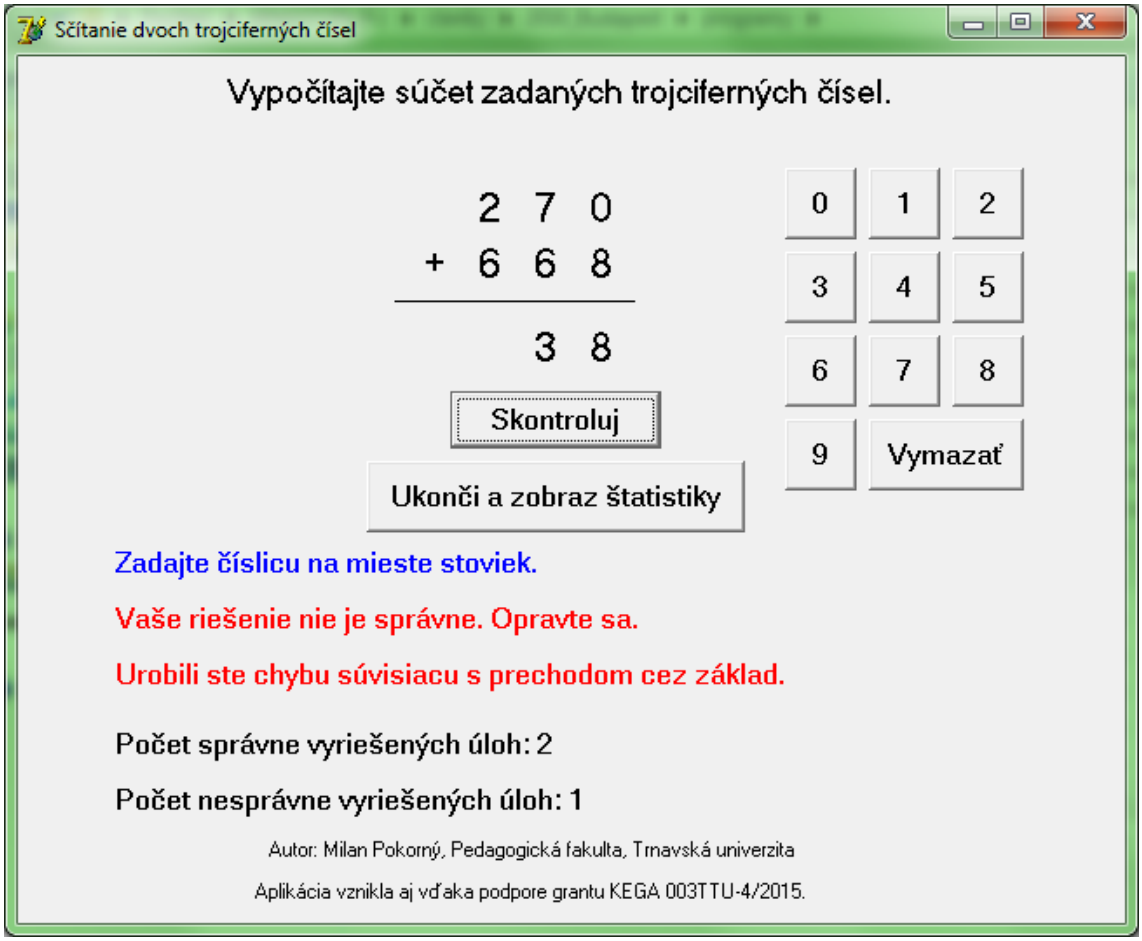

Figure 1: Application for addition of two 3-digit numbers with a feedback

Figure 1 depicts a moment when a student had to add numbers 270 and 668. However, he made a mistake that 270+668=838. The application detected that he had made a mistake connected with passing through the base and immediately inform the student (the red text). Consequently, the student is allowed to correct his/her mistake.

The application also provides a statistics showing the number of mistakes in different types of tasks (without passing the base, with one passing the base, with two passing the base). So the teacher has detailed information about each student. He exactly knows how

many tasks he completed, how many errors he made and which types of tasks make him problems.

We think that utilization of our interactive applications in a proper combination with a traditional way of teaching can be efficient. As the main advantages of our interactive elements we consider:

1. The elements are easily operated, so they are suitable also for primary school students.
2. The elements correspond with the demands determined by a State Educational Programme.
3. The graded difficultness of applications enables an individual and student-oriented approach. For example, some students can add 3-digit numbers, another can add 4-digit numbers and others can add triples of 4-digit numbers. Moreover, each student has his individual pace of solving tasks.
4. There is no language barrier, since the elements are in the Slovak language.
5. The operation of all elements is uniform, so we do not lose much time explaining how to work with elements.
6. The elements are fully operated by mouse. For this reason they can be used in combination with interactive whiteboards, for example when the teacher needs to explain the algorithms for all class.
7. The elements work on any type of interactive whiteboard. They only need the operating system Microsoft Windows.
8. The elements provide an immediate feedback about error. Moreover, they try to recognize the reason of an error and to provide immediate help how to fix it. The elements for addition and subtraction of 3-digit numbers provide a detailed statistics about errors.
9. The elements can be integrated into learning process in many ways. Since they are determined for active work of students without teacher's help, they can be used not only at the lesson, but also in school clubs, during switching teacher in cases of absence, or as homework.
10. It is possible to download elements into computer and to work with them without Internet connection. They run also on older computers with different versions of Microsoft Windows.

3 Conclusion

A proper integration of modern information and communication technologies can make the teaching process more interesting and more efficient. Although there is a huge number of applications for teaching mathematics at primary and secondary schools on Internet, their didactic quality is often low, as well as the level of their interactivity.

In the paper we characterize our interactive elements, which are determined for practising of addition, subtraction, multiplication, and division algorithm. These applications are free and available for all potential users. We are convinced that they can be useful for students and can help them to master these algorithms. Our belief is based on our experience with the utilization of similar interactive applications in teaching at primary schools. For example, Malatinská et al. (2015) focused on the students' achievement, as well as on their attitudes towards mathematics. The analysis of the results revealed a significant improvement of students' achievement in experimental groups, which were taught by blended learning. Moreover, similar results were also obtained in the attitudes towards mathematics. There was a significant improvement of the attitudes of both experimental groups taught by blended learning.

However, it will be useful to realise a research focused on the efficiency of the described interactive elements in teaching mathematics at primary schools and to analyse it results. This is one of our intentions for further study.

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