



THE ROLE OF DIGITAL MATERIALS IN DEVELOPING THE ESTIMATION ABILITY IN ELEMENTARY AND SECONDARY SCHOOL MATHEMATICS

LILLA KOREŇOVÁ

ABSTRACT. *One of the main tasks of school mathematics is to create the connection between school mathematics and the real world by viewing different real situations from a mathematical perspective and creating mathematical models. In real life we rarely need a precise calculation, most of the time an estimation is enough. Linking school mathematics to real life situations is one of the reasons of teaching students to estimate in mathematics. School mathematic activities, leading to estimates are an important part of the mathematic education. Digital environments, in particular the e-tests, can significantly increase the ability of estimation in students. During a research we have found out that the teachers have to achieve their goal with few available materials and their lack of time causes that mathematical tasks for estimation are mostly ignored. In this paper, we will point out the possibilities lying in increasing the student's ability of estimation by digital technologies.*

KEY WORDS: *estimation, e-test, digital material, GeoGebra, HotPotatoes*

CLASSIFICATION: *D40, U50, U70*

Received 26 April 2014; received in revised form 2 May 2014; accepted 12 May 2014

Introduction

One of the main tasks of school mathematics is to create the connection between school mathematics and the real world by viewing different real situations from a mathematical perspective and creating mathematical models. In real life we rarely need a precise calculation, most of the time an estimation is enough. Linking school mathematics to real life situations is one of the reasons for teaching students to estimate in mathematics. The State Education program for "Mathematics and the work with information"(ISCED2 and ISCED3) contains many references about "estimation". In the educational standard of the aforementioned document is stated that students should be able to estimate the length, surface and volume of solids, estimate the size of an angle, characterize something based on an estimation(even in circular diagrams),estimate the result of mathematical operations and estimate the result based on graphical presentation(tables, diagrams)

"With critical thinking, constructivist approach and experience a student should gradually build an estimation of a given mathematical problem" (Žilková, 2009)

During a research we have found out that the teachers have to achieve their goal with few available materials and their lack of time causes that mathematical tasks for estimation are mostly ignored. Nowadays students live in a digital world and digital technologies are getting more common even in schools therefore e-tests should be designed to develop the competencies of estimation in the students.

In a broad sense e-tests are electronic interactive materials, based on questions and finding answers, designed to measure not only knowledge, but to be suitable for teaching purposes too. E-tests can not only be used in classrooms equipped with computers and laptops but they are getting more commonly used on tablets too. One of the best known e-test making software which is available for free is HotPotatoes.

Fulier J. (Fulier, 2005), Partová E. (Partová, 2011) and Žilková K. (Žilková, 2009) deal with the topic of the application of digital technologies in education.

Types of estimation tasks

Tasks in the teaching of mathematics designed to develop the students competence in estimation are divided into several groups.

Concerning the purpose we can divide tasks to obtaining a particular knowledge (estimations of extent, count) and to tasks where using logical thinking the student estimates correctly.

Estimation tasks according to Samková could be divided to:

- Numerosity estimates, which can be divided also to:
 - 1-dimensional (estimation of the number of beads on a string)
 - 2-dimensional (estimation of the number of people in a square, the number of cars in the parking lot)
 - 3-dimensional (the estimated number of candies in a jar, the number of bricks on a pallet)
- computational estimates
- measurement estimates which can be also divided to:
 - 1-dimensional (estimation of length, distance, height, size, time)
 - 2-dimensional (estimation of content, surface, angle size)
 - 3-dimensional (estimation of volume, mass) (Samková, 2013)

In terms of integration tasks into themes we can divide estimation tasks to:

- Numbers and variables
- Relations, functions, tables, charts,
- Geometry and measurements
- Combinatorics, probability, statistics.

According to Eszter Herendiné-Kónya: "The estimation capabilities are not only essential in our daily lives but are also a great help in solving mathematical problems, because knowing the approximate value makes the verification process easier." (Herendiné-Kónya, 2013)

The four dimensions of understanding the concept of area measurement:

1. Skill-algorithm understanding is choosing an appropriate algorithm to calculate the area depending on the plane figure and the given sizes.
2. Property-proof understanding includes derivations of the basic formulas for the areas of triangles and other polygons, relations between area and perimeter of the same figure etc.
3. Use-application understanding includes area measurement in everyday life, applications in complex problems etc.
4. Representation-metaphor understanding includes area measurement with congruent tiles, cutting and rearranging polygons, area representation with an array of dots etc. (Herendiné-Kónya, 2012)

Levine D. (Levine, 1982), Krajčiová J. (Krajčiová, 2005) and Herendiné-Kónya E. (Herendiné-Kónya, 2012) are dedicated to the issue of the estimation skills in school mathematics.

In the following part we will show some e-material examples:

The estimation of a number (quantitative estimation):

In this type of tasks the students have to estimate the number of the objects under the given time. Objects (dots, stars, beads etc.) could be sorted or scattered around. This type of tasks can be found on the Internet (Figure 1), but these are rarely free. The students have to estimate the number of objects under the given time.



Figure 1

Such tasks can be made in the software HotPotatoes (Figure 2). In this task, the students have to estimate the number of cars in the parking lot. The test contains several different questions sorted by their increasing difficulty. The increasing difficulty is achieved not only by increasing the amount of cars but also by their uneven layout in the parking lot. This correct answer is decided by this interval,

$$\left(s - \frac{s-o}{s}; s + \frac{s-o}{s}\right),$$

where s is the correct number and o is the estimation of the student.

Feedback is important for the students, which includes not only the correct number of the cars but also the extent of their accuracy, for example: "The difference between your estimation and the correct answer is less than 10! Excellent!"



Figure 2

E-materials made for estimating numbers can be created using GeoGebra.

Interesting presentations were made by Samková (The application of GeoGebra in estimation tasks, 2013)

Estimation of extent:

There are several tasks on the Internet, where students have to estimate the relative length of a segment (Figure 3) and the angle in degrees (Figure 4)



Figure 3



Figure 4

On the website "Planéta vedomosti", purchased by the Slovak Ministry of Education and which is also accessible to all schools for free, contains several interesting puzzles. One of these is the estimation of metric units of length. (Figure 5)

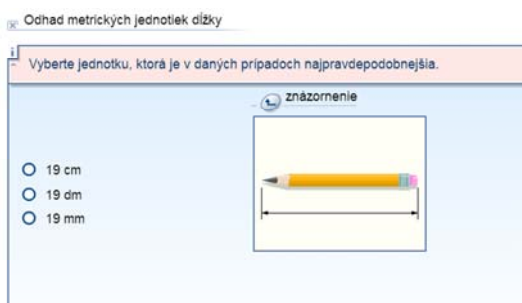


Figure 5

Computational estimates:

The most common tasks for calculations are the estimations of the results of mathematical operations with rounding. It's a very important skill that needs to be practised by the students during every types of mathematical operations. These tasks include, for example estimates for:

- addition, subtraction, multiplication and the division of natural numbers (Figure 6)

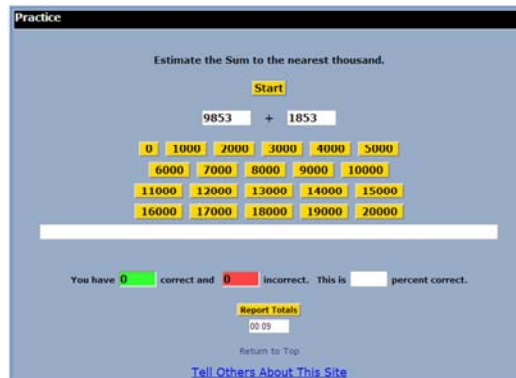


Figure 6

- addition, subtraction, multiplication and the division of decimals
- addition, subtraction, multiplication and the division of integers
- the calculation of square roots.

Interesting tasks are also where the students have to estimate the approximate location of numbers on the number line. The students must round the number and then decide to which number marked on the number line is their number closer. During these tasks they must solve inequalities. Such tasks can be found on the Internet (Figure 7) too, or can be created by HotPotatoes or GeoGebra.

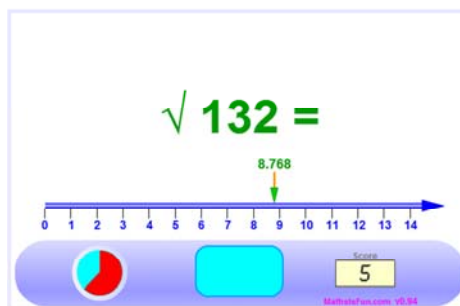


Figure 7

While creating these materials it's important to keep in mind that the feedback should assist the student in finding the right strategy for the estimation.

Teachers opinion poll

In February 2014 we proceeded with an opinion poll. Our goal was to determine the current situation of using estimation tasks in teaching on elementary and secondary schools by theme, type of the school and the used books. We were also interested in the possibility of using digital technologies during the lessons of mathematics. The poll was focused on gathering the teachers opinions whether estimation tasks are important and what kinds of tasks do they give to their students. The poll was realized via an electronic questionnaire. 130 teachers participated (108 women and 22 men), mostly absolvents of continuous teacher education.

We present a few interesting findings:

On the question „According to your opinion, are estimation tasks important in elementary and secondary school mathematics?“ 48% answered with yes and 42% with maybe yes – that means 90% of the participants answered positively. (Figure 8)

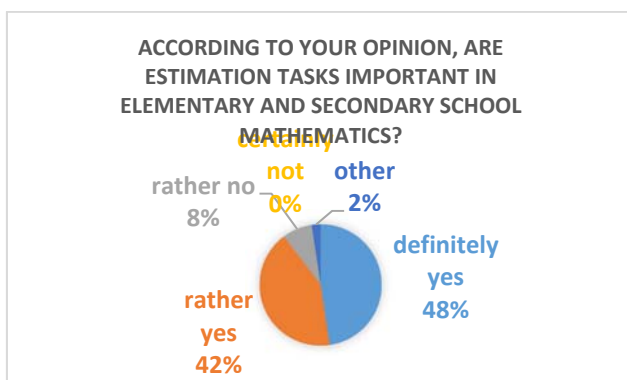


Figure 8

On the question “Is there a sufficient amount of estimation tasks in the textbooks?” 53% answered by no and 22% with definitely no – that means 75% negative.

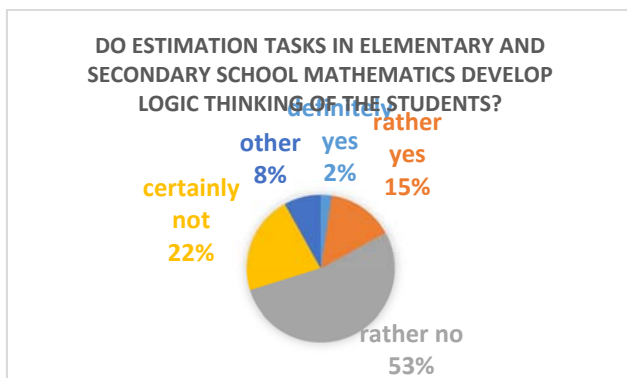


Figure 9

On the question “Do estimation tasks in elementary and secondary school mathematics develop logical thinking of the students?” 56% answered with definitely yes and 35% yes – that means 91% answered positively.

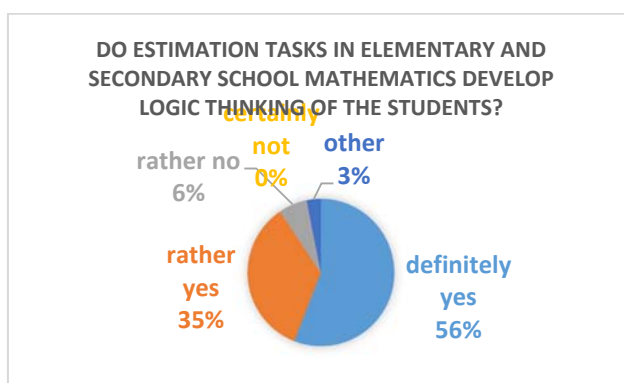


Figure 10

With this poll we have proven our hypothesis, that teachers consider using estimation tasks as important and feel the absence of these types of tasks from the textbooks.

Conclusion

With computing technologies on a rise, people put less emphasis on quick and accurate mechanical calculations, rather more importance is given to the students ability to understand each step of the calculation and algorithm. Therefore, tasks where students must reckon in their head and estimate are getting more popular. Tasks which develop the estimation competence of the students therefore are an important part of school mathematics and e-tests are a great way to increase their estimation skills even further. Students can solve these tasks individually, at their own pace and get immediate feedback. It's important where the students can make an "estimation strategy" for the tasks to get immediate feedback in the form of instructions for an appropriate strategy. Such e-tests can be found on the internet mostly in English. A great software to make e-tests like this is HotPotatoes.

References

- [1] Fulier, J. 2005. *Informačné a komunikačné technológie vo vyučovaní matematiky*. Nitra: Fakulta prírodných vied UKF v Nitre, 2005, ISBN 80-8050-925-5
- [2] Herendiné-kónya, E. 2013. A becslés szerepe In Herendiné Kónya E. (Ed.) *A matematika tanítása az alsó tagozaton*, Nemzedékek Tudása Tankönyvkiadó, Budapest, 2013, ISBN 978-963-19-7353-2
- [3] Herendiné-kónya, E. 2012. The role of tiling, cutting and rearranging in the formation of the concept of area, In.: Maj, B. Swoboda, E, Tatsis, K. (Eds.): *Generalization in mathematics at all educational levels*, Wydawnictwo Uniwersytetu Rzeszowskiego, Rzeszów, 2012, (p. 205-214), ISBN: 978-83-7338-780-5

- [4] Krajčiová, J. 2005. Odhady a nekonečno. In *Zborník príspevkov Pytagoras 2005*. Bratislava: P-MAT, 2005.
- [5] Levine, D. R. 1982. Strategy use and estimation ability of college students. In *Journal for Research in Mathematics Education*, 13 (5), 1982.
- [6] Partová, E. 2011. *Vyučovanie matematiky pomocou moderných technológií*. Bratislava: Univerzita Komenského v Bratislave, 2011, ISBN 978-80-223-3144-9
- [7] Samková, L. 2013. Využití programu GeoGebra při nácviku odhadů. In *Sborník 6. konference Užití počítačů ve výuce matematiky*. České Budějovice: JČU, 2013, ISBN 978-80-7394-448-3
- [8] Šedivý, O. a kol. 2013. *Vybrané kapitoly z didaktiky matematiky*. Nitra: Univerzita Konštantína Filozofa v Nitre, 2013, ISBN 978-80-558-0438-5
- [9] Žilková, K. 2009. *Školská matematika v prostredí IKT*. Bratislava: Univerzita Komenského Bratislava, 2009, ISBN 978-80-223-2555-4

Author's Address

PaedDr. Lilla Koreňová, PhD.
FMFI Univerzita Komenského Bratislava
korenova@fmph.uniba.sk

Acknowledgement

This contribution came into existence within the grant MŠVVaŠ SR, KEGA č. 094UK-4/2013.