

The potential of mobile
learning in elementary and
secondary school
mathematics

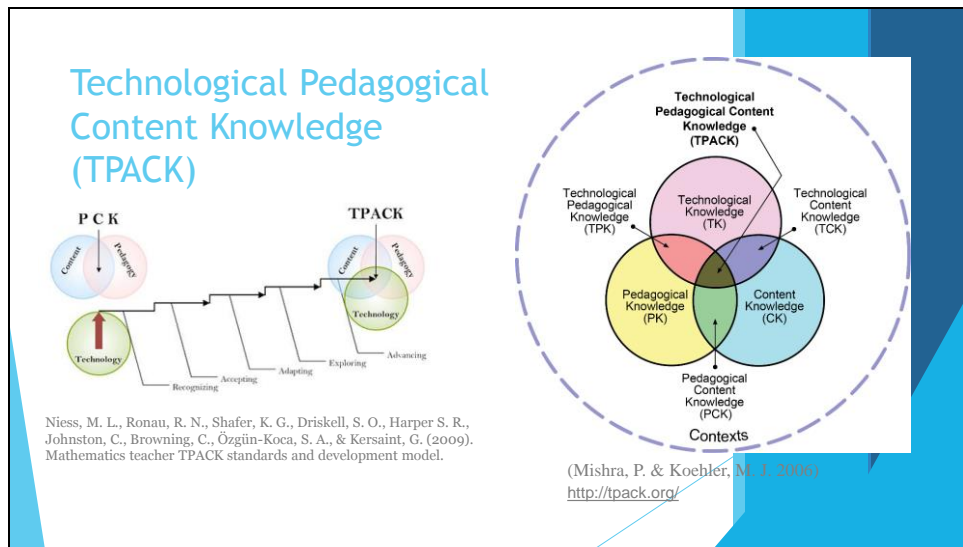
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Nowadays, using mobile technologies for younger generations is becoming an everyday reality. Smartphones and tablets combined with mobile Internet are easily accessible to students and are a part of their everyday life. In the past few years, we witnessed mobile technology entering school environments too. According to the European Commission/ICT cluster, 2010 there exists an increasing discrepancy between the possibilities of using ICT at home and in school, therefore schools should support the development of modern technical environment, thus connecting their experience with these devices at home with school and prepare them for real life situations.

We live our everyday lives in an environment, where we cannot imagine a day without a computer, the Internet, a cell phone and other ICT products. Elementary and secondary school pupils were born into this world and it's natural to them. Fortunately, this natural environment is already reaching into schools. By the term "digital environment in schools", we mean digital technologies that can be used for teaching. In this set of tools belong not only the computers and notebooks, but smartphones and tablets as well, which can be equipped with appropriate software and be used for electronic education (e-learning).

The term "e-learning" can be understood two ways. Mostly by e-learning, we mean electronic form of distance learning. However, in a wider meaning, e-learning stands for any kinds of education done via electronic devices.



<http://tpack.org/>

Proper training for teachers is necessary for an effective integration of interactive whiteboards and tablets into education.

Generally accepted theoretical basis in this area is Technological Pedagogical Content Knowledge (TPACK) as a framework for the integration of technology within teaching.

According Mishra, P. & Koehler: Teachers must understand how technology, pedagogy, and content interrelate, and create a form of knowledge that goes beyond the three separate knowledge bases. Teaching with technology requires a flexible framework that explains how rapidly-changing, protean technologies may be effectively integrated with a range of pedagogical approaches and content areas.

The questions of TPACK and maths teaching were in detail dealt with by Niess et al. On the Figure 2 is very well shown visual description of teacher levels at their thinking and understanding merge toward the interconnected and integrated manner identified by TPACK.



Mobile learning is a type of education which uses mobile technologies, like the smartphone, tablet or PDA with access to the internet. Such education is very attractive to students and so it increases the attractiveness of the subject itself. For the teacher new teaching possibilities open up while using mobile learning or blended learning. Through these methods they are "granted access" to different interactive and multimedia study materials on the internet. Mobile technologies are suitable for constructivist learning and for different modern methods of teaching too. In this presentation we would like to show several methods and forms of teaching mathematics in elementary and secondary schools using mobile technologies. These methodics were created by the soon to be teachers of mathematics on the Comenius University and by the teachers themselves within the new [EMATIK+ project](#). It has been shown that the appropriate software for mobile and blended learning are free softwares like: [GeoGebra](#), [HotPotatoes](#), [Open-Sankore](#) and [LMS MOODLE](#). We will present the views of the teachers of mathematics too on m-learning in the pilot survey and research made in the field of e-testing.

What is Mobile Learning?

► *M-learning* is form of education, where mobile devices are involved (mobile phones, MP3 players, iPods, PDAs, eBook readers, smartphones, notebooks, tablet PC, ...)



► It is very attractive and fun students

► The teacher has new opportunities for teaching methods and forms:

- constructivist learning
- project method for activating learning,
- educational games
- e-tests
- flipped classroom, ...

► teacher can use

- activities that are based on quick and simple interactions of students
- interactive and multimedia learning materials available on the Internet.



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From a didactic point of view, we can use these resources in different teaching methods:

- method of controlled discovering
- project education (this is another rising form of mathematics teaching, which is gaining new possibilities in the digital environment. Students use mostly cooperative learning, which is enabled by m-learning).
- peer instruction method (in this case, the tablet is used as a voting device)
- “The flipped classroom” method

From an educational point of view, teaching with a tablet is appropriate for both individual and collective work.

Why M-learning?

- Projects of the Ministry of Education of the Slovak Republic
www.digiskola.sk , www.skolanadotyk.sk
- tablets became very affordable (thanks to mobile providers) and attractive to students

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DIGIPEDIA DiGiškola

Úvod O projekte Dokumenty projektu DiGiškola FAQ Média a al

Národný projekt
 „Elektronizácia vzdelávacieho systému regiónu“

Digitálne sady do škôl	eGov služby
5680 interaktívnych tabulí 5680 notebookov 2686 farebných tlačiar 20000 tabletov 1000 wifi routerov	Sprístupňovanie školského vzdelávacieho programu Sprístupňovanie nástrojov rozvoja školskej pripravenosti

Partneri projektu: SLOVAKIA EDULIFE DIGITÁLNÝ LÍDER

o projekte

školy

materiály

súťaž

konferencia

In the next part, we will focus on the use of a tablet in elementary and secondary school education for several reasons: tablets became very affordable and attractive to students, thanks to mobile providers. There exist many projects, abroad and in our country, that are trying to introduce m-learning into schools. In Slovakia, there are 2 such projects. You can find more information about them at the following websites: <http://www.skolanadotyk.sk> and <http://www.digiskola.sk>. The first project, “school by touch”, was an initiative of private companies, that equipped 12 schools with interactive whiteboards and tablets for several classrooms. The second project was extensive. From EU funds, the Ministry of Education will buy 5680 interactive whiteboards, 5680 notebooks, 2686 printers, 20.000 tablets and 1000 wireless routers. Right now, this hardware is being installed into schools all over Slovakia and training for school teachers is under way. In the next phase, the Ministry wants to create digital content.

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Tablet as a source of information (e-books)

- study Materials (interactive textbook, text, video, audio, animation ...)
- Portal eAktovka (<http://www.eaktovka.sk/>)
- Websites
- Youtube
- ...

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The screenshot shows a web browser displaying a page from the eAktovka portal. The page is titled 'SVĚTELNÉ JEVY' (Optical Phenomena) and features a section on 'Zatmění Slunce a Měsíce' (Solar and Lunar Eclipses). It includes text, diagrams of the Earth, Moon, and Sun, and a series of images showing the phases of the Moon. The browser's address bar shows 'files.flexlearn.cz/ukazka/'.

At the moment, tablets can have a very wide range of application in Slovakia. Tablets became a popular alternative for eBook readers. This means they can be used for studying from school books in electronic forms. Some mathematics school books are available in electronic form in Slovakia.

The portal eAktovka (<http://www.eaktovka.sk/>) gives access to digital school books for students in elementary and secondary schools. These are available for free for all that register on this website. Among else, students can also access other internet sources in text, image, audio or video form.

„flipped classroom“
Khan Academy

Angle basics
Definition of an angle: How to denote an angle using points on the angle (including the vertex)

Angle Basics
Povedzme, že tieto dve úsečky sa pretínajú v bode

Angle basics and measurement
Measuring angles in degrees
Using a protractor
Measuring angles
Measuring angles
Acute right and obtuse angles
Angle types
Vertical, adjacent and linearly paired angles

Measuring angles
Using the KA virtual protractor to measure angles

Measuring angles
Measure the angle in degrees

je to vlastne vrchol uhla, a potom oločíte uhlomer

https://www.khanacademy.org/math/geometry/parallel-and-perpendicular-lines/Angle_basics/e/measuring_angles

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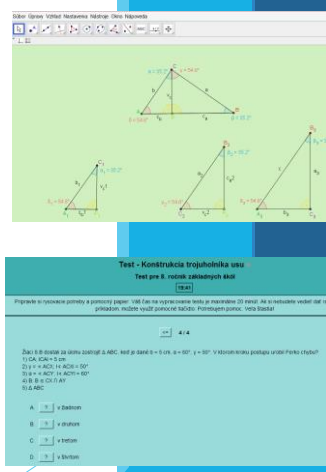
Method flipped classroom, which was established through initiatives, and Salaman Khan and his Khan Academy is closely linked to m-learning.

Students can learn anytime and anywhere with tablets and materials like Khan Academy.

E-tests on Tablets

- In a wider meaning, the e-test is an electronic interactive material based on a set of questions and search for answers, created not only for measuring, but also for reaching educational goals (hence can serve as a tools for innovative teaching methods)
- e-tests in websites of mathematics teachers:
 - Katarína Poláčiková <http://www.supermatematika.wbl.sk/>
 - Marty Megyesiová <http://megym.wbl.sk/>
 - <http://vcv.truni.sk/tests.php>
- Students thesis
 - <http://www.geogebraTube.org/student/b119490>
 - <http://www.geogebraTube.org/student/bVsaOVF4a>
 - <http://elearn.ematik.fmph.uniba.sk/course/view.php?id=223>
 - <http://elearn.ematik.fmph.uniba.sk/~babinska/>

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<http://www.geogebraTube.org/student/b119490>

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During mathematics classes, we can use tablets for e-tests not just to measure the students' knowledge, but also for exercising the study materials with immediate feedback. One of the most known software for e-tests, which is freely available to teachers is HotPotatoes. Website: <http://hotpot.uvic.ca/index.php>. Multiple choice tests, crosswords and other methods are great for reviewing study materials (and fixation), using interactive whiteboards, notebooks, tablets or smartphones. The advantage of this is, that every student can progress with their own pace and gets immediate feedback. In more carefully prepared e-tests, the student can get help, or view some pre-solved examples. In such organized class, the teachers can focus on less advantaged students. From a methodical point of view, teachers use HotPotatoes mainly for creating study materials in modern and attractive forms.

Currently, there are many portals and recently even applications for smartphones, which were designed for digital education of mathematics via m-learning:

website of PaedDr. Katarína Poláčiková <http://www.supermatematika.wbl.sk>


website of RNDr. Martha Megyesi <http://megym.wbl.sk>

tests on the website of the University in Trnava <http://vcv.truni.sk/tests.php>

and also, they are being created as diploma thesis at our University. e.g.: Constructional tasks are at the following webpage: <http://elearn.ematik.fmph.uniba.sk/course/view.php?id=223>

app GooglePlay

- Math Workout
<https://play.google.com/store/apps/details?id=com.akbur.mathsworkout>
- Math Tricks
<https://play.google.com/store/apps/details?id=example.matharithmetic>
- Kids Math
<https://play.google.com/store/apps/details?id=com.mobiloids.kidsmath>
- Math Formulae
<https://play.google.com/store/apps/details?id=com.nuzedd.MathFormulaeLite>
- Complete Maths Formulas Guide
<https://play.google.com/store/apps/details?id=com.commath.completemathsformulasguide>
- Algebra Vzorce
<https://play.google.com/store/apps/details?id=an.AlgebraFormulas>
- Simply Fractions is a great aid for exercising study materials on fractions (Figure 4)
<https://play.google.com/store/apps/details?id=com.SimplyLearning>



<https://play.google.com/store/apps/details?id=com.akbur.mathsworkout>

<https://play.google.com/store/apps/details?id=example.matharithmetic>

<https://play.google.com/store/apps/details?id=com.mobiloids.kidsmath>

<https://play.google.com/store/apps/details?id=com.nuzedd.MathFormulaeLite>

<https://play.google.com/store/apps/details?id=com.commath.completemathsformulasguide>

<https://play.google.com/store/apps/details?id=an.AlgebraFormulas>

<https://play.google.com/store/apps/details?id=com.SimplyLearningAid.SimplyFrac2Lite>

There are many beautiful applications, which serve as a source of information - in mathematics, formularies are very commonly needed. The Google Play store offers e.g.:

Math Formulae <https://play.google.com/store/apps/details?id=com.nuzedd.MathFormulaeLite>


Complete Maths Formulas Guide

<https://play.google.com/store/apps/details?id=com.commath.completemathsformulasguide>

Algebra Vzorce <https://play.google.com/store/apps/details?id=an.AlgebraFormulas>

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►QR



<http://new-to-teaching.blogspot.de/p/math-qr-codes.html>
https://www.youtube.com/watch?v=g_3dvdzZ2_o

- Scan your QR code using the Qrafter app
- Open URL in Safari
- Touch white space on page. In upper right corner, choose Open in...
- Choose neu.Annotate+ (red icon) from the drop down menu
- Set up and solve the problem on page 1
- Write a story on page 2
- Save JPG to Photos using arrow (right corner of screen)
- Be ready to compare and share!

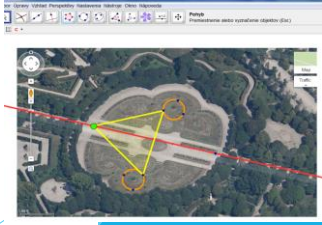
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Interestingly the use of QR codes in mathematics.

Project teaching +tablets

- Project teaching is another motivating form of teaching mathematics, which gains whole new possibilities in a digital environment
- The students can use the Internet, images, video, mathematical applications, collaboration via chat, Facebook, etc.
- Based on constructivist and connectional concepts of teaching, m-learning uses a few types of teaching:
 - cooperative teaching
 - active teaching
 - authentic teaching
 - situational teaching
 - teaching oriented towards solving problems
- Demonstration: students can model in GeoGebra and solve the "gardener problem" based on images

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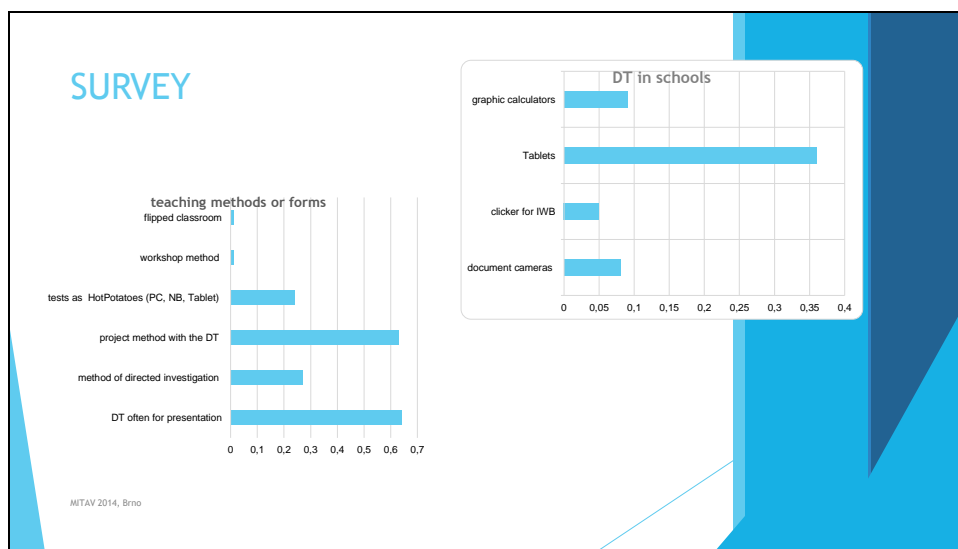
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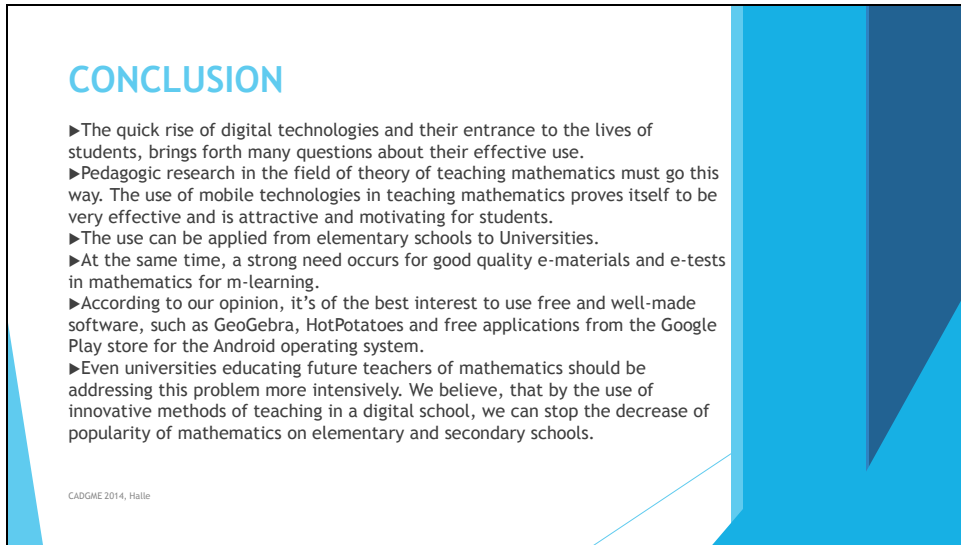


In May and August this year, a survey, using an electronic questionnaire, was carried out. The aim of the survey was to identify the state of affairs in schools – how they are equipped with the digital technologies (laying stress on blended learning, and m-learning) and their use in maths teaching. At the same time, we wanted to find out the influence of schoolings and courses on methods and forms of maths teaching in a digital environment.

We addressed the teachers on facebook pages aimed for teachers and at the same time, we sent a questionnaire to more than 400 teachers on their e-mail addresses. 94 maths teachers from the whole Slovakia completed the questionnaire.

The teachers had at their disposal document cameras at 8 % of schools and only 5 % of schools were equipped with a clicker for IWB. Tablets were used at 36 % of schools; as for graphic calculators, 9 % of teachers indicated that they had them at their schools.

In the end of the questionnaire, we asked what teaching methods or forms use teachers in maths lessons (when they take use of DT). So many as 64 % of the teachers used the DT often for presentation, it means for a classical lecture, 27 % of the teachers indicated that they had used the DT in a method of directed investigation (what is a constructivist approach), 45 % of the teachers had used this method from time to time. 63 % of the teachers used the project method with the DT often or from time to time. 24 % of the teachers used electronic tests as HotPotatoes on various hardware (PC, NB, Tablet) for practising the subject matter very often, 33 % from time to time, 18 % seldom, and 23 % never. The teachers almost did not use either the workshop method or flipped classroom.



CONCLUSION

- ▶The quick rise of digital technologies and their entrance to the lives of students, brings forth many questions about their effective use.
- ▶Pedagogic research in the field of theory of teaching mathematics must go this way. The use of mobile technologies in teaching mathematics proves itself to be very effective and is attractive and motivating for students.
- ▶The use can be applied from elementary schools to Universities.
- ▶At the same time, a strong need occurs for good quality e-materials and e-tests in mathematics for m-learning.
- ▶According to our opinion, it's of the best interest to use free and well-made software, such as GeoGebra, HotPotatoes and free applications from the Google Play store for the Android operating system.
- ▶Even universities educating future teachers of mathematics should be addressing this problem more intensively. We believe, that by the use of innovative methods of teaching in a digital school, we can stop the decrease of popularity of mathematics on elementary and secondary schools.

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The quick rise of digital technologies and their entrance to the lives of students, brings forth many questions about their effective use. Experience shows, that pedagogic research in the field of theory of teaching mathematics must go this way. The use of mobile technologies in teaching mathematics proves itself to be very effective and is attractive and motivating for students. The use can be applied from elementary schools to Universities. At the same time, a strong need occurs for good quality e-materials and e-tests in mathematics for m-learning. According to our opinion, it's of the best interest to use free and well-made software, such as GeoGebra, HotPotatoes and free applications from the Google Play store for the Android operating system. Even universities educating future teachers of mathematics should be addressing this problem more intensively. We believe, that by the use of innovative methods of teaching in a digital school, we can stop the decrease of popularity of mathematics on elementary and secondary schools.

