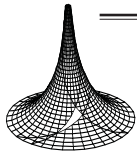

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tmcs@science.unideb.hu
http://tmcs.math.unideb.hu

Teaching
Mathematics and
Computer Science

Report of Meeting
Researches in Didactics of Mathematics and Computer Sciences
January 24 – 26, 2020 Sárospatak, Hungary

The meeting Researches in Didactics of Mathematics and Computer Sciences was held in Sárospatak, Hungary, on the Comenius Campus of the Eszterházy Károly University, from the 24th to the 26th of February, 2020. It was organized by the Doctoral School of Mathematical and Computational Sciences of University of Debrecen and the Eszterházy Károly University.

The 76 participants – including 15 PhD students – came from 9 countries, 23 cities and represented 33 institutions of higher and secondary education. There were 4 plenary, 48 session talks and 4 poster presentations in the program.

After the warm welcome of Judit Kelemen, General Director of Education and Research, Eszterházy Károly University, Comenius Campus, the conference was opened by professor Gyula Maksa, Leader of the Didactical Program of Doctoral School of Mathematics and Computer Sciences, University of Debrecen. He welcomed the participants and emphasized the increasing number of participants and the importance of the fact that the conference was held this year at a new location, in Sárospatak, in Hungary.

The subjects presented in the lectures and posters of the conference were of great variety. Beyond the use of alternative methods in teaching mathematics, as well as surveys on students thinking there were several lectures on digital technology using in mathematics and computer science education.

The conference venue, Sárospatak is a small city in the northern part of Hungary. A very memorable event was the visit to the Big Library of the Reformed

College which is a famous and beautiful historical-cultural monument from the 16th Century.

In his closing speech, professor Zsolt Páles, Leader of the Doctoral School of Mathematics and Computer Sciences, University of Debrecen appreciated the high quality of the lectures, with special regard to the works of the invited lecturers and PhD students. He also gave his thanks to all the lecturers, the chairs of sessions, and also to the members of the Organizing Committee: Eszter Kónya, Ilona Téglási and Gyöngyi Szanyi, whose work essentially contributed to the success of the conference.

Subsequently, we provide the abstracts of the lectures in alphabetical order of the authors' names.

List of abstracts of lectures

András Ambrus: *Discovery, inquiry based mathematics learning, instruction or Direct, guided mathematics learning, instruction?*

We will discuss these two questions based on the newest results in the mathematic-didactical scientific literature: the memory system by Baddeley, Cognitive Load Theory by Sweller, the Hattie-Donoghue learning model. There are two scientific arguments for direct, guided learning: comparative studies and the results of the brain research. They states: at learning, acquiring new information direct, guided learning is more effective. Some problems with discovery learning in classroom environments: only the brightest students discover the material; a lot of students find nothing, they only copy what others have found; some students find false knowledge and they will remember better for the false things, then for the corrected knowledge; the direct version is more effective considering the necessary teaching time. At teaching mathematical problem-solving applying worked examples is an effective method, the main aim is to bring a lot of problem-situations with their best solving steps into the long term memory of students, what needs a lot of practice, divided into more months. What is the answer on the questions posed in the title? Both! At teaching and learning new material the direct, guided approach is more effective, but if the students have enough available previous knowledge to solve the problems, the independent work is desirable.

Gabriella Ambrus: *Word Problems based on real situations–analysis of students' solutions*

The simple word problems, where the situation is real or close to it,–which are in the focus of our current research–are similar in their wording to the traditional "closed" word tasks in the textbooks. Partly due to this fact, students usually want to work with them without considering the real situation in the text–according to results of the surveys in the relevant literature and to our results with the "Pocket money" problem (and its variations).

Within a development program, students from two secondary schools in Budapest worked on such word problems, on five sessions. The sessions were led by their mathematics teachers, who took part in a training beforehand. For the evaluation of the student's works, we worked out a method, which may help to take a closer look at the student's way of thinking about the solutions of the tasks. The solutions of the students are analysed with this method.

Szilvia Árvai-Homolya, Attila Körei, Szilvia Lengyelné Szilágyi: *Supplementary cards for the cooperative learning supporting game Brainbox–Functions*

Nowadays gamification plays definitely an important role in all level of education even in higher education. Recently education researchers pay more and more attention to the innovative methods based on gamification, since new tools are needed to meet the requirements of competence-based education. Brainbox as one of the most popular family board games is perfectly suitable for developing generic competences. Using the idea of the basic game we elaborate the mathematical game called Brainbox - Functions, which supports the correct engravement of the basic characteristics of the most important function classes. In order to apply the game in higher education practice it was necessary to add to extra cards. For this purpose, the game was extended of 45 additional cards which help students to learn about higher mathematics functions in the framework of a co-operative game.

Gabriella Babcsányi-Tóth: *Teaching basic operations in the lower grades of elementary school*

In the presentation I introduce a way of teaching basic operations, I used is two institutions that belong to reform pedagogy, namely: at Világfa Waldorf School, Kőröshegy and at Szekszárdi Waldorf School, Szekszárd. During teaching I took into consideration the age-appropriate features of the students in the application of concrete physical presentations and image-based representations. When moving to the symbolic representation, I built on the operational properties (commutative, associative and distributive law) of a set of natural numbers as an

algebraic structure. During the lecture I will present the results of the students' works.

Tamás Balla, Sándor Király: *Quality improvement of learning efficiency at kodolosuli.hu website*

The authors' research was supported by the grant EFOP-3.6.1-16-2016-00001 ("Complex improvement of research capacities and services at Eszterházy Károly University"). The lack of software developers is a continuous problem in the IT industry. However, the number of students in higher education is low, and the problem is compounded by the high dropout rate. One of the strategies to increase student enrollment is to ensure that more people are involved in the world of programming in public education, and for this purpose, we developed the kodosulosuli.hu portal in 2016, which provides interactive tutorials in C++, C and Java. In this presentation, we focus on the experiences of the last 4 years. Based on the experience gathered, we will identify possible future improvements. Our primary goal is to improve the quality of learning through intelligent algorithms built into the LMS (such as neural networks).

Tünde Klára Baranyai: *Current Issues in Teaching Mathematics in primary school*

In my lecture I present the university textbook: "Methodological issues of Teaching Mathematics in primary school". In elementary classes, we teach the four basic operations: addition, subtraction, multiplication and division. Starting with definition of operation with sets, then discover the properties of operations, introduce the names associated with operations, and get to know the relationships between operations, and finally we present the related tasks and didactic games.

Csilla Bereczky-Zámbó, Janka Szeibert: *Testing the test: re-thinking the levels of understanding geometry based on hungarian test results*

Vygotsky's theory about the proximal zone of development, the theory of the Van Hiele's based on it and the Usiskin test based on the Van Hiele theory are all well-known and recognised in the literature. The Van Hiele-theory distinguishes five consecutive levels of development in geometry. Students are assigned to one of these disjunct levels based on their knowledge, understanding and approach of geometry. In our research we carried out an experiment to examine the validity of the Vygotsky-Van Hiele theory and the test of Usiskin concerning university mathematics. Subjects of the experiment were first graders of BSc in mathematics at ELTE and first grader pre-service mathematics teachers of ELTE. Our research

questions were the following: Are the theories of Vygotsky and Van Hiele valid on university level? Does the Usiskin test measure properly on university level?

József Borján: *Faktor analysis of a complete experiment*

The classic test of factor effects is the variance analysis. Here a new method for analysing the effect and interaction of factors, different from variance analysis, will be presented that is simpler and has a wider range of applications. Its essential is to express the effect and interaction of factors in terms of the deviations of empirical distribution funktions and quantile functions.

Zoltá Csernai: *The place of Computational thinking and development opportunities in the Complex Basic Program*

One of the current priorities is the improvement of STEM competences, that is, the acquisition of knowledge and skills related to (S)cience, (T)echnology, (E)ngineering, and (M)athematics via interdisciplinary and transversal instruction schemes.

According to experts the demand related to STEM competences and skills is expected to increase. Analysts forecast a 3% overall growth in employment in the EU until 2020, and this figure could reach up to 9% in STEM-impacted professions (Szegedi, 2014). Simultaneously computational thinking (Wing, 2008) is gaining increasing popularity as an umbrella term for the aforementioned four areas.

Subscribing to a deductive approach utilizing a specifically elaborated criteria system, I explore various interpretations of the given concept in the international community. Furthermore, I will analyse how computational thinking helps the methodological culture change of the educators with modern digital solutions in Complex Basic Program.

Mária Csernoch: *Didactics of Mathematics and Informatics–What is inherited and what can be given?*

It is widely accepted that both informatics and its didactics are originated in mathematics and its didactics. However, it has become clear recently that the didactics of informatics were not able to adopt the effective and efficient methods and approaches of mathematics. Furthermore, it is also overlooked that the two sciences, subjects share common features, but they are not identical. One of the misconceptions circulating is that the teachers of informatics are the polyhistor of the 21. century: mathematician, software engineer, physicist, engineer, linguist, musician, master of arts, etc. Officially, teachers, especially teachers of informatics are those who are able to help students developing their computational thinking

skills as the four fundamental skill along with the 3Rs, which can be achieved through the various tools of informatics solving real world problems. However, tools took their toll and focusing primarily on the tools has led us to the paradox of the of the digital era: the tools are needed to solve the problems, but they kill the problemsolving by focusing on the interfaces. In the present paper, we focus on the backtracking aspect of the didactics of the two subjects; what informatics can offer for the didactics of mathematics, which are those problems that were not part of school mathematics but can be included in the digital era and which are those that we do not need anymore. Further narrowing the subject, we focus on the concept of function. The question is how spreadsheeting and teaching spreadsheeting as a functional programming language would affect the students' knowledge in understanding and handling functions, how both sciences would take advantages of teaching this concept on shared background.

Edith Debrenti, Balázs Vértessy: *Developing Problem Solving Strategies in Mathematics Class*

Mathematics is a comlex subject which includes many types of assignments. A 'recipe' would be helpful for the majority of pupils to solve each type of exercise. During the teaching process we found that in the course of problem solving it is difficult to interpret the word problems, to choose the appropriate method (strategy, way) to solve the problem, to apply them, then to give feedback to the original task, to check etc.

In order for students to develop problem-solving abilities, regardless of age, different problem-solving strategies must be explicitly taught. In our lecture we would like to discuss a developmental experiment in which logical problems by tabulation, as well as problems requiring reverse reasoning and reasoning were solved by fifth grade pupils (experimental group) for several weeks. The control group was observed several times, and data were collected from the pre- and post-test from them. During the pre- and post- test processing average calculation, deviation, corrected deviation, variance were calculated and statistical tests were used: F-test statistics and t-test.

In our lecture we present the teaching experiences and draw the conclusions.

Linda Devi Fitriana: *Problem Solving: How Do Students with Different Personality Solve Mathematical Problem?*

Problem solving plays a prominent role in doing and learning mathematics. This research aims to investigate students with different personality type in solving mathematical problem. The subjects are four secondary school students

on the second grade. All of them have high mathematics ability and represent each type of Keirsey personality type, namely rational, idealist, guardian, and artisan. Qualitative data were collected through problem solving test, interview, and were analyzed based on problem solving steps by Polya. The problem given has more than one way to gain the solution on the topic of 2-dimensional figure. The result underlines that all students understand the problem, can find the strategy, implement the strategy, and re-examine their work. Nevertheless, striking characteristics emerge among students following their tendencies in receiving information, making decisions, and their typical patterns when carrying out the assignment. Rational student propose logical argument and associate the given information with his prior knowledge, while idealist student tend to provide subjective reason in choosing the strategy. Artisan and guardian students with their tendency, more focus on the picture rather than having insistence to directly find the connection among proposed information. This condition can be a beneficial input for teachers in designing instruction and training students to be good problem solvers by considering their character.

ANDRÁS FERENC DUKÁN: *Teaching experiment: Development of the logical thinking in themathematics classes*

Studying the psychology of learning, brain research and the international didactics literature we conclude that we can improve logical thinking via playing with board games. The board games need complex logical operations with little factual knowledge.

Our research is based on a control-team school experiment. We investigated two groups that have basically the same ability. The improvement of the groups was measured with input and output tests and initial knowledge level measurement.

The 9th-grade experimental group played (not mathematical) board game through a semester in every third maths class. We have investigated their mathematical improvement compared with the control group who have around one and a half times more time for learning maths in a classic way.

GYÖRGY EMESE: *Students' Solutions of Open, Realistic Problems*

An experiment was carried out to examine students' problem solving using open, realistic problems. Two Grade 9 and one Grade 11 groups were the experimental groups, about 15 students in a group, and for each experimental group we had a similar control group. The experiment was part of the work of the Hungarian Academy of Sciences' Subject Pedagogy Research Program. This study

was part of a longer project of a group of researchers led by Gabriella Ambrus to examine students' thinking.

In the talk I will describe this experiment, briefly talk about our research group's work before this experiment (that led to this experiment), report on the numerical results of the experiment and my and other participating teachers' reaction, experiences, our impressions and plans for the future and show some videos of the lessons.

Katalin Földesi: *Two themes in the correspondence between Tamás Varga and the Reményi couple*

Tamás Varga renewed not just Hungarian, but general math teaching as well. This fall we celebrated his 100th birthday. He too was surrounded by friends, colleagues and people with views opposed to his. Among his friends and colleagues were high school math teacher Gusztáv Reményi, and his wife, Gusztávné Reményi, born Katalin Tóth, who acquired her math teacher credentials during those years while already working. The couple lived in Nyíregyháza for a decade from the end of the 40s, while Tamás Varga lived in Budapest. Their correspondence is mostly from this time period. The effect of one of Piaget's works is visible, and so is the effect of the at the time easily obtainable Soviet mathematical didactics. Furthermore, one can discern the effect of the Péter-Gallai I. book, and a defining moment of the book's history. This book has recently been the subject of renewed interest. I also find it possible to outline an inner path, discernable from the correspondence, that turned Tamás Varga's interest towards mathematical logic. My presentation is about the effect of one of Piaget's works, and the immediate effect of the Péter-Gallai I. book.

Miklós Hoffmann: *Mathematics as a human vocation–do we need math teachers in the next century?*

In this talk we intend to point out those substantial attributes of scientific discovery and teaching, which make the personal involvement of human scientists and teachers inevitable, and consequently make the substitution of mathematician and math teachers by computer algorithms and articifial intelligence in the scientific and teaching process hopeless and impossible. Our arguments will deeply lean on the standpoint of Max Weber, who has seen the essence of scientific activities in specialisation and enthusiasm. These key notions will be analysed in our study from the viewpoint of automatised scientific discovery. The aim of our paper is to convince the reader that artificial intelligence, although can evidently and effectively support everyday scientific activities as useful tool, is not able to

make genuin invention, not suitable for creative scientific discovery and teaching of mathematics in itself, due to the disability for specialisation and the lack of enthusiasm.

Enikő Jakab: *Difference between evaluation and evaluation*

My research topic is the development of mathematical competencies with ICTs. In the next stage of my empirical research I compare the effectiveness of mathematics learning, teaching process in an environment where ICTs are used and in a classical environment. During the experiment I compare the results of modul tests written in two sixth grade grammar school classes. As evaluation also means the comparison of measurement results, I had to carefully rethink the scoring guide.

I am comparing the evaluation methods of written papers and worksheets. I examine the differences between the old and the new one.

Ján Gunčaga: *Possibilities of developing a geometric thinking in public education*

In this lecture we present some plane and spatial geometry examples using GeoGebra DGS, which have a significant positive impact to students' mathematical and digital competences. We will also analyze the results of some national and international mathematical measurements (PISA, OKM, etc.).

GeoGebra software supports a better understanding of problems via visualization and has an positive influence to affective, cognitive and psychomotor factors by pupils and students. Educational experiences are also presented. Supported by grant VEGA 1/0079/19.

Ioannis Papadopoulos: *Navigating in the diverse landscape of problem posing*

Problem posing has been recognized as an important intellectual activity in school mathematics and integral part of a balanced mathematics curriculum. However, "the field of problem posing is still very diverse and lacks definition and structure" (Singer, Ellerton, & Cai, 2013, p. 4). Taking this as a starting point, this plenary will try to organize this diversity by distinguishing and commenting on three different aspects of problem posing as they were examined and presented in the ProMath19 conference by Papadopoulos et al. (2019).

The first aspect concerns the difficulty of a researcher who enters the agenda of problem posing to navigate through the spectrum of the different definitions found in the research literature. A possibly good way to deal with this difficulty is to organize all these definitions in groups. Five such groups of definitions are suggested: (i) Problem posing as generating new problems, (ii) Problem posing

as reformulating already existing problems, (iii) Problem posing as both creating and/or reformulating problems, (iv) Problem posing as raising questions and viewing old questions from a new angle, and (v) Problem posing as an act of modelling.

The second aspect concerns the navigation through the different ways problem posing has been conceived by the research community: in isolation as an autonomous mathematical construct, or in connection with other mathematical constructs like problem solving or Creative Mathematical Thinking.

The third aspect concerns the navigation through the different ways of implementing problem posing in research and teaching settings. The existing information in the literature is organized in three groups: (i) Problem posing as a tool for teacher training leading to the enhancement of their subject didactic competence, (ii) problem posing as a pedagogical/ educational tool, and (iii) problem posing as a diagnostic/ assessment tool.

Some arguments will be provided on questions that arise because of this rich diversity.

Zsuzsanna Jánvári: *Developing levels of statistical literacy*

The concept of statistical literacy has received increasing attention internationally for 20 years. From the early 2000's to the present days, many prominent researchers in the profession have published in this field. To view the statistical process as a whole, to explore data in ways beyond those given in textbooks; to pose new questions (Chance, 2002). For statistics teaching, two outcomes were defined as distinct outputs: adequate acquisition of competencies (basic knowledge, basic reasoning) and "citizenship" (becoming a critical beholder of the surrounding world) (Rumsey, 2002). The development of statistical literacy is particularly important in higher education and PhD studies (Parke, 2008). The classic elements of statistical literacy represent the higher dimensions of statistical thinking. J. M. Watson (2017) defined a six-level hierarchy of statistical literacy. During my doctoral studies I would like to define the levels taking into account the characteristics of today's Hungarian public education, examining the statistical literacy of students leaving secondary school. In this presentation, I would like to introduce the initial steps of this process, through the basic conception of developing the framework.

Tamás Kádek, Piroska Biró: *The Use of ProgCont API to Evaluate Program Codes*

ProgCont is an automated system for evaluating programming tasks. It has helped us in teaching programming subjects and running competitions organized by the Faculty of Informatics at the University of Debrecen for nearly a decade. The software has undergone many changes during this period in order to meet growing needs. An important milestone in these developments is the ProgCont API, which provides a unified framework for services that require automated evaluation. The goal was to create a tool that enables the development of applications similar to the Moodle CodeRunner plugin or the Biró and Mester systems of Eötvös Loránd University, hoping to become a real competitor to those software products.

This lecture shows the architecture and operating principles of ProgCont API, and presents its applications via our experience gained in running our local and international competitions.

Sándor Kántor: *Problems in teaching mathematics*

We will examine some issues of teaching secondary school mathematics through examples that are relevant with regards to the correct use of and understanding of definitions. The examples are from three main fields: interpretation of terminology, use of undefined notions, exercises taken from real life.

Sándorné Kántor: *Cooperative learning – a link in the learning and teaching of mathematics*

We don't know and don't see the future. We are uncertain about what to teach and how to teach in the 21st century. What kind of knowledge will be necessary for the man of the next century? How do we prepare the new generation? What's important: using the Internet, smart phone, or anything else, using ICT tools or networking? Based on our secondary school and university teaching experiments I present the method of cooperative learning as a method that I think is well suited to today's math education and prepares students for the challenges of the future.

Fruzsina Kiss: *What is the radius of the sphere that the surface of the temperate zones on the Earth could cover?–final exams in Mathematics before World War II*

In our research connected to the history of mathematics education, we are studying the final exams in Mathematics written in the predecessor of Fazekas Mihály Grammar School in Debrecen from 1893 until 1931. Some special features

of the final exams are the stylistics of the problems, as well as several problems demanding knowledge in geography and physics. Problems including arithmetic and geometric progressions, solid geometry or diophantine equations belonged to the most frequent types. After choosing three of them, we had a group of last-year students from a special mathematics class solve the problems. We also consulted the laws and regulation of the final exams at that time.

MÁRTON KISS: *A metacognitive developing experiment in the Mathematics lesson*

The starting point of the developing experiment was one of our earlier research. The experience shows that the target 9th grade students are not accustomed to handle the given problem after indicating their answer and the method of solution. After our past experience, we planned a developing experiment, which aimed at accustoming students to handle mathematical problems in a wider perspective and more consciously, as well as making them realize that not every mathematics problem has one and only one right answer. We analysed students' work based on the content of their exercise books, four tests and the observation during the lessons. We picked three students whose development was analysed more detailed in comparison with the results of the group.

IMRE KOCSIS: *Changes in the environment of the STEM education related to the 'VET 4.0' concept*

In the talk we are dealing with the implications of the 4th industrial revolution for the education and, in particular, for the vocational education and training (VET). In the era of 'Smart factories' and 'Digital production systems' the desired knowledge and competences, and consequently, the vocational education and training processes (curriculum design, organization and provision of training, assessment of competences) are changing. These changes require new pedagogical practices and new competences of the VET teachers and trainers.

RITA KISS-GYÖRGY: *Artworks as illustrations in high school Mathematics textbooks*

We have analysed three different Math textbooks, which have been used in high school education for the past 30 years, to show how the visual arts connect mathematical ideas in Math textbooks. We point out the six dimensions, which have been shown in a Spanish research, to categorise the illustrations of the three different coursebooks. We concluded that there were only few illustrations in the coursebooks and mainly used for ornamental purposes to decorate texts. We could find only a few pictures with math concepts making students' participation

more active by encouraging analytical and critical thinking. Finally, we offer some examples of using artworks in a more effective way.

Kitti Páleníková, Janka Medová: *Prospective Pre-Primary Teachers' Problem Solving in Mathematical Logic*

The propaedeutic of logic is included into pre-primary curricula. Certain level of mathematical knowledge is needed to more open teaching approach. The Zebra riddle was solved by 115 prospective pre-primary teachers in year 2. They were involved in hands-on activity where manipulatives were used to solve the Einstein puzzle. Based on the results of statistical implicative analysis we conclude that the result in test in formal logic was related to the level of provided reasoning. The students achieving high in the logic test were able to provide satisfactory reasoning of their solution and preferred to organize the findings into the form of table. The solutions revealed the wrong understanding of implication. One group of students stated that implication could not be true when the premise is not true. Other misconception that occurred quite often was that the statement $0 \Rightarrow 0$ is false and based their reasoning on this fact.

Zoltán Kovács, Eszter Kónya: *Problem posing in math class?*

Problem posing is part of mathematician's activity. Is this part of the mathematics literacy developed in mathematics teaching? Reviewing textbooks and methodological materials, it is hardly disputed that currently it is not part of everyday mathematics teaching in Hungary. First, we argue with a brief meta-analysis that problem-posing is part of critical thinking as a fundamental element of XXI. century skill. We then examine whether it is realistic to use problem-posing as a learning activity in mathematics teaching. Based on classroom observations, we concluded that 5-8 grade students are able to form relevant mathematical problems without specific preparation.

Lilla Korenova: *Use of Augmented Reality to Develop the Ability to Estimate in STEAM Education*

Recent years' research has highlighted the benefits of using AR (Augmented Reality) applications in teaching and learning of different school subjects. In our contribution we want to point out to the possibilities of using AR in teaching and learning mathematics. We conducted research on the use of AR applications for smartphones which are used to measure length, circumference and area. We proceeded from the principles of constructionist teaching / learning and STEAM education principles. One of the main tasks of school mathematics is to create a

connection between school mathematics and the real world. Connecting mathematics to real life is one of the reasons students learn to estimate in mathematics. We focused on the possibilities of using available AR applications in order to develop the learners' ability to estimate measurable quantities. The research was conducted with the participation of pre-service teachers (students of teaching) at The Comenius University in Bratislava (Slovakia) and the University in Ostrava (Czech Republic).

Eszter Kovács-Kószó, József Kosztolányi: *Structured pair-work in mathematics lessons*

Experiments all over the world prove self-verbalizing and cooperative learning highly effective in the learning process. However, the implementation of these methods is hard and takes a lot of time during the lesson as well as during the preparation process.

As a possible solution we study the sage and scribe technique from Kagan in which one student (the sage) solves the problem and tells it to his or her partner. The scribe?s duty to write down the solution and help the sage when it is needed. In this way the children are accountable individually.

I would like to present our experiments and results about this topic, and a wider theory behind it. Our aim is to help Hungarian teachers in their day by day teaching.

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Tünde Lengyelné Molnár, Péter Antal: *Digital technology and design in the public education sphere*

The Horizon Report Europe: 2014 Schools Edition (2014) determines the schedule and pace of the development of the European Union public education sphere until 2020. The Report predicts that in addition to formal teaching non-formal and informal instruction methods coupled with the inclusion of real life experiences will become part of teaching activities eventually leading to the phenomenon of "authentic learning". What is the current status of Hungary in this process? Our lecture explores how the school-based application of the Complex Basic Program contributes to the realization of the objectives of the European Union. Furthermore, we examine the possibilities provided by the methodological revolution for promoting authentic learning at the primary location of non-formal learning, the library.

Zoltán Matos: *History of mathematics in secondary school–experiences of an experiment*

In the 2019/2020 school year, one half of the human orientation class of Elementary and Grammar School of University of Szeged tried out a compilation of math history pieces designed for the nineth grade algebra and number theory curriculum. After getting to know and talking about the handout, the class teacher was given full freedom to use it. Perhaps that is why he received it with great enthusiasm and tried to incorporate as much of it into his class as possible.

Katalin Munkácsy: *History of teaching analysis in high school. Examination of sources*

In the course of the lecture, I would like to present online and offline resources that I could use to gather information. 1. The beginnings Felix Klein, Beke Manó, `https://www.icmihistory.unito.it/`. Mathematics at the Hungarian Lutheran Grammar School around the turn of the last century 2. Between the two world wars Hungarian high school curricula, The writings of Beke Manó 3. Tendencies in IEA's Trends in International Mathematics and Science Study (TIMSS), B population OPI examinations on Hungarian IEA results in the 1970s, Content features of recent international TIMSS studies.

Anna Muzsnay, Tímea Török: *The long-term effect of test-enhanced learning in abstract algebra*

Test-enhanced learning has been proven effective concerning learning texts or words, but these experiments were primarily conducted in laboratory environments. This presentation is about an experiment that demonstrates the efficacy of test-enhanced learning in abstract mathematics, concerning the long-term knowledge of students. The participants were six groups of undergraduate pre-service mathematic teachers studying the Algebra and Number Theory 1,2,3 courses at ELTE TTK. Three groups learned the material using the testing effect, and the other three learned using traditional methods. The experimental and control groups learned the exact same information in the lecture and they wrote the same final test and post-tests two months and five months after the final. The experimental group performed significantly better than the control group. The results indicate that test-enhanced learning has a significant advantage in learning how to solve complex mathematical problems and also results in a more enduring knowledge.

Róbert Nagy: *Digital options for the reduction of the rate of dropping out from schools*

The assessment and evaluation criteria of the Digital Pedagogy component of the Complex Basic Program (EFOP-3.1.2-16-2016-00001) urges a practical approach for the substantiation of the respective multipolar theoretical background and the related condition and impact system behind preventing dropping out from schools. The sub-program promotes the digital transformation of the respective institutions while taking into consideration the student, teacher, institution, and parent-related aspects of the given learning environment. The presentation introduces the main themes of the Digital component of the Complex Basic Program and demonstrates their connection to actual pedagogical practice. Furthermore, an overview will be provided concerning the devices, methodologies, and solutions facilitating experience-based learning, the enhancement of student motivation and by extension the reduction of the rate of premature school leaving.

János Pánovics, Márk Kósa: *The first eight years of the Regional Programming Contest of the Faculty of Informatics, University of Debrecen*

The Regional Programming Contest at the Faculty of Informatics, University of Debrecen was first organized in 2012. The goal of the contest is to popularize programming team competitions, improve the teamwork and algorithmic programming skills of the participants, and compare these skills at regional level. Besides educational institutions from Borsod-Abaúj-Zemplén, Hajdú-Bihar, Heves, Jász-Nagykun-Szolnok, and Szabolcs-Szatmár-Bereg counties, Hungarian and foreign partner institutions have registered teams for the contest in one of three categories. This lecture presents the history of the contest, our experiences, and the way how the contest became one of the greatest events of the faculty.

Réka Racsko, Csilla Kvaszingerné Prantner: *The role of technology in various forms of learning*

The era of digital transformation poses new challenges to theformal public education sphere as the respective technology-dominated context (i.e: DigComp 2.1, WEF, 2015; 2018) forcespeople to meet different competence expectations. We aim to explore the way documents of educationaladministration in Hungary (National Curriculum 2012, and its2018 draft) treat the respective technological background andthe role of digital culture. Furthermore, we examine the mainfields in the given system and its evolutionary tendencies in thepast decade. We will also analyse the expectations related to the digitalcompetence development

efforts and their compatibility with thephilosophy of the Digital component of the Complex BasicProgram.

Nikolaj Popov: *The Place of Logic in Mathematics, Programming and Real World*

There are three main branches of Mathematics: Algebra, Geometry, and Logic. Algebra is the abstract art of dealing with numbers and symbols without their material instantiation. Geometry started historically as the science for measuring land. It went a very long way, however, it still deals with idealized models of real world objects: measuring, computing and proving their properties. Logic is the science of thinking and making conclusions from a set of given facts – reasoning and inferring. In that sense, logic is the thinking kernel of mathematics. Logic's computational offspring, programming, has entered our genesis together with the advance of physics and technology within the last hundred years. The challenge here is clear – make a machine think and decide on its own. Although real world is mostly driven by sexual and hunger forces, logic shall stay behind any reasonable human activity. Interestingly enough, nearly any chaotic behavior may be described with a logical system based on precisely chosen rules.

Anna Rékasi: *Examination of pre-service teachers' problem posing skills focusing on the possibilities of development*

The goal of our research was to invetigate opportunities for the development of problem posing abilities of pre-service math teachers. In our experiment 43 pre-service teachers had to pose problems in two specific situations (part A and B). In part A they had to pose 3-5 problems leading to a solution of a high-school competition problem and in part B they had to pose problems in given situations. We wanted to see if one any of the settings helps the other. The participants were randomly assigned into two groups. The groups completetd the two parts in different order. We evaluated the posed problems according to our own criteria, especially in terms of originality and consistent structure. We found that part A helps part B. It was common mistake in both groups, that the posed problems were not age-appropriate for high-school students.

Erika Román: *Does a set diagram help?*

In my presentation I would like to speak about the results of a research carried out among the students of Ferenc Rákóczi II Transcarpathian Hungrarian College of Higher Education specializing in primary education and among the students of the Vocational School of Ferenc Rákóczi II. Transcarpathian Hungarian College of Higher Education. The aim of the research based on questionnaires was to

examine whether the set diagram helps or hinders students in solving logical problems. The results show that reading the elements of the filled in set diagram in many cases causes difficulties but almost everybody managed to place the elements on the set diagram.

János Saxon-Szász, Zsuzsa Dárdai, Eleonóra Stettner: *PUSE METHODOLOGY–Visual Experience Based Mathematics Education*

Poly-Universe = Math + Art + Game... The main objective of our Erasmus+ project was to develop a new visual educational system for mathematics: the PUSE (Poly-Universe in School Education) Methodology. The PUSE was based on the Poly-Universe game, which is a geometric skill-developing game by János Szász SAXON Hungarian fine artist. The novelty value of Poly-Universe lies in the scale-shifting symmetry inherent in its geometric forms and a colour combination system. It can be used universally and impact the educational system, particularly in the education of mathematics: geometry, sets and logic, combinatorics and probability, graphs and algorithms etc. The complexity emerging from its simplicity makes it more than a game, more than art, more than mathematics: these elements come all together–creating synergy in education... The PUSE methodology book was created by a group consisting of teachers and students, the inventor and external experts. The four partner organizations (Finnish, Hungarian, Slovak, Spanish) come from different regions of Europe and operate in different educational systems. The presentation will introduce the invention, the project, the resulting PUSE Methodology book, the student worksheets, the PUSE interactive platform, and the PUSE grand plans... The PUSE Methodology Book and Worksheets can be downloaded free of charge from the project website: `www.poly-universe.com`

Dóra Sipos: *Application of online tests in Engineering Mathematics to provide instant feedback on the learning process*

Online tests as a method of gaining immediate feedback have been applied in Engineering Mathematics classes at Faculty of Engineering of University of Debrecen for several semesters to provide instant feedback on the learning process. Our aim was to control the educational process and to discover the problems concerning the acquisition of the new material in order to correct the errors in time. In this talk the method of compilation of online tests will be presented. The methodology of tests for general knowledge of mathematics and short online tests for providing instant feedback will be compared and their questions will be categorized.

Anna Krisztina Stirling: *Comparison of pre-service teachers' problem posing and problem solving abilities*

In our study we investigated hungarian pre-service teachers' problem posing abilities. We also examined how are the problem posing skills were related to the problem solving skills. In our experiment the participants' first task was to solve a set of geometry problems, than they posed their own mathematical problems also in geometry. We evaluated the posed problems based on our score system, and compared the results to the particiants' years spent in university, their mathematical knowledge, etc. Our main evaluation aspects were originality, creativity and dressing up. Among others we found that students with deeper mathematical knowledge and better problem-solving skills posed better problems. Sadly, the years spent in university did not improve the participant pre-service teachers' problem solving abilities.

Ildikó Stockné Bereczki: *Teaching percentage calculations using the realistic mathematics education approach*

The ability to calculate proportionality both in the field of mathematics and in our everyday life is of great importance. As part of this topic, it is very important that we learn and teach how to calculate percentages. Having reviewed several Hungarian textbooks and based on my teaching experiences, I would like to introduce a new approach that takes the students pre-existing knowledge into consideration as opposed to using technical terms and formulas. I have based my method on Marja van den Heuvel-Panhuzien's (2003) "bar modell" model and the RME (Realistic Mathematics Education) approach. The understanding of the topic was aided by an elastic strip. Due to the strip's elasticity it allowes the measurement and the drawing of the objects and their segments. With the help of the strip students can discover the connections and the calculation methods for themselves. I would like to report on the method in practice and introduce my current research plans on the topic.

Csaba Szabó: *Some beliefs and misbeliefs on teaching and learning strategies*

In our talk we discuss the efficiacy of a few wellknown learning and teaching strategies.

Erzsébet Váradi Szilvási Istvánné: *What can we do to amend the results of the National Competence Measurement?*

Content fields of the mathematics tests of the National Competence Measurement; thinking operations; test matrices; the consept of mathematical competence, its components and upgradeability. The role and possibility of the mathematics teacher: building the exercises of the Competence Measurement continuously into the practisisng/evaluating processes, to have time to integrate into the pupils' cognitive structure, so that their knowledge become applicable. Conclusions.

Tibor Tajti: *Examples for generating mathematical exercises in Python programming language*

The Python programming language and its freely available libraries provide a number of options that allow us to easily create an problem-generating program. The ability to generate exercises by a program can help generate enough customized problems for students. With proper design and implementation, it can be easy to adjust the difficulty of the tasks or to set details from parameters, e.g. in case of text tasks, specify the actors by age group.

Anna Mária Takács: *'Mobile' maths*

Learning about generation theory has a strong impact on our teaching methods. We have to provide experience to maintain the attention of students both in lecture and in recitation. Parallel to traditional methods we have incorporated the use of smart mobile phones by introducing various software and applications. Smart phones have been afforded a role in present time display of the material. We show some smart phone applications through examples in our presentation, and summarize our findings.

Ede Mátyás Troll: *Our digital education habits in the light of their environmental impact*

In today's school, we are increasingly relying on the potential of digital devices. We regularly use mobile devices, cloud-based services, e-learning curriculum and much more in the teaching-learning process. These tools should all make life easier for educators and students and enhance their learning experience. Also, we assume that we have become more environmentally conscious by using less amount of paper. Unfortunately, however, experience has shown that the workload of teachers has not been reduced, and there has been no significant improvement in learning outcomes, at the same time we have forgotten about the environmental impact of these tools. We compare some commonly used educational tools with their usage patterns and their environmental impact of generating the energy needed to operate them. Our aim is to highlight that a

more conscious use of digital devices contributes to environmental protection, as does selective waste collection or conscious purchasing. (Research was supported by the grant EFOP-3.6.1-16-2016-00001 (Complex improvement of research capacities and services at Eszterházy Károly University)).

Ibolya Veress-Bágyi: *Perspectives of statistics education in a digital environment*

In addition to digitalization, the third millennium also brought about an era of data. In this era, we need both statistical knowledge and digital technology skills. There is the opportunity to engage digital contents and digital tools at all levels of statistics education, helping to implement interesting, relevant and entertaining statistics lessons. In my presentation, I present the good practices abroad that can be applied in statistics education by age group, but I also share the domestic aspirations. Additionally, I will introduce the iPAC framework system, which is based on three important features of mobile learning, namely, authenticity, social interactivity and customization (Kearney et al., 2012), and I would like to talk about STEMS (science, technology, engineering, mathematics and statistics) which is an Australian project.

Péter Versényi: *Entertaining Computer Science*

Students involved in the Computer Science Bsc training in the University of Debrecen Faculty of Informatics have major issues with a course called "Logic in Computer Science". If a student fails this class, he or she loses 6 credits, and won't be able to take two other classes, losing 12 more credits. This means that the student has to achieve 10% of the total credits later, than it is recommended, which leads to further failures.

I held practical courses last semester, twice a week for fourteen weeks. Most of my students took the course for the 2nd or 3rd time (27 out of 28). During the semester it became clear to me, that the students don't learn logic at home, except before the tests. My mentor thinks inner motivation is way more efficient than outer motivations. In order to activate these motivations, she considers pedagogical gamification to be appropriate. To raise the interest, I started to develop a desktop application under a competition. The application contains 6 primitive games. In these games, toscore points, the user has to solve exercises, which are fundamental to complete the logic class too. The students will be able to learn during playing. Each task takes few minutes, which encourages the students to join. For the students, it is easier to find 10 minutes 3 or 4 times, than it is to find 30 minutes once. In addition the mini-activities may help the

intensive learning later. In the future I would like to extend the variety of games with games related to the course called "Foundations of artificial intelligence". The application is written in C++, using the Qt toolkit.

List of abstracts of posters

Gábor Bihari: *The development of the concept of exponentiation in the 9th grade*

In our research, we are dealing with the development of the concept of exponentiation as well as searching for different types of errors and their causes. We created a test with four tasks which focus on operations with exponentiations and further operations with exponents. The test was written by 9th grade students (48 students) in a grammar school of Debrecen before starting to learn this topic. We wanted to find out to what extent the students managed to learn the basics of exponentiation during their 7th and 8th grade studies. According to the results, the students seem to have deficiency. Our aims include following up the development of these students, clearing up whether these errors can be eliminated and a stable concept of exponentiation can be built up by the end of the school year.

József Borján: *Faktor analysis of a complete experiment*

Experiment. Pictures.

Borbála Herendi: *Physics teaching with modern clickers*

On my poster I show the results of a small-scale educational experiment based on the first topic of the physics curriculum in 9th grade. During the experiment we used the smart phone application named Kahoot. In the experimental class at the end of each lesson we used a few MCQ to review what we have learned that day. It was also useful that the students could assess if they understood what they have just learned. All of that was realized in a playful and competitive way. In the control group we did not do any revisions at the end of lessons. I summarize my findings and conclusions according to the results of the post-test and the opinion of the students.

Zoltán Matos: *Some Hungarian pioneers in the history of mathematics in secondary school*

The appearance of mathematics history in secondary school in Hungary is associated with the names of some excellent teachers. The most prominent are the polytheist doctor László Vekerdi and the professors Márton Sain and Imre

Hajnal. All three are Calvinists and are linked to Hódmezővásárhely. He is a distinguished lecturer and teacher, who is still able to influence the teaching of mathematics in Hungary through his books.

List of participants

1) András Ambrus, Eötvös L. University, Mathematics Teaching and Education Centre, Budapest, Hungary
ambrus@cs.elte.hu

2) Gabriella Ambrus, Eötvös L. University, Mathematics Teaching and Education Centre, Budapest, Hungary
ambrusg@cs.elte.hu

3) Péter Antal, Eszterházy Károly University, Eger, Hungary
antal.peter@uni-eszterhazy.hu

4) Eszter Árokszállási, Vak Bottyán Secondary Grammar School, Paks, Hungary
arokszallasieszter@gmail.com

5) Szilvia Árvai-Homolya, University of Miskolc, Faculty of Mechanical Engineering and Informatics, Institute of Mathematics, Miskolc, Hungary
szilvia.homolya@uni-miskolc.hu

6) Gabriella Babcsányi-Tóth, Waldorf Primary School, Szekszárd, Hungary
gabytoth@freemail.hu

7) Tamás Balla, Eszterházy Károly University, Institute of Mathematics and Informatics, Eger, Hungary
balla.tamas@uni-eszterhazy.hu

8) Tünde Klára Baranyai, Babeş-Bolyai University, Satu Mare, Romania
baratun@yahoo.com

9) Krisztina Barczi-Veres, Neumann János Secondary Grammar and Vocational Grammar School, Eger, Hungary
bkrixta@gmail.com

10) Csilla Bereczky-Zámbó, Eötvös Loránd University, Faculty of Science, Budapest, Hungary
csilla95@gmail.com

11) Gábor Bihari, University of Debrecen, Faculty of Science and Technology, Debrecen, Hungary
gaboka0209@gmail.com

12) József Borján, Budapest University of Technology and Economics, Budapest, Hungary
jborjan@gmail.com

13) Csaba Csapodi, Eötvös L. University, Mathematics Teaching and Education Centre, Budapest, Hungary
csapodi.csaba@ttk.elte.hu

14) Zoltán Csernai, Eszterházy Károly University, Eger, Hungary
csernai.zoltan@uni-eszterhazy.hu

15) Mária Csernoch, University of Debrecen, Faculty of Informatics, Debrecen, Hungary
csernoch.maria@inf.unideb.hu

16) Zsuzsa Dárdai, Poly-Universe Ltd, Szokolya, Hungary
saxon@poly-universe.com

17) Edith Debrenti, Partium Christian University, Oradea, Romania
edit.debrenti@gmail.com

18) András Ferenc Dukán, Madách Imre High School, Budapest, Hungary
dukan@cs.elte.hu

19) György Emese, János Xántus Bilingual Secondary School, Budapest, Hungary
gemese2@gmail.com

20) Földesi Katalin, Upsala, Sweden
katalin19@gmail.com

21) Ján Gunčaga, Comenius University in Bratislava, Slovakia
jguncaga@gmail.com

22) Miklós Hoffmann, Eszterházy Károly University, Institute of Mathematics and Informatics, Eger, Hungary
hoffmann.miklos@uni-eszterhazy.hu

23) Enikő Jakab, Bethlen G. Hungarian Grammar School, Beregszász, Ukraine
jeniko18@gmail.com

24) Zsuzsanna Jánvári, Szerb Antal Secondary Grammar School, Budapest, Hungary
zsjanvari@gmail.com

25) Tamás Kádek, University of Debrecen, Faculty of Informatics, Debrecen, Hungary
kadek.tamas@inf.unideb.hu

26) Sándor Kántor, University of Debrecen, Institute of Mathematics, Debrecen, Hungary
kantor.sandor@science.unideb.hu

27) Sándorné Kántor, University of Debrecen, Institute of Mathematics, Debrecen, Hungary
tkantor@science.unideb.hu

28) Fruzsina Kiss, University of Debrecen, Faculty of Science and Technology, Debrecen, Hungary
kiss.fruzsina.96@gmail.com

29) Márton Kiss, University of Debrecen, Faculty of Science and Technology, Debrecen, Hungary
kmarci88@gmail.com

30) Rita Kiss-György, University of Debrecen, Institute of Mathematics, Debrecen, Hungary
kgyrita@gmail.com

31) Imre Kocsis, University of Debrecen, Faculty of Engineering, Debrecen, Hungary
kocsisi@eng.unideb.hu

32) Eszter Kónya, University of Debrecen, Institute of Mathematics, Debrecen, Hungary
eszter.konya@science.unideb.hu

33) Lilla Koreňová, Comenius University in Bratislava, Bratislava, Slovakia
lillakorenova@gmail.com

34) Zoltán Kovács, University of Nyíregyháza, Nyíregyháza, Hungary
kovacsz@nyf.hu

35) Eszter Kovács-Kószó, University of Szeged, Bolyai Institute, Szeged, Hungary
koszesz94@gmail.com

36) Attila Körei, University of Miskolc, Faculty of Mechanical Engineering and Informatics, Institute of Mathematics, Miskolc, Hungary
matka@uni-miskolc.hu

37) Csilla Kvaszingerné Prantner, Eszterházy Károly University, Eger, Hungary
kvaszingerne.prantner.csilla@uni-eszterhazy.hu

38) Károly Lajkó, University of Debrecen, Institute of Mathematics, Debrecen, Hungary
lajko@science.unideb.hu

39) Szilvia Lengyelné Szilágyi, University of Miskolc, Faculty of Mechanical Engineering and Informatics, Institute of Mathematics, Miskolc, Hungary
matszisz@uni-miskolc.hu

40) Linda Devi Fitriana, University of Debrecen, Doctoral School of Mathematics and Computer Sciences, Debrecen, Hungary, Indonesia
flindadevi@gmail.com

41) Gyula Maksa, University of Debrecen, Institute of Mathematics, Debrecen, Hungary
maksa@science.unideb.hu

42) Zoltán Matos, Elementary and Grammar School of University of Szeged, Szeged, Hungary
matos@freemail.hu

43) Janka Medová, Department of Mathematics, Constantine the Philosopher University in Nitra, Nitra, Slovakia
jmedova@ukf.sk

44) Katalin Munkácsy, Eötvös Loránd University, Faculty of Science, Budapest, Hungary
katalin.munkacsy@gmail.com

45) Anna Muzsnay, Eötvös Loránd University, Faculty of Science, Budapest, Hungary
annamuzsnay@gmail.com

46) Róbert Nagy, Eszterházy Károly University, Eger, Hungary
nagy.robert@uni-eszterhazy.hu

47) Ilona Oláhné Téglási, Eszterházy K. University, Faculty of Mathematics and Informatics, Eger, Hungary
olahneti@ektf.hu

48) Kitti Páleníková, Department of Mathematics, Constantine the Philosopher University in Nitra, Nitra, Slovakia
kpalenikova@ukf.sk

49) Zsolt Páles, University of Debrecen, Institute of Mathematics, Debrecen, Hungary
pales@science.unideb.hu

50) János Pánovics, University of Debrecen, Faculty of Informatics, Debrecen, Hungary
panovics.janos@inf.unideb.hu

51) Ioannis Papadopoulos, Department of Primary Education, Aristotle University of Thessaloniki, Greece
ypapadop@eled.auth.gr

52) Ildikó Perjésiné Hámori, University of Pécs, Faculty of Engineering and Information Technology
perjesi@mik.pte.hu

53) Ildikó Pomuczné Nagy, Tereskei Elementary School, Tereske, Hungary
nagyildikoanna@freemail.hu

54) Nikolaj Popov, Research Institute for Symbolic Computation, Johannes Kepler University of Linz, Austria
npopov@risc.uni-linz.ac.at

55) Réka Racskó, Eszterházy Károly University, Eger, Hungary
racsko.reka@uni-eszterhazy.hu

56) Anna Rékasi, Eötvös Lorand University, Faculty of Science, Budapest, Hungary
annarekasi99@gmail.com

57) Erika Román, II. Rákóczi Ferenc Transcarpatian Hungarian College, Beregszász, Ukraine
veres.erika13@gmail.com

58) Dóra Sipos, University of Debrecen, Faculty of Engineering, Debrecen, Hungary
dorasipos@eng.unideb.hu

59) Eleonóra Stettner, University of Kaposvár, Faculty of Economic Science, Kaposvár, Hungary
Stettner.Eleonora@ke.hu

60) Gordana Stankov, College of Applied Sciences, Subotica, Serbia
sgordonka@yahoo.com

61) Anna Krisztina Stirling, Eötvös Lorand University, Faculty of Science, Budapest, Hungary
stirling.anna@gmail.com

62) Ildikó Stockné Bereczki, Eötvös Loránd University, Faculty of Science, Budapest, Hungary
bereczkildiko@gmail.com

63) Csaba Szabó, Eötvös Loránd University, Faculty of Science, Budapest, Hungary
csaba@cs.elte.hu

64) Gyöngyi Szanyi, University of Debrecen, Faculty of Engineering, Debrecen, Hungary
szanyi.gyongyi@science.unideb.hu

65) János Saxon-Szász, Poly-Universe Ltd, Szokolya, Hungary
saxon@poly-universe.com

66) Dóra Szegő, University of Pécs, Faculty of Engineering and Information Technology
szego.dora@mik.pte.hu

67) Janka Szeibert, Eötvös Loránd University, Faculty of Science, Budapest, Hungary
szeibert.janka@gmail.com

68) Istvánné Szilvási Váradi Erzsébet, Practice School of Eszterházy Károly University, Eger, Hungary
szilvasi.istvanne.varadi.erzsebet@uni-eszterhazy.hu

69) Tibor Tajti, Eszterházy Károly University, Eger, Hungary
tajti.tibor@uni-eszterhazy.hu

70) Anna Takács, Budapest Business School, Faculty of Finance and Accountancy, Budapest, Hungary
Takacs.Anna@uni-bge.hu

71) Ede Mátyás Troll, Eszterházy Károly University, Eger, Hungary
troll.ede@uni-eszterhazy.hu

72) Magda Várterész, University of Debrecen, Faculty of Informatics, Debrecen, Hungary
varteresz.magda@inf.unideb.hu

73) Éva Vásárhelyi, Eötvös L. University, Mathematics Teaching and Education Centre, Budapest, Hungary
vasareva@gmail.com

74) Péter Versényi, University of Debrecen, Faculty of Informatics, Debrecen, Hungary
versenyi98@gmail.com

75) Ibolya Veress-Bágyi, Hungarian Development Centre, Budapest, Hungary, Budapest, Hungary
veressbibolya@gmail.com

76) Balázs Vértessy, Kölcsey Ferenc Reformed School, Debrecen, Hungary
vertessy01@gmail.com

(Compiled by E. Kónya and Gy. Szanyi)