Teaching
Mathematics and
Computer Science

Report of Meeting
Researches in Didactics of Mathematics and Computer Sciences
April 1 – 3, 2022
Baja, Hungary

The meeting *Researches in Didactics of Mathematics and Computer Sciences* was held in Baja, Hungary, at Eötvös József College, from the 1st to the 3th of April, 2022. It was organized by the Doctoral School of Mathematical and Computational Sciences of the University of Debrecen and by Eötvös József College.

The 62 participants – including 18 PhD students – came from 8 countries and represented 26 institutions of higher and secondary education. There were 3 plenary and 40 session talks in the program.

After the welcome of Ibolya Szilágyiné Szinger, Rector of Eötvös József College, the conference was opened by Zoltán Muzsnay, Leader of the Didactical Program of the Doctoral School of Mathematical and Computational Sciences, University of Debrecen. He welcomed the large number of participants, who had been looking forward to this event, not least because the conference, which has been held every year since 2009, was cancelled in 2021 due to Covid-19.

There were two or three sessions in parallel, including several presentations in English. The presentations were varied and useful. The breaks between the sessions were also filled with in-depth technical discussions.

The conference took place in Baja, a small Hungarian town on the left bank of the Danube. During the sightseeing tour we visited the famous buildings and walked the pedestrian streets, but unfortunately the weather was not in our favour and we had to cut the programme short. The building of Eötvös József College was freshly renovated and welcomed the participants.

After the presentations on Sunday, Ibolya Szilágyiné Szinger and Eszter Kónya, head of the organising committee, thanked the participants for their high-quality presentations and assessed the conference as a success. Other members of the organising committee were Emőke Báró, Márton Kiss and Orsolya Dóra Lócska.

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

List of abstracts of lectures

Éva Ádámkó, Gusztáv Áron Sziki: *Measurements for the analysis of the computational thinking of elementary school students*

We conducted an investigation to determine the level of computational thinking among the fifth, sixth, seventh and eighth-graders of the Gönczy Pál Primary School in Debrecen. 95 students participated in the experiment. The students completed a six-question multiple-choice test, in which questions measured the different skills of computational thinking, such as algorithm design or decomposition. The relationship between computational thinking and students' attributes was examined by year, age, IT, mathematics, foreign language grade, musical background and gender. The studies were performed using statistical methods with SPSS software. In the presentation, we summarize our experiences and the results of the measurement.

András Ambrus: *Is the use of concrete and visual representations relevant only in lower grades?*

There are different opinions about the use of concrete and visual representations among mathematics teachers. We cite some – controversial – teacher opinions, then we analyze the most important theoretical base of this problem, the human memory structure, limits of working memory. Reasons for the necessity of the use of concrete and visual representations for all students: the phonological store and the visual store, the role of episodic memory, concept image.

Gabriella Ambrus: *Some utilization ideas for a textbook geometry task*

Recently solving geometry problems has been losing its significance in mathematics teaching in Hungary, so a tendency of teacher students arriving to the university with less knowledge in geometry is an experience as well. However,

geometry is important not only as a field of mathematics, but also for didactical reasons; for example, considering the development of the problem-solving skills and the mathematical thinking. Very often, a problem in geometry may be solved in several different ways if you try. There are many problems particularly appropriate for this purpose. A problem of this kind, found by chance, is going to be analyzed in the lecture, with its possibilities to use it in teacher training and school education, considering some research results as well.

SZABOLCS BAJÁK: *Teaching computer networks at the BBS FFA*

In recent years, at the Faculty of Finance and Accountancy studying computer networks was provided for students also in the Cisco Networking Academy. Based on their previous results, approximately 100 students get the opportunity each year to enter the program, and after successfully passing the exams achieve the Cisco certified CCNA degree. In this talk, we present the form of the available courses, their connection to other mathematical fields, and the experience gained during the teaching of the material.

EMŐKE BÁRÓ: *Observing critical thinking during online pair work*

The closures of schools caused by the pandemic and the transition to online education put teachers and students in a difficult position. When teachers were asked to select their top three concerns about distance learning on students, common answers were: students' social isolation, decreased student well-being, and potential learning loss. We elaborated a chapter from the curriculum in a problem-based way suitable for online learning with these concerns in mind. We also paid attention to the manifestation of students' critical thinking, learning outcomes, and motivation. In this paper, we aimed to analyze a part of a lesson in which we paid increased attention to observing critical thinking and the teacher's role during online pair work and students' reflections about that.

ILDIKÓ BERECZKI, CSABA CSÍKOS: *Structure of a task battery for measuring the development of proportional reasoning among 10 to 14-year-old students*

Proportional reasoning is an important ability for both everyday thinking and successful performance in several fields within mathematics. Mastering this ability is challenging, and appropriate performance level can be reached by the students at fairly different ages. In this research, the phases of the development of proportional reasoning are analyzed with emphasis on the lower secondary (or upper elementary) school grades. The presentation focuses on the development of a task battery in which the tasks are arranged according to three dimensions: (1)

discrete versus continuous quantities (2) in both the item stem or in the response choices, and whether (3) the task is visualized or is presented as a word problem.

GÁBOR BIHARI: *The cognition of the concept of exponentiation in the 9th-graders' mind: What are the bases, and the barriers?*

In my research, I am dealing with the concept of exponentiation and searching for different types of errors and their causes. I created three tests which were written by 9th-graders. With the tests I wanted to find out to what extent the students managed to learn the basics of exponentiation during their earlier studies, correct the discovered errors, and develop the concept into a stable integer exponent in their 9th grade. In order to further investigate the reasons behind the discovered errors, I made interview with 4 of the students, in which they solve a few tasks while loudly sharing their thoughts with me. The interviews confirmed the results of the 3 tests, also, I could make some further conclusions too.

BALÁZS BOLLER: *Correlation and regression analysis in secondary school: International examples and practises*

The appearance of correlation and regression analysis in curriculum can have many advantages. It can improve counting skills, problem solving and decision making. Moreover, self-sufficient data-collection from the real life can be an exciting experience for the students. Studying the strength of linear relationship between two normal variables (correlation) or the cause-effect relationship between the variables (regression) are good opportunities to get routine in statistics. But these topics require complex mathematical thinking, so their implementation in the Hungarian curriculum must be substantially thought over. In many European countries correlation and regression analysis is part of the curriculum with different standards. Examining these countries' practises can lead to the grounding of the inland teaching contents and methodology. In this talk, through analysing practises and curriculum conditions, I will present how correlation and regression analysis appear in schools of some European countries.

JÚLIA CSEHNÉ SZENDERÁK: *On a metamatemEthical question in talent care*

Recently, more and more ethical issues arise in several sciences. We think that didactics of mathematics is not an exception. In this talk, we investigate the question whether we can insist less on mathematical precision in talent care. We suggest that we have to start from the formulation of a problem. We present an interview on this question with Sándor Róka, one of the most well-known math teacher of Hungary.

EDITH DEBRENTI: *Problem-solving with visual representations*

In our research, we examined the problem-solving abilities of primary school pupils and university students, by using different kinds of visual representations: virtual and two-handed manipulations. In previous research, we found out that those who solved the problem with manipulation worked more precisely, were more motivated and solved the problem faster than those who worked online. We were curious if this has changed or not, because of online learning, will the elementary school students, the digital natives, achieve better results by using computers than with the well-established method, manipulation? The research is based on three logical exercises, the solution of which requires not only logical thinking, but also reading comprehension, due to the high level of complexity of the exercises.

LINDA DEVI FITRIANA: *First experience with problem-posing: What can be done with a multiplication table?*

Having been identified as a principal skill to face the world, critical thinking should be encouraged in all educational levels, including teacher preparation programs. This research is guided by a question: How does problem-posing promote students' critical thinking? The participants are Indonesian prospective mathematics teachers. They were directed to observe patterns in the multiplication table and pose problems to their peers. Data analysis was carried out by observing the dialogues of prospective teachers which might be in the form of simple answers, answers with reasoning, and comments or evaluations of their peers' oral manifestations.

PAUL DRIJVERS: *Computational thinking in the mathematics classroom*

Nowadays, much attention is paid to the development of students' competences in the field of digital literacy and computational thinking. However, it is not always clear what computational thinking exactly is. Also, as mathematics educators, we may feel some resemblance between higher-order learning goals in mathematics teaching and computational thinking, but still are unsure about how to reconcile the two, and how to address computational thinking in the mathematics classroom. What is computational thinking and how can it be related to mathematics education goals and practices? To address these questions, I will first reflect on the notions of computational thinking and mathematical thinking. Next, the results of a Delphi study on computational thinking in mathematics teaching will be presented. Finally, I will address the preliminary results of the

teaching experiments we carried out in applied and pure mathematics courses for 16-17-year-old students in the Netherlands.

GYÖRGY EMESE: *Presentation of the MTA-ELTE research project "Modern Complex Mathematics Education in the 21st Century"*

From 2015 to 2021, I participated in this two-part research project with university lecturers, primary and secondary school teachers, supported by the Hungarian Academy of Sciences. The aim was to process the legacy of Tamás Varga, and to incorporate the three decades of development since then. In my talk, I will describe the project, and my role as a high school teacher in the project, what experiences I gained, how I and my colleagues utilized the project in our teaching, and how we utilized our teaching experience in the project.

ÁGNES FECZKÓ, REBECCA PRINS: *Possibilities of gamification in mathematics lesson based on university course experiences*

In our presentation we introduce a gamified course in number theory for first year preservice math teacher students. We show how to embed didactical tools into gamification. Then we show three different gamification systems, which can be used in primary and secondary school as well: points, badges, and story-based system. Each system follows the curricular and administrative prerequisites, and none of them results in extra work for the teacher.

KORNÉLIA FICZERE: *Teaching trigonometry using the realistic mathematical method in the online environment*

In the 2020/2021 academic year, I examined the results of a 11th-grade group in the online environment for the sine and cosine theorems of Trigonometry. In the presentation, I show the realistic tasks discussed in the lessons, the results of the analysis of the learners' task solutions and a test completed by the students. I hope that with this presentation I can encourage more colleagues to bring more realistic tasks to their lessons.

ZSOLT FÜLÖP: *Regula falsi method in lower secondary school education*

The false position method or 'regula falsi' is a specific arithmetical problem-solving method used to solve word problems with two or three unknowns. In our opinion, this method is useful in the lower secondary school educational processes, especially to reduce the great number of random trial-and-error problem-solving attempts among the lower secondary school pupils. In this presentation, we will give the results of our studies concerning the effects of teaching false position method on students' problem-solving strategies. We investigated the advantages

and disadvantages of the false position method in the solutions of word problems. The findings from our research works suggest that the false position method approach gives beginners a satisfactory way of solving problems, while the typical solution by equation demands maturity on the part of students and could be postponed for a later time.

EVELIN ANNA GESZLER: *Opportunities for digitalization of the final exam of Math through specific tasks*

Within the framework of my Ph.D. studies, I am researching for potential opportunities to make the final examination of Math digital in Hungary. After considering the adaptation of existing tasks, my short-term goal is to develop complex tasks that can be set in the digital environment. The basic requirements for these new tasks are measuring similar competencies to the current paper-based exam, while placing greater emphasis on 21st-century skills such as digital literacy, critical thinking, and problem-solving. I use the well-known GeoGebra, which provides an opportunity to measure students' ability of mathematical modeling instead of standard calculations.

ZSUZSANNA JÁNVÁRI: *Presentation of the compilation and the results of an unusual descriptive statistics worksheet*

A worksheet containing descriptive statistics tasks was developed to further investigate the levels of statistical literacy. The worksheet included questions that meet the requirements of the new math curricula but was unusual for students. Another consideration was to include items that fit the established levels of statistical literacy. The survey also included a short student and teacher attitude test, and a set of questions for teachers that required explicit answers. Filling out the worksheets took place in the spring of 2020, involving three high schools; nearly 150 students and their teachers participated in the measurement. After the filling, we talked to some of the participating students about their experiences during the survey, and a short interview was recorded. In this presentation, I would like to speak about the background and purpose of compiling the worksheet, the results obtained, and some interesting experiences from the attitude tests and interviews related to the survey.

SÁNDOR KÁNTOR: *Theory and practice of thinking in mathematical talent management*

In the acquisition of new knowledge in mathematical talent management, the knowledge material built in a logical system must be understood and memorized with thinking, and in the solution of problems, a logical system must be created

with thinking. I mainly examine the didactic laws of the latter thinking. *Theses*: The mix of understanding and problem solving should be directed. Learning is more effective if it follows the teaching. The development of similar material is an important didactic task.

SÁNDORNÉ KÁNTOR: *From teaching to learning: A new paradigm for mathematics education*

It is worth researching paradigm shift in the history of mathematics education. Advances in science and social change in education have also led to a change. At the beginning of the 20th century, M. Beke was pioneer of the mathematics teaching reform in Hungary. The paradigm shifts that took place in the second half of the 20th century are attributed to G. Pólya, Z. Dienes, I. Lakatos, and later they are characterized by the concepts of T. Varga, J. Surányi and J. Szendrei. In the 21st century, a new definition of math education appeared: the concept of mathematical competence, teaching-learning paradigms, new teaching-learning methods, visualization, digitalization. *Keywords*: Paradigm shift in mathematics education, principles and methods of learning and teaching.

PÁL KATONKA: *Results in 9th-grade mathematics*

In my presentation, I compare the results of the admission and level assessment of 9th-grade students in a rural grammar school. I also present their performance in the competency measurement from the previous school year. I analyze the solutions of the tasks belonging to the individual content areas of the competence measurement and the corresponding admission tasks. I also compare the results in terms of the training profile. The are 87 students in the sample study from five fields of study.

ALIYA KATYETOVA: *Computer science in state educational programs for primary schools*

Computer science lessons have a high educational value, and therefore more and more countries are anchoring it compulsorily from primary school age. In addition to the ability to program in the informatics classes, to "communicate" with technology, one learns to develop procedures and explain them. In addition, computer science, especially programming, enriches general education with new elements without which education in the future IT-based knowledge society can no longer be imagined. This article aims to provide a comparative study of state educational programs of Hungary, Slovakia, and Kazakhstan, particularly in primary school computer science. The research intends to determine the place and role of computer science in individual state curricula, especially programming.

The results can help to improve computer science programs for primary school children.

Márton Kiss: *Voice message from home and your maths test*

A real challenge in online learning is to ensure that the assessment reflects the learner's own knowledge. This is how I came up with the idea of asking Year 12 secondary school students to give oral explanations alongside the written test. Students had to make a short audio recording of their oral explanation and send it in. In our research, we analysed the students' oral explanations based on their written work, looking for more information about the students' thought processes and the quality of their oral communication. Asking students to think out loud is related to metacognition, as the situation itself contributes to rethinking the problem-solving process. Aloud explanations force learners to engage with the retrospective stage of problem solving, the most neglected step described by Pólya.

Zdenka Kolar-Begović, Ana Katalenić: *Prospective primary school teachers' work in the course of didactics of mathematics during emergency remote teaching*

The emergency remote teaching implemented in various ways during Covid-19 global pandemic brought many challenges. The knowledge gained could be beneficial for regular and online prospective teachers' education. In this presentation, we present analysis of students' work in online exercises during emergency remote teaching. Content analysis coupled with the MATH taxonomy provided powerful tool for categorizing students' answers and classifying questions in mathematical tasks. Students approached the assignments strategically, relying heavily on peer support. We discuss how the results of our study can affect the design and assessment in the course. For example, online assignments for students, with individual feedback and synchronized with the course content, as means of continuous formative assessment, could complement lectures into a blended learning environment.

Judit Kollár: *New challenges in mathematics education*

Mathematical knowledge of undergraduates varies on a very wide scale. Several combined impact factors must be taken into account, in view of teaching this subject. Continuous changes, the new curriculum and the expectation to reduce the number of fallouts resulted in the re-thinking of the catch-up courses and the launch of learning aid trainings. With this new unforeseen situation, Covid-19 challenged every actor in the education system. All of a sudden, traditional face-to-face, live education partially or completely disappeared, and was replaced

by online or hybrid teaching. Even contact-focused education's well-tried/best-practice methods have been placed in a different context. Students have more responsibility in the online environment. Traditional role of a student is being transformed, in order to be self-regulating in the first place. Opportunities – generated by new situations – come with new challenges students have to face. In my presentation, I will introduce currently adapted teaching methods in terms of current unusual environments appropriate to the given circumstances, their effectiveness and students' opinions from the perspectives of basic knowledge, motivation and willingness to learn.

ZOLTÁN KOVÁCS, ESZTER KÓNYA: *Problems of switching between representations in paper-folding tasks*

Paper folding is inherently a mathematical activity. This fact can be used to illustrate and introduce simple mathematical principles in mathematics teaching. Folding in class can be effective because, as a practical activity, it can facilitate the learning process by making it more memorable. However, more complex mathematical problems can be posed by doing simple folds. Our research question is to what extent the concrete material representation of a mathematical problem influences the pictorial or symbolic representation of the problem and how it affects the problem-solving process. We hypothesize that by examining the solution of mathematical problems formulated by paper folding, we can better understand the process of problem-solving and its dynamic nature. Since paper folding as an artifactual activity can in many respects be paralleled to manipulations with dynamic geometry programs, we hypothesize that the research goes beyond paper folding. In our research, we investigated the problem-solving activities of prospective teachers in a problem based on pentagon folding. Our main finding is that critical evaluation of paper-folding inferences, i.e., metacognitive awareness, is typically absent in problem-solving or occurs only for more straightforward statements. Our pedagogical conclusion is that the inclusion of paper folding problems in methodological training can enhance teacher candidates' critical thinking and help them correctly evaluate the role of paper folding in teaching.

ESZTER KOVÁCS-KÓSZÓ: *Group work in the literature before and after the Millenium*

Group work was in the focus of education at the end of the 20th century both in teaching practice and in the research of mathematics education. Several experiments, observations and analysis were carried out to find out the mechanism of group work concentrating on both the students and the teacher. There were

several articles, books and webpages to incerase its popularity. Although, at the beginning of the 21st century its popularity decreased, and research concluded that we do not know exactly the mechanisms of it. Recent research developed frameworks to understand it better, considering agency and others. In my presentation, I would like to illustrate a brief picture of this topic. *The authors' research was supported by the grant ÚNKP-21-3-439 New National Excellence Program of the Ministry for Innovation and Technology from the source of the National Research, Development and Innovation Fund.*

ATTILA KÖREI, SZILVIA SZILÁGYI: *Help in calculating the limit of sequences of real numbers, the LimStorm didactic game and its results*

Game-based learning plays an important role in all education and learning processes, including higher education nowadays. In the course, Mathematical Analysis, offered during the first semester, all students studying informatics learn about sequences of real numbers, convergence, and limits. These concepts are of key importance to understand advanced mathematical concepts and successfully complete advanced courses. Based on the benefits of game-based learning, we came up with the idea of LimStorm, which helps study groups of 4-10 students to learn and practice the limits of sequences of real numbers. In our presentation, we introduce the game and summarize our experiences gained during the two-year experimental phase.

ORSOLYA DÓRA LÓCSKA, BALÁZS VÉRTESSY: *First steps to developing algebraic thinking in seventh grade – Comment: Krisztina Fodorné Faragó*

The traditional structure of algebra learning starts with the foundation of procedural knowledge on algebraic expressions. Our talk reports on action research conducted in two schools in seven classes involving 152 seventh-grade students. The intervention, consisting of four experimental lessons integrated into the curriculum, aims to provide students with opportunities for generalization based on numerical experience. We present the findings of the first pilot lesson from the perspective of the teacher and the researcher.

JOHN MASON: *A Mathematician's Work Is Never Done: The role of generalisation in learning, appreciating, and comprehending mathematical ideas*

Participants will be invited to engage in a sequence of activities through which to be reminded of the importance of generalisation, example spaces, and personal narratives in learning, appreciating, and comprehending mathematics.

ZOLTÁN MATOS: *'Errare scholasticum est', or about the errors made by the students in their test paper*

Following Beke Manó's idea that the error can be turned to the benefit of teaching, suggestions are made to systematize the errors made by students in their test paper in recent years and to try to trace their possible causes.

ANNA MUZSNAY, CSILLA GYÖNGYVÉR BERECZKY-ZÁMBÓ: *Where to find the fifth floor?*

The van Hiele theory suggests a possible way of structuring and describing people's understanding of geometry: focusing on understanding geometrical shapes and structures. They distinguish five levels of geometrical understanding characterized as visual, descriptive, relational, formal deduction, and rigor. The fifth level is the most abstract of all: a person at this level can compare systems based on different axioms, can think and construct proofs in different kinds of geometric axiomatic systems. Although the van Hiele theory has been suggested to be the best and most well-defined theory for students' levels of thinking in the field of geometry, it is not obvious whether or not the theory works efficiently at higher levels. In our talk, we would like to address a few questions about the fifth level.

ERIKA PERGE, TIBOR GUZSVINECZ, CECÍLIA SIKNÉ LADÁNYI, ÉVA ORBÁN-MIHÁLYKÓ: *Improving methods to test spatial perception skills*

The ability to perceive space correctly is essential for people working in various fields. Traditional methods to measure this ability were developed before the digital revolution and are still based on paper. We have designed our own method, which has been successfully applied in the education of multiple professions, including engineering. Our method mainly involves performing traditional tasks, but it makes use of recent technologies, and the measurements are made online. We originally included three test types, namely, Mental Rotation Test (MRT), Mental Cutting Test (MCT) and Purdue Spatial Visualization Test (PSVT), and recently added Heinrich Spatial Visualization Test (HSVT). We hereby present our method and the experience we have gained so far with the above four tests. *Keywords*: spatial ability, Mental Rotation Test, Mental Cutting Test, Purdue Spatial Visualization Test, Heinrich Spatial Visualization Test

MARIANNA PINTÉR: *Children born after 2010, a complex math teaching experiment and digital learning materials*

In 2018, I conducted an online questionnaire survey to obtain information about the digital device usage habits of a child born in 2010 or later, and their

experience base for learning mathematics in early childhood. The questionnaire was completed by relatives of 345 children. One of the interesting experiences of the survey is that if a child prefers to play something that develops mathematical competencies among the virtual games, he or she prefers to play with the traditional games that shape the mathematical experience base. In other words, we can state that the time spent by children with IT and traditional games with a mathematically developing effect is mostly positively correlated with each other, i.e., there is no real trade-off between them. For this reason, I considered it important to examine whether digital learning materials could be incorporated into the spirit of the complex mathematics teaching experiment, to see if this connection could be exploited in mathematics lessons as well. The results of my research show that, taking into account the principles of J. Brunner and R. Skemp, following the spirit of the complex mathematics teaching experiment, carefully selected digital learning materials and developmental games can be inserted into the process in the right place. In my presentation, I will report on some of the results of the 2018 research, and I will present the process of acquiring mathematical knowledge with specific digital games and tasks through a concrete example.

CSILLA PRANTNER: *Examination of heat maps by image analysis*

A few years ago, during an ergonomic web interface survey supported by an eyetracker device, certain calculation data for heat maps could not be extracted from the free software. It would have been important for us to know exactly how and to what extent the attention of people differed in screen pages. In addition, image files of individual heat maps saved by the software are available, the similarities and differences of which can be quantified by mathematical analyses. The presentation is about comparing the image analysis of heat maps and its usefulness.

ANNA KRISZTINA STIRLING: *Investigating problem posing in mathematics classrooms: What makes a problem good?*

The examination of problem-posing skills of students studying in public education, and practicing problem-posing in mathematics classes, is becoming more and more common, but it is certainly a fairly new trend in mathematics didactics research. Different people mean different things when it comes to problem posing. Thus, the concept of problem posing is not yet uniformly defined, and there is no uniform system neither for the way it is tested, nor for the assessment of the tasks produced. In our research, we have developed a complex set of criteria for

the evaluation of posed tasks and problems. In our talk, we will describe this evaluation and illustrate its application with some examples.

JANKA SZEIBERT, CSABA SZABÓ, ÉVA VÁSÁRHELYI: *Geometric representations of irrational algebraic numbers*

Irrational numbers are present in our everyday life, but their exact values cannot be given in a form that pupils easily understand. In this talk, we show some geometrical constructions and calculations in which non-rational numbers naturally arise and gain meaning. We look at numbers which are expressible with at maximum two roots and are present in the Hungarian curriculum. We explain how to find these numbers and show problems and solutions where they appear.

JANKA SZEIBERT, CSABA SZABÓ, ÉVA VÁSÁRHELYI: *How to calculate* $\cos 15°$ *?*

Have you ever tried to calculate $\cos 15°$? We have. In our talk, we present problems where $\cos 15°$ shows up, and problems where $\cos 15°$ can be calculated by pupils. By introducing these problems and solutions to university students, they can see that different areas of mathematics are interrelated.

BRIGITTA-KRISZTINA SZŐCS, EDITH DEBRENTI: *PUNTE – Poly-Universe – in developing the problem-solving skills of preschool children*

Poly-universe is a practice-based game, developed by János Szász Saxon. The tool consists of simple elements, and it is based on a simple principle. Yet, it is complex, as there are countless possibilities from the combination of colours and the connections between them. Children can find tangible patterns and connections between them, invent creative solutions, and soar their imaginations. In the last 10 years, thousands of students tested the game among different age groups, in hundreds of institutes and at many events (schools, mathematical festivals, museums) across Europe. We also used this game among preschoolers. Our observation has proved that the game is attention-grabbing and enjoyable, and it can be applied to illustrate, raise, and solve problems in various areas of mathematics.

SÁRA SZÖRÉNYI: *Exploring the possibilities of gamification: When, why, how?*

Gamification has been used for ten years in the corporate culture to improve productivity, employee motivation and engagement. A similar effect can be achieved in education, by improving students' engagement. Engagement improves students' achievement and attitude. The psychological explanation for the effect of gamification is the flow experience, first described by Csíkszentmihályi. Based on a 2017 definition of gamification, advantages of using gamification in

education are presented. Gamification methods, the taxonomy of players and their application in a university mathematics course are shown.

Anna Takács: *Experience – gamification – teaching mathematics*

Among the characteristics of students entering the university we can observe that their attention is often distracted, on certain occasions they easily give up learning mathematics. A reason for this can be the development of incomplete skills, or even recalling incorrect abstractions. In lectures, seminars and self-paced learning it is an important factor to maintain motivation. Gamification is a possible way to increase motivation and make the monotonous but necessary practice more interesting. We present some of its possible elements within the Moodle framework used at our university. We also present the smartphone apps used in the lectures.

Ilona Téglási: *Correct Mathematics at School: Ideas around a methodological course*

At Eszterházy Károly Catholic University, there exists a methodological course within the frames of mathematics teacher education with the above title since 2009, as a mandatory course for future secondary school teachers of mathematics. In my lecture, I would like to present what this course is about, how can we define the "mathematical correctness" in school education. During the past years, the content of the course has changed continuously, following the changes of the primary and secondary school curricula, adapting the common basic standards. I would like to raise an issue, through presenting these changes, about the future role of this course in the new teacher training model. My lecture is meant to be a keynote for a discussion, and waiting for the opinions of the listeners.

Ibolya Veress-Bágyi: *MobilStat method*

For students who are still learning statistics in the traditional way of the paper-and-pencil method, can the mobile application exploratory learning method be used? I am looking for the answer to this in my research, called MobilStat. In recent years, I have been working on mapping the situation of statistics education, then I conducted a series of interviews with statistics teachers, and finally I was able to try out the MobilStat method last November. In my presentation, I would like to talk about the process of the experiment, the results of the pre-test, and briefly about the experience.

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