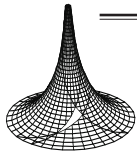

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Teaching
Mathematics and
Computer Science

Report of Meeting
Researches in Didactics of Mathematics and Computer Sciences
31 March – 2 April, 2023
Oradea, Romania

The meeting *Researches in Didactics of Mathematics and Computer Sciences* was held in Oradea, Romania, at Partium Christian University, from 31 March to 2 April, 2023. It was organized by the Doctoral School of Mathematical and Computational Sciences of the University of Debrecen and Partium Christian University.

The 85 participants – including 18 PhD students – came from 9 countries and represented 30 institutions of higher and secondary education. There were 4 plenary and 53 session talks in the program.

After the warm welcome of József Pálfi, Rector of Partium Christian University, the conference was opened by Zsolt Páles, Head of the Doctoral School of Mathematical and Computational Sciences, University of Debrecen. There were two or three parallel sessions, mainly in Hungarian, including also several presentations in English as well. The contributions were varied and useful. The breaks between the sessions were also filled with in-depth scientific discussions.

The conference took place in Oradea, a Romanian-Hungarian town. During the sightseeing tour, the participants visited the theatre and famous buildings, and walked along the pedestrian streets. On Saturday evening, the dinner took place in a restaurant on the banks of the Sebes-Körös River.

After the presentations on Sunday, Zoltán Muzsnay, Head of the Didactics Programme, Doctoral School of Mathematical and Computational Sciences, University of Debrecen, Edith Debrenti and Eszter Kónya, heads 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: *Teaching programming skills through technical mechanical problems*

At the Faculty of Engineering, University of Debrecen, we decided to build problems selected from the field of engineering into the curriculum of Engineering Informatics 1-2. The aim of the methodological development is that the students acquire the skills included in the above subjects through problems chosen from the study materials of professional subjects like Engineering Physics and Technical Mechanics. In this way, practicing not only the solution methods applied in the given but also those in the professional subjects, as well as understanding the role of modern IT knowledge and tools in technical life. In this presentation, we introduce the technical mechanical problems processed within the Engineering Informatics 2 subject, supplemented with the related methodological considerations.

András Ambrus: *Some remarkable tendencies in the international mathematics education in research and practice*

It is characteristic in English-speaking and Scandinavian countries that Mathematics Education (Mathematics Didactics) belongs to the Educational Departments and not to the Faculty of Sciences at the Universities. In my talk, I will analyze four main tendencies in international mathematics education research and practice: the Hattie–Donoghue model of learning; working memory and cognitive load; the Zone of Proximal Development (scaffolding); the importance of self-reflection in the teaching and learning of mathematics (metacognition).

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

Solving word problems pose many difficulties in mathematics education. Even understanding the text is often hard, so the solution of the so-called "traditional type word problem" seems to be more favorable for many teachers and students. The basic situation in the tasks and the wording of the tasks are now in focus,

and based on this, different types of tasks can be distinguished. The appearance of these word problem types in textbooks will be examined in the case of direct proportionality with the help of three Hungarian textbook series.

Tamás Balla, Sándor Király: *sqlsuli.hu – Online way to learn SQL*

The new Hungarian National Base Curriculum (NAT 2020) makes many changes in public education, including several innovations in the field of Computer Science Education (newly known as Digital Culture). NAT 2020 makes knowledge of the Structured Query Language (SQL) mandatory for students in the advanced final examination. This poses new challenges for both students and their teachers. Based on the changes of the Hungarian National Base Curriculum, we designed and developed a new web portal related to relational database management. Our goal with the design and development of sqlsuli.hu was to give the teenage generation the opportunity to learn the basics of relational database management and SQL in a playful and effective way.

Tünde Klára Baranyai, Edith Debrenti: *Basic logical operational skills among students*

What is learned in mathematics is also used in other subjects; building relationships with other subjects is of fundamental importance. Our research took place at the end of 2022, and our test consisted of three groups containing logical tasks: A. measured the interpretation of at most/at least, B. the negation, and C. the conclusion. The tasks were formulated in a mathematical, physical, chemical, or biological context. Students completed the C tasks in the largest proportion, followed by A, and lastly, B. The students completed the "mathematics" exercises in the largest proportion, followed by biology and physics, and lastly, chemistry.

Emőke Báró, Zoltán Kovács, Eszter Kónya: *Students recalling favourite math experience: How does problem-based approach promote mathematical engagement?*

This presentation explores the mathematical engagement of lower secondary students after using problem-based methods for four years. First, we asked students about their favourite math experiences six months after finishing lower secondary school. Then, after coding and analysing students' answers, we concluded that different components of engagement (cognitive, behavioural, and emotional) were present in the students' self-report; moreover, we systematically characterised the factors that trigger engagement. We also examined the co-occurrences of the reported motifs, explored the tightest relationships, and discussed a possible

explanation for why an interpersonal relationship is connected to every engagement component.

Ildikó Bereczki, Csaba Csíkos: *Two more or twice as much?*

The presence of proportional reasoning determines students' school performance not only in mathematics but in other areas as well, and also plays an important role in everyday life. The emergence and development of proportional reasoning are influenced by many factors, including the recognition of multiplicative relationships. In our research, we examined proportional reasoning by means of interviews with 5th-, 6th-, and 7th-grade students. During the interview, together with solving proportional problems, the students solved open-ended problems that gave insight into their additive and multiplicative reasoning. Our data and results can bring us closer to understanding the important prerequisites of proportional reasoning.

Csaba Biró, Csilla Prantner, Ferenc Koczka: *Quantum informatics in grades 5-8 of primary school?*

The emergence of quantum informatics in IT curricula is inevitable. We think that education and teachers must keep up with technological progress so that it does not surprise students who will be employed in the IT sector in the future, regardless of whether it is a training for IT teachers, physicists, or programmers. In our presentation, we will first present the state of the education systems of countries where knowledge in this area has already appeared at some level or is in the preparation/introduction phase. We present some of the practices we consider good from the international scene, as well as our own ideas about how, in what depth and form, certain topics of quantum informatics can be integrated into the curricula at different levels of education.

Csaba Czeglédi: *Examination of problem-posing with different methods in given topics in the vocational training*

In our research, we investigated the problem-posing and problem-solving abilities of ninth-grade students in a vocational school and a high school. The experiment allowed students to use two different problem-posing strategies: the problem variation method and the thematic problem-posing method for a given mathematical topic. The problems were corrected and evaluated according to a complex set of criteria. Both groups worked on problem-posing for 3 weeks. The problems posed in the vocational school were compared with problems prepared by elite high school students.

Zsófia Csepely: *Developing mathematical skills via board games*

Recent research in cognitive neuroscience has shown that the prefrontal cortex and the parietal lobe are responsible for formal thinking and geometric reasoning. These areas are developed between the age of 12 and 24. These can be improved through proper board games similar to formal education. We have investigated the potential of board games in classrooms to develop the formal logic and geometric reasoning of students who have played board games for one mathematics class a week instead of the usual curriculum.

Zoltán Csernai: *Methodological application of computational thinking in courses at ranked universities*

Computational thinking (CT) is one of the skills related to STEM education (Weintrop et al., 2016), and consists of "solving problems, designing systems, and understanding human behaviour, by drawing on the concepts fundamental to computer science" (Wing, 2006, p. 33). In my presentation, I will examine course descriptions from internationally ranked universities (QS, THE) to explore how the conceptual framework of computational thinking is represented and what tools and methods are used in practice. Based on my research, I plan to develop an e-learning material for teachers in upper primary schools, based on which an e-learning material will be created.

Zsuzsa Dárdai, PUNTE team: *Poly-Universe + PUNTE Good Practices workshop*

Poly-Universe has given birth to the PUSE (Poly-Universe in School Education) teaching methodology in recent years. The novelty of the tool lies in the scale-changing symmetry of the shapes and the colour combination system assigned to them. Its strength is mathematics, but it can also be used in a wide range of educational contexts; it is incredibly simple and yet complex: more than play, more than art, more than mathematics, synergies in education... The Erasmus+PUNTE project is currently being coordinated by Eszterházy Károly Catholic University and focuses on the STEAM (science and art) approach of the tool and teacher training. During the workshop, in addition to the game, we will share our interdisciplinary collection of exercises with the interested audience: https://www.punte.eu

György Emese: *Hypothesis testing in high school educational experiment – through the eyes of a high school teacher*

This school year, I participated in a research project with university lecturers, and primary and secondary school teachers, supported by the Hungarian Academy

of Sciences (Vancsó, 2022; Vancsó, 2016-2021). The purpose of this part of the project is to examine whether hypothesis testing can be taught in Grades 11-12 and can be included in the advanced graduation requirements. In my presentation, I will talk about the project, 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 used our teaching experience in the project.

Ágnes Feczkó, Rebecca Prins: *Gamification in an adaptive manner*

The concept of gamification was born in the early 2000s, and its essence has been formulated since the 2010s. In the last few years, it has been used more and more frequently in education as well. Gamification requires flexibility on the part of teachers; fixed systems often do not work. In our presentation, we show a vocational school and a high school experiment with two different gamification systems.

Linda Devi Fitriana: *A promising path toward infinite improvement in mathematics teaching and learning*

A mathematically challenging and social interaction-rich learning environment was implemented with six Indonesian teacher trainees to increase student engagement in active learning principles. A vital component of the intervention was problem-posing, extended by implementing their problems in real-life teaching situations and reflecting on their teaching. The entire procedure is based on continuous peer feedback and control. The intervention and the experiences gained during its implementation will be presented. *Keywords*: active learning, problem posing, teacher trainee, teaching implementation, teaching reflection

Zsolt Fülöp: *From numerical computations to structural thinking – a functional approach to algebra*

Our main aim is to illustrate the advantages of the functional approach in introductory algebra teaching activities. It is obvious that the transition from arithmetic to algebra involves a shift from procedural thinking to structural thinking. In order to succeed in algebra, pupils have to break away from arithmetical conventions and adopt an algebraic way of thinking. In our attempts, we have adopted teaching strategies based on numerical procedures and a functional approach to algebra which could smooth this transition. Using this approach, we implemented an introductory algebra course in two grade-7 classes. In order to investigate the main aspects of the functional approach, we analysed the pupils' answers and compared our findings with other previous research work.

Evelin Anna Geszler: *Benefits of digital assessment*

As part of my doctoral training, I am addressing questions related to the digitalization of the final exam of Mathematics. Given the impact of the medium on performance, our goal is to reach a high level of digitalization, where the use of digital devices provides a significant advantage. A 3D modeling program can pave the way for students who were previously disadvantaged by the lack of proper spatial perception to solve 3D geometry tasks, as the ability to explore and animate objects can ensure a completely different experience for them. Moreover, transferring manual calculations to a device can also reduce cognitive load. Due to a lack of time, self-monitoring and reflection are often pushed to the background in class, but digital tools can come up with a solution for this too.

Miklós Hoffmann: *Representation of Microeconomics problems with Poly-Universe*

The Poly-Universe educational tool was originally inspired by mathematics and art. However, in recent years it has become clear that the tool is more universal than this; that is, it can be used and deployed in other areas of education as well. In this presentation, we use the Poly-Universe tool to represent problems of microeconomics, showing that the tool can be widely used in secondary school and even in higher education beyond mathematics and art education.

Szilvia Homolya, Erika Rozgonyi: *The possible effect of the modified mathematics graduation requirements according to NAT 2020 on university education*

In connection with the modified basic curriculum introduced in 2020, new requirements will come into force for the school leaving exams, so also in the case of the mathematics exams. The changes will have an effect on university education, as topics will be left out of the secondary school curriculum that the mathematics subjects of BSc courses belonging to the field of engineering, IT, and economics were previously based on. In the new admission system, the majority of higher education institutions do not require the completion of the advanced-level school leaving exam; hence the focus of our investigation is primarily on the intermediate-level exam requirements. In addition to the comparison, we discuss what kind of intervention may be necessary for university mathematics education.

Enikő Jakab: *Further to be done in the development of mathematical competence*

During my research on the development of mathematical competencies with ICT tools, I was looking for tools and methods that are available in mathematics education in Transcarpathian schools and that can improve the efficiency of the

mathematics learning and teaching process. While researching the usability of ICT tools, I came across the retrieval-enhanced learning method. Related to current research in Hungary, I examined the applicability of ICT and retrieval-enhanced learning methods in parallel and their impact on mathematics learning. My experiences with both of the examined teaching methods are positive. My goal is to use the two methods together, which create good practice and provide a solution for teaching mathematics that meets new needs.

Antal Joós: *Teaching mathematics to vocational students*

After teaching mathematics at the university, I would like to share my recent teaching experience in vocational classes in vocational schools in Dunaújváros. I teach 9th- and 13th-grade students. The students come from the outskirts and peripheral areas of Dunaújváros.

Sándor Kántor: *A vision of future mathematics education*

I only deal with one aspect of mathematics education: what we will or will not teach in the future. I present some examples of changes in the 20th century. Changing the educational material is determined by the needs of the next educational stage and the needs of everyday life, and only to a small extent by the needs of general education. Thanks to the use of computers, the teaching of definitions, theorems, connections between curriculum parts, and areas of use will be more detailed and precise, increasing proportionately at the expense of the teaching of proofs.

Sándorné Kántor: *How does the subject of humans and their environment appear in mathematics lessons?*

In the 21st century, the human environment is divided into three parts. The life of the rising generation must be in harmony with this so that it preserves the values of the natural and historical environment, does not destroy everything with human activity, and does not cause fatal, irreversible damage to technical development. We consider it important to educate and prepare children in an environmentally conscious manner. We look back at the famous mathematics textbooks of the 16-19th centuries, and then we examine NAT 2020's ideas about the human environment and their implementation in the brand-new textbooks for grades 5-7 and 9-11 (Physics 7 – 8 (OH - FIZ78TA), Mathematics 5 – 7 (OH MAT 05TA - OH MAT 06TA - OH MAT 07TA, OH MAT 05TB - OH MAT 06TB - OH MAT 07TB), Mathematics 9 – 11 (OH MAT 09TA - OH MAT10TA - OH MAT 11TA, OH MAT 09TB - OH MAT10TB - OH MAT11TB), Technology and Design textbook 6 module B (OH TET06A/B). We mention the 1st and 2nd-grade

Mathematics and Environment textbooks (Hungarian) used in the lower schools of Romania. *Keywords*: old and new mathematics textbooks, human environment, environmental awareness.

Gergely Kardos, Zoltán Matos: *Outcomes of a cross-curricular experiment in teaching mathematics*

As secondary school teachers, we frequently experience that students are unable to apply the knowledge they have gained in one subject to other subjects or that the occurrence of multiple areas of mathematics in a single task can pose a challenge for them. In order to address this issue, we conducted an experiment with students from a specialized physics class who often struggled with this issue. In every physics class, we assigned homework that required the use of mathematical tools, and in every math class, homework that needed the use of tools from two separate mathematical domains. Our investigation evaluates the impact over a period of one month.

Pál Katonka: *Skills test results and their relation to previous measurements*

In my presentation, I will examine the mathematics achievement of 10th-grade students in a rural high school based on the following measures: 8th-grade entrance exam, 9th-grade diagnostic test, 8th-grade competency test, and 10th-grade competency test. I will analyse the resolution of tasks related to specific content areas and thinking operations of the competency assessment. On this basis, I will select the types of tasks that were solved most correctly and those that were solved least correctly. I also compare the results in terms of training profile.

Márton Kiss: *What is the experience of the looking back phase of Pólya's model with 9th-grade students?*

An important moment in the process of mathematical problem solving is the Looking Back phase, i.e., phase 4, described by Pólya's model. We analysed the work of a group of 9th-grade students in terms of how they implemented the aforementioned reflection when instructed to do so in a written task sheet during independent work. Our aim is to investigate how 9th-grade groups evaluate and control their problem-solving activities. The groups had no prior preparation, and the problem sheet was unexpected, but the problem itself did not require significant subject knowledge from the students.

Judit Kovács, Zoltán Kovács, Gabriella Ambrus, Eszter Kónya: *Facilitators, engagement and results of learning mathematics in the narratives of first-year primary teacher students*

Efficient learning of maths is highly dependent on engagement to be supported by teachers. Giving feedback has proved to be a factor of high importance in former studies. In our project, we targeted to screen a wide range of supportive factors. We asked first-year students from elementary teacher training schools to recall and write down a memorable earlier positive experience regarding learning maths and to characterize their teachers of the recalled time on scales. The content analysis of memories showed supportive teacher behaviour to be related to engagement in general and cognitive engagement to be related to academic success. Students who gave more positive evaluations on the scales recalled more memories about their teachers and shared more detailed and vivid memories.

Attila Körei, Szilvia Szilágyi: *Visualisation and representation of cycloid curves by LEGO robots*

In geometry, a cycloid is a plane curve traced by a fixed point on the radius of a given circle or on an extension of the radius if the circle rolls along a straight line without slipping. Because of their practical importance, the visualisation and representation of these curves are worth discussing in detail in higher technical education. Educational robotics provides the opportunity to make cycloids visible using a light source mounted on the wheel of a LEGO robot. In our presentation, we show the results of such an experiment, where not only cusped and curtate but also prolate cycloids were visualized. Then we show two different LEGO robots of our own design, each capable of drawing all three types of cycloids.

Lilla Korenova: *Digital technologies from the perspective of the COVID-19 pandemic*

The need to improve mathematics teaching using digital technologies has been addressed for more than 30 years. We educators and researchers felt that this topic was moving in the right direction for a while. The need for online education during the COVID-19 pandemic has shown how prepared or unprepared we are for the full use of digital technologies from primary school to university. In my lecture, I want to point out the technological, pedagogical, and didactic aspects of e-learning in mathematics education based on my own experience and international research published recently.

Gábor Kusper: *The role of abstraction levels in teaching of programming*

A program meeting the same requirement can be written in many different ways, either in one huge class or broken into many very short classes. Among the possible solutions, we look for the optimal one: the source code that is easiest to understand, improve, and reuse. In this sea, we need lighthouses that answer the question of how to program. These are the principles of programming, which are located at different levels of abstraction. At the lowest level, there are restrictions on syntax, e.g., do not use the goto statement. Next is the level of OOP principles, design patterns, and then design principles. Finally, there are hard-to-grasp concepts like clean code. In this article, we elaborate on our related educational experiences.

Orsolya Dóra Lócska: *Rethinking the bridging function of graphical representation in the arithmetic-algebra transition: the issue of strategy choice*

The presentation focuses on the joint research of Zoltán Kovács, Zoltán Kondé and Orsolya Dóra Lócska. The presentation will explore the factors that influence students' choice of the graphical solution when solving word problems on the topic of "work and timer". The research examines the independent problem-solving activities of 75 Hungarian eighth-grade students in terms of the type of representation they use and the effectiveness of their problem solving. Observations were carried out in five classes with four teachers. The results show that almost half of the students have adequate graphical representation skills in the type of problem under study. At the same time, flexible and adaptive choices between representations are influenced by their own self-regulation skills and by the teacher's methods.

Szende-Barbara Majoros, Enikő Nagy: *How do we plan? How to plan!*

In Romania, the structure of the 2022-2023 academic year has changed; it is no longer divided into two semesters but into five units. Despite the changes, at the end of the eighth grade, the students continue to participate in a national exam in mathematics. We set ourselves the goal to organize similar exams, which are based on the samples that are published by the Ministry of Education. We are preparing a collection of exercises for high school classes, which tries to make competency-based education conscious for math teachers. The other work that we would like to present is the methodology of how we have tested the eighth-grade students so far, a possible implementation of how, as a teacher, you can consciously help students prepare for the national assessment.

Carolina Martins, Vanda Santos, Sandra P. Ferreira, Teresa B. Neto: *Task design with Poly-Universe: a STEAM approach*

When talking about education today, it is almost impossible not to mention teaching materials as promoters of student learning. The didactic materials, on the one hand, play a ludic role and, on the other hand, have a dynamic function in the understanding of concepts. The present study intends to investigate the contribution of didactic materials, namely Poly-Universe, to the learning of concepts in the 4th and the 7th years (in the subject of mathematics) from an interdisciplinary perspective. In order to achieve the objective, it is intended to answer the question about the role played by the Poly-Universe material in student learning. The research team designed tasks with Poly-Universe and carried out a pilot study to reformulate the strategies to be implemented in the classroom.

Anna Muzsnay, Csaba Szabó: *The effect of retrieval practice on conceptual knowledge in learning polynomials*

To teach mathematics effectively, mathematics teachers need to acquire deep mathematical knowledge that can be applied in the long term and integrated into the teaching process. A possible tool to increase further retention is retrieval practice, the strategic use of retrieval to enhance memory. In this study, we investigated the effect of retrieval practice in an authentic educational setting. We examined the potential benefit of retrieval practice in learning polynomials at the university level, focusing on the conceptual knowledge of pre-service mathematics teacher students.

Péter Négyesi: *The impact of an interdisciplinary, tool-based course on the motivation of teacher training students*

Adaptive teaching methods are pioneers in mathematics education today. My presentation will provide a literature review of adaptive methods currently used in teaching number theory in secondary schools. In particular, computer-based adaptive assessment and instruction have been shown to be an effective method for students struggling with number theory concepts. Through learning models, teachers can better understand students' strengths and weaknesses, and tailor instruction to their individual needs; and gamification in e-learning systems has been shown to increase motivation and engagement. In sum, adaptive methods have the potential to transform the way number theory is taught and improve student outcomes in this important area of mathematics.

Oláh-Gál Róbert: *Selections from the Bolyais' mathematical manuscripts, Bolyai summation, For children about the Bolyais – Description of my latest books and their methodological and didactic background*

The focus of my presentation is János Bolyai. The year 2023 was declared by UNESCO as the Bolyai Memorial Year because the letter written by János Bolyai to his father was dated November 3, 1823, in Timişoara, with the lines that have become a catchphrase: "I created a new, different world from nothing." What do we know about this new, different world? What do we know about János Bolyai's mathematical work? Unfortunately, the public knows very little. In fact, even the experts know very little about the two Bolyais. In the background of my presentation, I would like to introduce my three most recent books written about the Bolyai people, the purpose of which is precisely to sharpen and clarify our vague image of them. Of course, I will cover the activities of the two Bolyais, which we can use in our methodological and educational activities.

Ilona Oláhné Téglási, Zoltán Kovács: *The impact of an interdisciplinary, tool-based course on the motivation of teacher training students*

At the international level, there is a growing emphasis on interdisciplinary approaches in public education. Therefore, we believe that it is essential that this tendency is reflected in teacher education. In our lecture, we give an example of this with the introduction of a tool-based methodological course developed for international cooperation and its analysis. In our research, we examine the impact of the courses developed during the academic year 2021/22 and tested in several partner institutions on the motivation of students. The courses were attended by students studying in various areas of teacher training on a scale ranging from a kindergarten teacher, special education teacher training to secondary school teacher training. After presenting the objectives, the structure of the course, and the activities of the students, we would like to present the analysis of the feedback from the motivation questionnaires and the conclusions that can be drawn from it.

Enikő Palencsár, Szilvia Szilágyi: *Integrating game-based learning in the field of numerical series*

Infinite series and improper integrals play a major role in numerous scientific fields, including engineering, informatics, and economics. However, past experience indicates that many university students have serious problems when it comes to understanding the aforementioned topics in their Calculus classes. Game-based learning offers a relatively stress-free, rewarding way of engaging students in topics they would otherwise be disinterested in. Consequently, my research is centered

around developing a cooperative board game that gives students an intuition on how to use a comparison test to determine convergence. My aim is to help students get a solid grasp on the concept of infinity by familiarizing them with the topic of infinite series and improper integrals.

Ioannis Papadopoulos: *Mental argumentation and the use of structure in problem solving*

Mental argumentation, in the context of problem solving, is considered as property-based thinking, developed exclusively in the mind, aiming to find the solution to a given problem without the use of paper-and-pencil or any form of writing. It is a topic of interest because it works contrary to the common image that mathematics is nothing more than the manipulation of symbols created in an automatic way without any underlying meaning. Figuring out a problem mentally indicates that its content makes sense to the individual in one or another way. Therefore, mental processing of mathematical tasks can be considered as a signal of sense-making in mathematics. In this sense, mental argumentation highlights the power of seeing as a strategy of thought which combines the visual perception of mathematical objects with existing knowledge and past experiences. Indeed, to a great extent (without being limited to this), mental argumentation involves considering the problem situation in terms of a whole and is strongly linked to the solver's ability to see and use the underlying structure of the problem. Although most teachers recognize the importance of mental argumentation, they are unsure about its exact nature as well as when, where, and how it can be effectively implemented. To demonstrate how mental argumentation can support problem-solving, I will use the topic of 'equation' as my first example. Solving an equation might be a problem for students who do not possess the necessary algorithm. Mental argumentation, based on seeing and using the equation's structure, can help them get the solution. Then, a small collection of problems will be presented and discussed to demonstrate how mental argumentation can facilitate problem-solving in at least three different ways.

Gabriella Papp: *E-tests as motivational opportunities in mathematics classes*

We can read in many studies what techniques are used in the educational process to deepen knowledge and what can motivate students to learn. In the spring semester of the 2021/2022 school year, we carried out action research within the framework of a course, where we examined how much it motivates students if they write an e-test as a retrospective in order to deepen the material of the lesson. The selected course was 20 hours. During the research, the students wrote

one input, 6 motivational, and one output e-tests. At the conference, we will present the results of the action research and the experiences we have gained, as well as the students' opinions regarding the motivating effect of the tests.

Erika Perge, Tibor Guzsvinrecz: *Tests to assess spatial ability in the education of engineering students*

Improving spatial ability is an important part of various subjects in elementary school, high school, and college-level education. Moreover, a number of professional courses also exist with the same goal. Tests to measure different aspects of spatial ability are based on traditional paper-based or modern digital methods. I hereby present a few such tests used by instructors educating students of engineering at the Faculty of Engineering, University of Debrecen.

Marianna Pintér: *Using bedtime math stories for kindergarten math sessions to make math education fun and engaging for kindergarteners*

Preparing for the planned mathematics sessions often causes anxiety for practicing kindergarten teachers. One of the reasons for this is that they are uncertain how they could enable activity-based knowledge acquisition for children in the areas defined in the ONOAP, taking into account age and individual characteristics, so that they do not transfer knowledge but accustom children to action and thought activities. Laura Overdeck's *Bedtime Math* series of books can provide you with ideas for this. The problems and puzzles in the books are designed to be fun and challenging and encourage children to think critically and creatively about math. In my presentation, I will show some examples of this by presenting each actual part of the book and the corresponding draft sessions.

Ildikó Pomuczné Nagy: *Content and teaching of the topic of number theory in the 11th grade of high school*

Considering content and teaching of the topic of number theory in the 11th grade of high school, NAT 2020 dedicates an entire chapter to the topic of number theory in the 11th grade of the high school curriculum. Number theory is also the topic of chapter IV of the centrally published textbook, which contains 12 lessons. This is considered a novelty compared to the previous 11th-grade teaching materials that date back several decades. In my presentation, I will present the course material included in the centrally published textbook, and I would also like to touch on the antecedents of the topic in the lower grades. I highlight the knowledge and problem-solving methods that are new in the new curriculum and look back at older curricula from the point of view of teaching number theory.

In my presentation, I would like to introduce the documentation created in my mathematics lessons for the 11th-grade group I am currently teaching.

Csilla Prantner, Zoltán Csernai, Réka Racsko: *Collaborative learning spaces supported by VR/AR technology*

Collaborative learning spaces have significantly influenced our thinking about learning and teaching. Sharing content, collaboratively evaluating and/or annotating it, and collaboratively creating new products are part of our everyday lives. We are interested in how the learning process and method are affected when collaborative spaces are rendered in 3D. In our lecture, we will discuss the pedagogical use of virtual and augmented reality, and give an overview of the areas in which they are used in teaching-learning. We will also present where VR/AR technology is being researched, where teaching aids are available on the subject, and what hardware tools are currently available on the market.

Dóra Fruzsina Sipos: *Presenting a method for increasing the effectiveness of technical mathematics education*

In the field of engineering education, the experiences gained by us show that the traditional method of processing the mathematics curriculum – frontal presentation of the theoretical knowledge written on a blackboard or projected, then the solution of the related mathematical problems in the exercises presented by the instructor or together with the students – is not motivating for the majority of students, so the absorption of new knowledge is not so successful. We prepared a task database that contains tasks of different categories (of different wording and difficulty levels) using the mathematical tools they had learned. The aim is to develop mathematical and professional intelligence parallelly by improving the ability to create models and by showing connections to professional topics.

Stankov Gordana: *Games and inclusion with Poly-Universe*

Using Poliuniversum sets in games where students with disabilities can participate equally with their peers.

Eleonóra Stettner: *How can colors and proportions become music?*

It is well known that each colour has a numerical code (HEX, RGB, CMYK). Based on the 4 colours of the Poly-Universe and the ratio of colours, we can assign a single number to each element. When this number is mapped to the range of audible sounds, the elements sound like a small key. With the triangle elements in GeoGebra, you can play the Poly-Universe scale. Later we can also set some of the patterns to music.

Attila József Szabó: *The motion picture as a tool for motivation and knowledge transfer in mathematics teaching*

The focus of this study is the analysis of educational videos with mathematical content appropriate for high school students. I try to answer the question: are there open-access, high-production quality videos that can increase the efficiency of mathematics learning? From a technical aspect, I examined the structure of the videos, the visual presentation, and the camera work. From a didactic viewpoint, I inspected the use of visual elements, the narration, the problem presentation methods, and the nature of knowledge transfer. I also looked for elements suitable for motivating students. I evaluated 19 videos. It can be concluded that there are videos that can be used in education, and the set of criteria used in the study can be suitable for evaluating the usability of educational materials.

János Szász Saxon, Kristóf Fenyvesi: *Development of STEAM educational tools based on the creative reinterpretation of the Poly-Universe math and art system*

This presentation will focus on the STEAM tools created by Saxon as a further development of the mathematical-artistic system of the Poly-Universe, and will also give an insight into the details of the creation process. The project provided a number of pedagogical lessons, as the product design challenge included many of the same elements that teachers may face when preparing to use a new transdisciplinary tool, either in the classroom or in an informal context. In these cases, similar to the objectives of the product design course, there may be a pedagogical need for further creative thinking about the individual artifacts, development of their play mechanisms, site/user-specific extension, application, product redesign (development), and further multimedia concepts.

Janka Szeibert, Csilla Zámbó: *Developing students' mathematical thinking via number theory problems*

Number theory is an area of mathematics where we find the most diverse ideas and the most varied types of problems possible – from simple classroom problems to Olympic competition problems. We designed an experiment that links the learning of number theory and solving number theory problems with general mathematical problem-solving skills. Grade 7 and grade 8 students participated in the experiment. The students in the experimental group were given a number theory task at the beginning of each lesson, while the students in the control group were given a task related to the regular curriculum. The effectiveness

of the experiment was tested by regular curriculum assessments and by leveled assessments in which number theory was not included.

Gusztáv Áron Sziki, Éva Ádámkó: *Teaching Engineering Informatics through technical and natural science problems*

At the Faculty of Engineering, University of Debrecen, we decided to build problems selected from the field of engineering and natural sciences into the curriculum of Engineering Informatics 1-2. The aim of the methodological development is that the students acquire the skills included in the above subjects through problems chosen from the study materials of professional subjects like Engineering Physics and Technical Mechanics. In this way, they practice not only the solution methods applied in the given but also in the professional subjects and understand the role of modern IT knowledge and tools in technical life. In this presentation, we introduce the physics problems processed within the Engineering Informatics 1 subject, supplemented with the related methodological considerations.

Tibor Tajti: *Generating exercises for teaching programming*

When teaching algorithms and programming, we need tasks that are interesting and playful for students so that they are motivated to invest the time and energy needed to solve them. The production of class assignments, homework, and essay problems is time-consuming and can be reduced by using a task generator. In my presentation, I will show some examples of how to generate tasks of different complexity from a program for students. In doing so, the aim was also to be able to produce multiple versions of tasks of the same difficulty in order to make copying from one to another more difficult.

Anna Mária Takács: *Comparison of digital and traditional accounting for a specific set of maths problems*

Our business students used to take their exams in the traditional way, but during the pandemic, we had to go digital. The latter was the more suitable of the two study frameworks available, Coospace and Moodle. Last year, we returned to paper-based reporting. In my previous job, I had the opportunity to try the MAPLE TA web-based test and exam system, and this academic year BGE PSZK bought student licenses in the successor system, which is called Möbius. We had our students write their second final examination in a test mode with Möbius. We compare the results obtained in traditional and Möbius in our paper. The results obtained are consistent since the solutions are entered in Möbius as if they were written on paper. The work of the tutors is facilitated by the fact that the analysis and feedback of the solutions entered are done digitally.

Tompos Anna: *Developing a geometric perspective through playing board games in a vocational school*

In our presentation, we will present an experiment conducted in two tenth-grade classes at Than Károly Eco School and Technology in Budapest. The research examined whether logical thinking and geometric approach can be developed by playing board games. During the examined period, one class spent one mathematics lesson per week playing board games (the experimental group), while all the lessons of the other group took place in a traditional manner (the control group). During the experiment, we investigated how the attitude of the students in the experimental group towards mathematics and their geometrical, logical abilities changed compared to those of the control group. We were also interested in whether their class performance worsened due to having one less traditional math class.

Adrienn Vámosiné Varga: *About online teaching experience*

In the last few years, the epidemic situation has posed challenges for both teachers and students. In the presentation, we analyse student outcomes and summarize the advantages and disadvantages of online education.

Maria da Piedade Vaz Rebelo, Maria Graça Bidarra: *Motivation and engagement in achievement contexts*

Many students express beliefs and expectations of controlling outcomes that are identified with debilitating or low motivation patterns for success, namely in mathematics, saying that mathematics is difficult and they frequently experience anxiety when learning it. They often attribute their failure to a lack of ability or the subject's difficulty, generalizing an impotence response to a subject that they could otherwise learn. This, in turn, results in situations of discouragement or helplessness. Indeed, we can distinguish a set of cognitive-motivational variables, such as causal attributions, outcomes control expectancy, and goal orientation, which are particularly pertinent in the context of learning mathematics. Associated with the study of motivation, the concept of student engagement has come to be seen as crucial to understanding academic performance. From a historical perspective, the roots of interest in engagement are, at least in part, driven by the desire to enhance student learning. It was also noted that the engagement concept had primary a focus on preventing school dropout, evolving to the basis of school interventions to promote students' development in academic but also social, emotional, behavioural domains, considered either as a process or a product.

In this paper, we intend to address these concepts of motivation and engagement, and to identify motivational patterns in achievement contexts.

Ibolya Veress-Bágyi: *Statistics learning environment*

In my presentation, I am looking for an answer to what we mean by a learning environment and what the expected characteristics of a statistics learning environment are in 2023. We examined the presence of the key elements of the Ben-Zvi et al. (2019) statistics learning environment model in statistics classes in economics higher education.

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