9th Illia O. Teplytskyi Workshop on Computer Simulation in Education

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Abstract

This is an introductory text to a collection of selected papers from the 9th Illia O. Teplytskyi Workshop on Computer Simulation in Education (CoSinE 2021), held in Kherson, Ukraine, on the October 1, 2021. The volume presents the contributions to theworkshops affiliated with the ICTERI 2021: the 17th International Conference on ICT in Education, Research, and Industrial Applications.

Keywords

ICTERI 2021, CoSinE 2021

1. CoSinE 2021 as is

CoSinE (**Co**mputer **S**imulation **in** **E**ducation) is a peer-reviewed international workshop focusing on theory and practice of computer simulation in education. This workshop was founded by Illia O. Teplytskyi (1941–2018), whose pioneering works in the field of computer simulation in education inspires us.

CoSinE topics of interest since 2019 [1, 2, 3] are:

- Computer simulation in STEM education

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Figure 1: Illia O. Teplytskyi.

- AI in education
- Educational data mining and learning analytics
- Learning environments models
- Learning virtualization
- Modelling systems in education

This volume represents the proceedings of the 9th Illia O. Teplytskyi Workshop on Computer Simulation in Education (CoSinE 2021), held in Kherson, Ukraine, on the October 1, 2021. It comprises 9 contributed papers [4, 5, 6, 7, 8, 9, 10, 11, 12] that were carefully peer-reviewed and selected from 50 submissions. Each submission was reviewed by at least 3, and on the average 3.1, program committee members. The accepted papers present the state-of-the-art overview of successful cases and provides guidelines for future research.

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3. CoSinE 2021 workshop overview

3.1. Session I: Modelling systems in education. Educational data mining and learning analytics

The objectives of work "Computational modelling of stochastic processes for learning research" [10] by Oleksandr H. Kolgatin (figure 2), Larisa S. Kolgatina and Nadiia S. Ponomareva were to use computer-based statistical modelling for comparison and systematisation of various approaches to non-parametric null hypothesis significance testing. Statistical model for simulation of null hypothesis significance testing has been built for educational purpose. Fisher's angular transformation, Chi-square, Mann-Whitney and Fisher's exact tests were analysed. Appropriate software has been developed and gave authors possibility to suggest new illustrative materials for describing the limitations of analysed tests. Learning researches as the method of understanding inductive statistics have been suggested taking into account that modern personal computers provide acceptable time of the simulations with high precision. The obtained results showed low power of the most popular non-parametric tests for small samples. Students can't analyse the test power at traditional null hypothesis significance testing, because the real differences between samples are unknown. Therefore, it is necessary to change the accents in Ukrainian statistical education, including PhD studies, from using null hypothesis significance testing to statistical modelling as a modern and effective method of proving the scientific hypothesises. This conclusions correlate with observed scientific publications and the recommendation of the American Statistical Association.

This article highlights further research by the authors, begun in [13, 14, 15, 16, 17, 18, 19, 20, 21].

The problems of synchronized curriculum shaping are discussed in the paper "A Petri net-based simulation of synchronized curriculum for IT-specialists' training" [7] by Lyudmyla I. Bilousova and Liudmyla E. Gryzun (figure 3) in the context of the challenges of contemporary

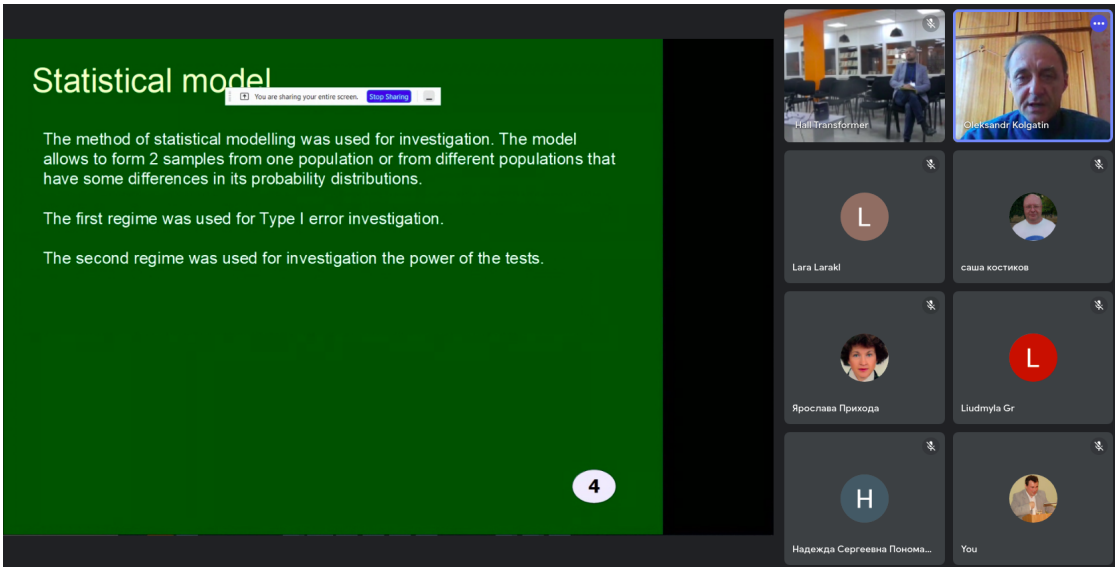

Figure 2: Presentation of paper [10].

IT specialists' training in terms of permanent evolution and rapid expansion of computing. The authors' technique of the curriculum simulation based on Petri net applying is presented. The theoretical framework which allowed us to elaborate the technique includes some didactical fundamentals of curriculum design and academic disciplines structuring as well as the theoretical basics of Petri nets in terms of their significant facilities for different processes synchronization. The technique of academic disciplines structuring based on frame model of knowledge representation is covered as a chain of stages which results in the net of disciplines modules (frames) including the proper learning elements along with preserving and spreading links between them. In order to solve the problem of synchronization of the learning elements mastering throughout the academic disciplines with regard of the established links in the frames, it is offered the practically-driven approach to curriculum modeling based on Petri nets simulation. The different types of the precedence relations for the learning elements (inputs and outputs of the frames) were distinguished. Using these precedence relations, we managed to simulate through Petri nets a learning element itself and the process of its mastering. Using the operations of Petri nets modifications and learning elements' connections of different types, we could obtain a model of a curriculum discipline module and finally – a curriculum discipline model. Built Petri nets models represent all the evolution of the learning elements mastering by students in the curriculum courses. Synchronization of their mastering is guaranteed by the rules of Petri net execution and modifications. The peculiarities of the offered technique are analyzed. The benefits in terms of applying such a simulation to the building of synchronized curriculum for IT-specialists training are formulated. The prospects of the research are outlined in the lines of using the obtained results for special software development.

This article highlights further research by the authors, begun in [22, 23, 24, 25, 26, 27, 28].

In this paper "The algorithm for knowledge assessment based on the Rusch model" [5] by

Figure 3: Presentation of paper [7].

Alexander A. Kostikov (figure 4), Kateryna V. Vlasenko, Iryna V. Lovianova, Sergii V. Volkov and Evgeny O. Avramov the algorithm for adaptive testing of students' knowledge in distance learning and an assessment of its effectiveness in the educational process has been proposed. The paper provides an overview of the results of the application of modern test theory, a description and block diagram of the proposed algorithm and the results of its application in the real educational process. The effectiveness of using this algorithm for the objective assessment of students' knowledge has been experimentally shown.

This article highlights further research by the authors, begun in [29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46].

Figure 4: Presentation of paper [5].

Nowadays, there is a wide variety of scientific articles. Due to this fact, it is hard to read and be familiar with all of them. Also, it is hard for a young scientist to understand the complicated

terms and methods that are used in a specific research domain. This problem was partially solved by bibliographic management software and other specific software. The article “Ontology-based learning environment model of scientific studies” [8] by Roman A. Tarasenko, Stanislav A. Usenko, Yevhenii B. Shapovalov (figure 5), Viktor B. Shapovalov, Adrian Paschke and Iryna M. Savchenko is devoted to the development of an approach for structuration and processing sets of studies using the IT Platform Polyhedron using an ontology-based hierarchical model. In its structure, the ontological graph is complex because it has additional branches from child nodes. The basis of our solution was IMRAD which has been represented in the view of nodes. Those nodes have been connected with specific representations of IMRAD elements. Specific articles have been represented in the view of leaf nodes. That could help to use the taxonomies for the structuration of the articles. Each data block is in the form of separate attributes of the ontological node. The proposed solution allows to obtain structured sets of studies and to separate their characteristics. Thus, the proposed ontology provides the possibility to view all methods, measured parameters, etc. of the studies in a graph node structure and use them to find the studies where they were used.

This article highlights further research by the authors, begun in [47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58].

Figure 5: Presentation of paper [8].

3.2. Session II: Learning virtualization. AI in education

Any person, not even a financier, should be knowledgeable in the field of personal finance management. As a result of the survey, it was concluded that schoolchildren and students should be interested in the study of personal finance, even within other disciplines in the form of separate sections. Successful personal experience and knowledge of the teacher in the field of personal finance is an important component of the effectiveness of the formation of competence of pupils, students, and adults in the field of personal finance. Business simulators come in handy here. That is why Dmytro S. Antoniuk (figure 6), Tetiana A. Vakaliuk, Vladyskav V.

Didkivskyi, Oleksandr Yu. Vizghalov, Oksana V. Oliinyk and Valentyn M. Yanchuk, the authors of article “Using a business simulator with elements of machine learning to develop personal finance management skills” [4] developed a business simulator for the development of personal finance management skills, which was developed in the form of a web service. The main features of this simulator, which are presented in different sections of the simulator, are considered. It is shown what skills of personal finance management are developed using this business simulator. Since this simulator was designed to develop personal finance management skills, an attempt was made to apply machine-learning elements to make this business simulator work even better. The proposed simulator can be used in the future to teach the elements of personal finance management to people who are not sufficiently knowledgeable in the field of such finance. Moreover, the web application can be useful even for school-age children, so the simulator can complement the educational process within the economic courses not only in higher education institutions but also in secondary education institutions of Ukraine.

This article highlights further research by the authors, begun in [59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98].

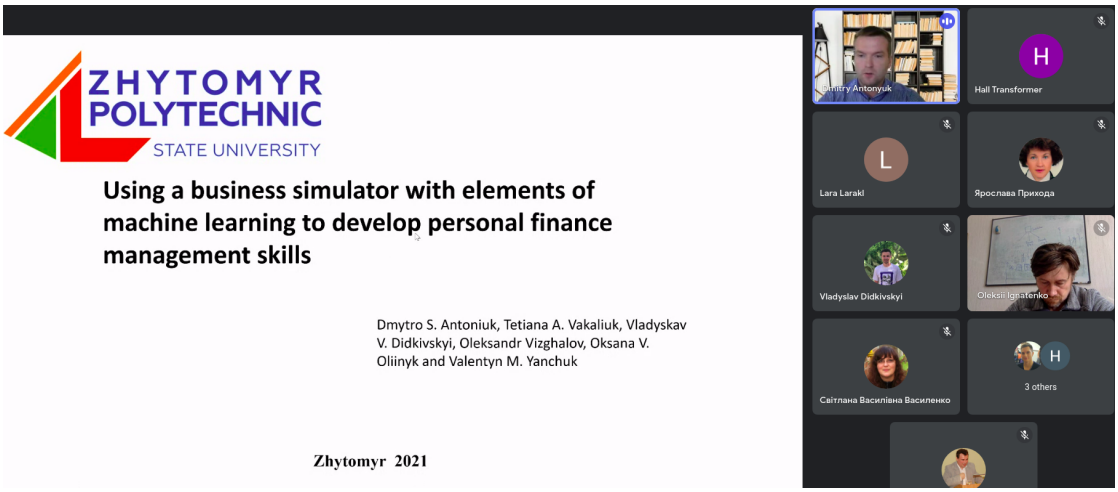

Figure 6: Presentation of paper [4].

The article “Modeling of the internal certification system of educational resources view or update” [6] by Oksana P. Buinytska and Svitlana V. Vasylenko (figure 7) analyzes the research, which was carried out for several years to model the system of internal certification of educational resources for blended and e-learning in Higher education. The authors describe the prerequisites for the internal certification system modeling and the features of recent changes in the process of internal certification of educational resources, approved by the university regulations, which is related to the requirements of the situation with COVID-19. The article describes the current model of the system of internal certification of educational resources, which is based on the approbation of the pilot model of e-learning courses (hereinafter – ELC) certification. The key components of the internal certification system are three mandatory expertise (professional, resource and technical). Based on the results of which, the methodological commission decides

on the quality of educational resources of the ENC and its certification. Expectations from the current system of internal certification of ELC implementation were justified to a high degree, in particular, we have the following advantages of their use: the creation of quality educational resources, expanding access to various categories of participants in the educational process to educational content; ensuring the individualization of the educational process under the needs, characteristics and capabilities of learners; improving the quality and efficiency of the educational process through the use of digital and innovative educational technologies; ensuring systematic monitoring of the quality of education, implementation of blended and e-learning in higher education.

Figure 7: Presentation of paper [6].

Behavioral game theory typically investigate difference between game-theoretic solution and real behavior, one can observe from experiments. The research question, formulated by Oleksii P. Ignatenko (figure 8) in the article "Strategic learning towards equilibrium. Exploratory analysis and models" [12], is how players learn in complex strategic situations which they never faced before. We examine data from different games, played during lectures about game theory and present findings about players progress in strategic learning while competing with other players. We proposed four "pick a number" games, all with similar-looking rules but very different properties. These games were introduced (in the body of scientific popular lectures) to very different groups of listeners. We model and analyse data from the experiments to explain different models of thinking, agent can apply in the games. All data gathered are available in open repository for replication and analysis. Finally, we discuss the findings propose hypothesis to investigate and formulate open questions for future research.

This article highlights further research by the author, begun in [99, 100].

Nowadays computer modeling and simulation widely use in computer science education. There are several ways of increasing the efficiency of educational process. One of the such ways is visualization, other way is flipped classroom concept. The aim of the article "Some ways of increasing the efficiency of teaching data structures" [11] by Zarema S. Seidametova (figure 9)

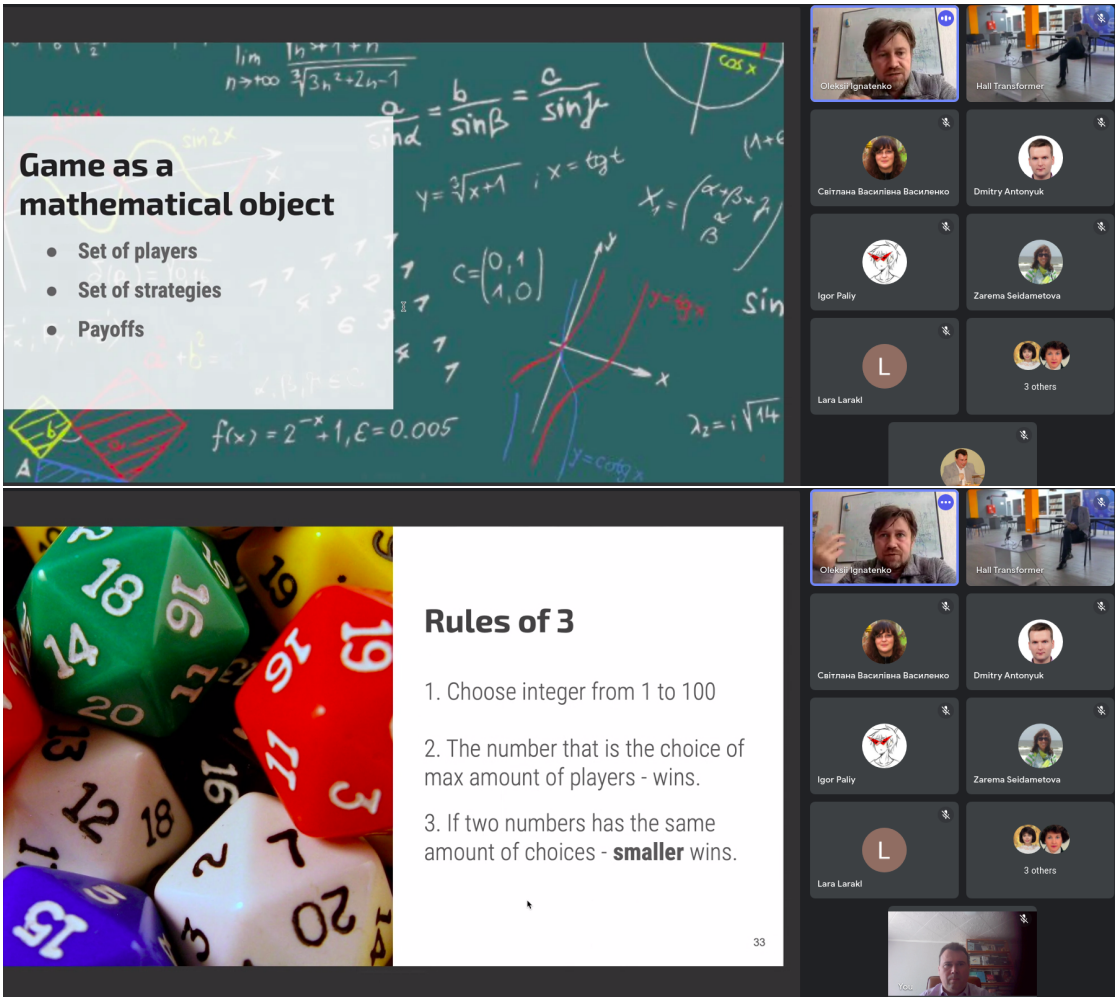

Figure 8: Presentation of paper [12].

is to present some ways of increasing the efficiency of teaching data structures (hashing, trees) during Algorithms and data structures course. Author conducted two experiments with four study groups of two subjects of the Algorithms and Data Structures – (1) Hashing, (2) Trees (BST, RBT, AVL), – taught second year bachelor students. In the first experiment study groups were prepared on the subjects (1) and (2) by the same level of teaching technique with or without visualization tools. Unlike the first experiment, in the second experiment we used flipped classroom concept for one study group and a standard way of teaching for another group.

This article highlights further research by the author, begun in [101, 102, 103, 104, 105].

Currently, augmented reality is one of the most actively developing technologies, which has also found its application in the field of education. Analysis of various publications has confirmed that AR technology opens up new opportunities for teachers and increases the attractiveness of learning for students of different ages. mobile AR apps allow the student to see a real-world environment with overlaid or composite virtual objects. This is especially true for young children.

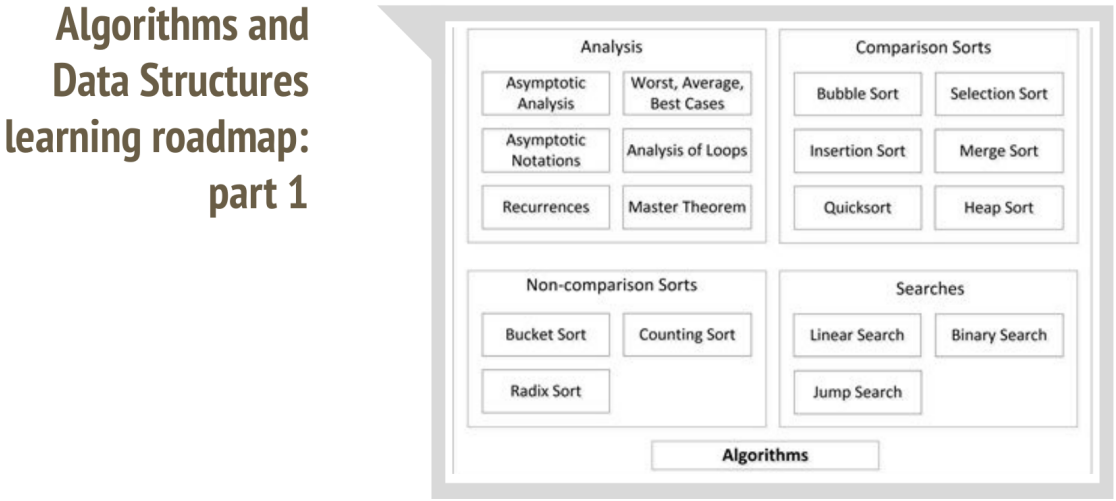

Figure 9: Presentation of paper [11].

The article "Using augmented reality for early literacy" [9] by Olena Ie. Piatykop (figure 10), and Olha I. Pronina, Iryna B. Tymofieieva and Ihor D. Palii identifies the activities that provide a child's personal experience using AR technology. Comparison of existing AR applications for learning the alphabet is given. A new AR application is described, which was developed using Unity, C#, Vuforia. The developed mobile AR application provides an opportunity to study the Ukrainian alphabet, the names of numbers, the sounds of animals. Thanks to this application, the learning process is accompanied by three-dimensional visualization and sounding of each letter and number. An analysis of a survey of teachers and parents showed that when using an AR application, the interest and self-efficacy of children in learning letters and numbers significantly increased. The use of the AR application increased the speed of memorizing the material and helped to retain the child's attention while learning a new material.

This article highlights further research by the authors, begun in [106].

4. CoSinE 2021: Conclusion

CoSinE 2021 workshop at ICTERI 2021 would not have been possible without the support of many people. We would like to thank all the authors who submitted papers to our workshop and thus demonstrated their interest in the research problems within our scope (figure 11). We are also very grateful to the members of our Program Committees for providing timely and thorough reviews and being cooperative in doing additional review work. We would like to thank the local organizers of the conference, the steering committee, and the technical support team for their valuable service and help. Special thanks go to the sponsors of ICTERI 2021 whose financial and technical contributions enabled the materialization of this instance of the conference and its sub-events. All these people, their devotion, energy, and efficiency, made our workshop a very interesting and effective scientific forum.

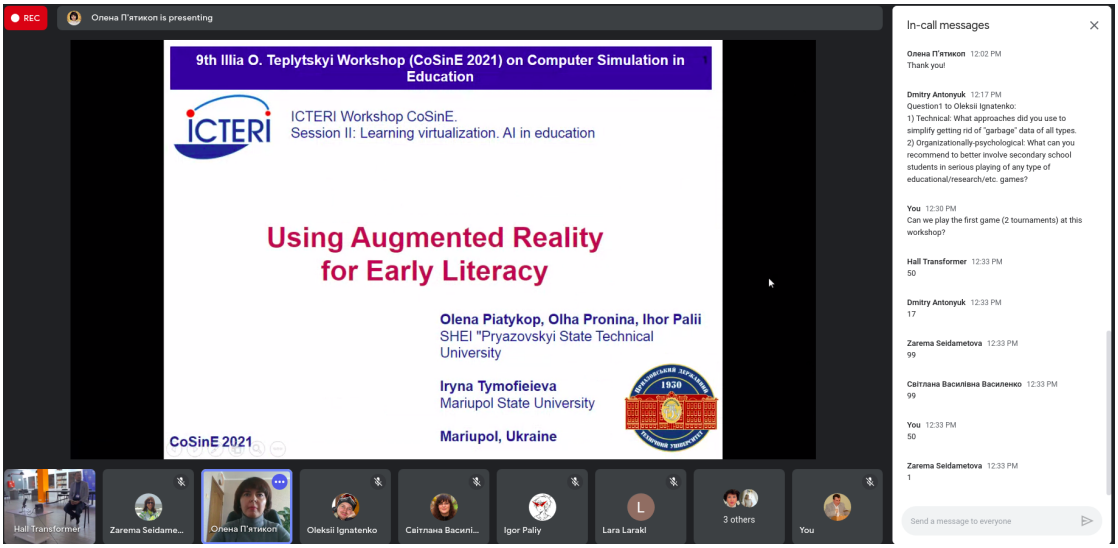

Figure 10: Presentation of paper [9].

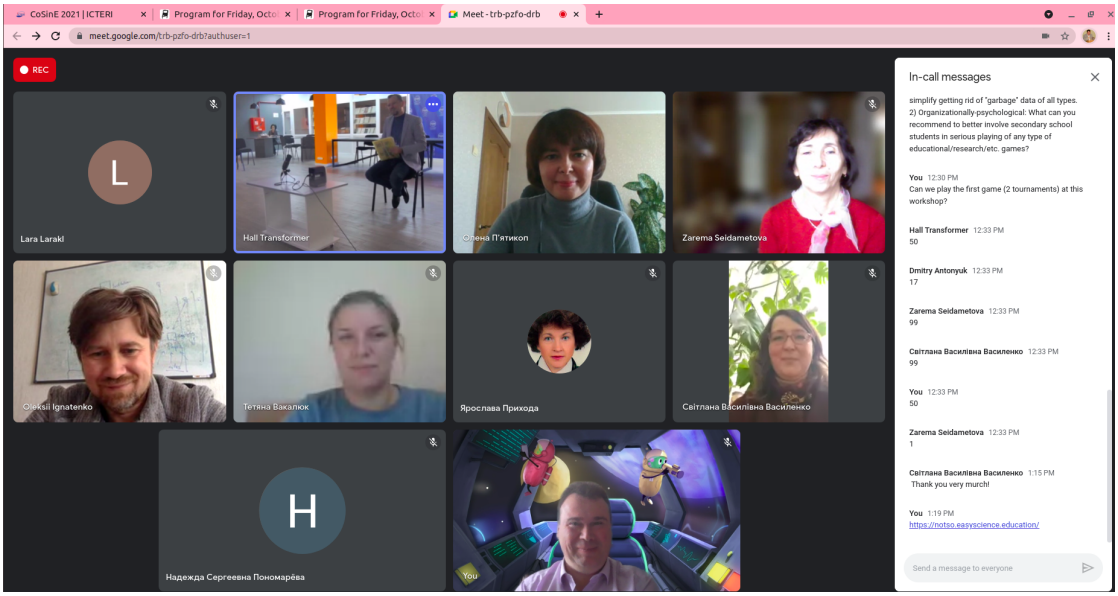

Figure 11: Blended workshop in pandemic times.

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