

From cloud computing to quantum informatics: Advances in educational technology at CoSinE 2024

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Abstract

The 11th Illia O. Teplytskyi Workshop on Computer Simulation in Education (CoSinE 2024) brought together researchers exploring innovative applications of computer technologies in education. This paper presents an overview of the workshop's proceedings, comprising 10 peer-reviewed papers selected from 12 submissions. The contributions span diverse areas including cloud-based learning technologies, statistical education, quantum informatics, augmented reality, and digital linguistics. Notable themes include the integration of practical tools like R programming and GeoGebra, innovative approaches to STEM education, and the application of emerging technologies in teacher preparation. The workshop's hybrid format, hosted in Kryvyi Rih, Ukraine, facilitated global participation despite ongoing regional challenges, maintaining its tradition of fostering international collaboration in educational technology research.

Keywords

computer simulation, educational technology, STEM education, cloud computing, augmented reality, educational data mining, learning analytics, virtual learning environments, teacher education, quantum informatics

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1. Introduction

CoSinE (Computer Simulation in Education) is a peer-reviewed international workshop focusing on theory and practice of computer simulation in education.

The 11th Illia O. Teplytskyi Workshop on Computer Simulation in Education (CoSinE 2024) was a highly anticipated event that brings together researchers, educators, and practitioners from various fields to explore the latest advances and applications of computer technologies in education. Co-located with the XVI International Conference on Mathematics, Science and Technology Education (IconMaSTEd 2024), CoSinE 2024 will take place on May 15, 2024, in Kryvyi Rih, Ukraine, in a hybrid mode accommodating both in-person and online participants.

The workshop is named after Illia O. Teplytskyi (1941–2018), a pioneering figure in the field of computer simulation in education [1], whose groundbreaking work has inspired and shaped the focus of this annual gathering. CoSinE has a rich history dating back to 2005, with previous editions held at prestigious institutions such as Kryvyi Rih State Pedagogical University, National Metallurgical Academy of Ukraine, Kryvyi Rih National University, Kherson State University, V.N. Karazin Kharkiv National University, and the Institute for Digitalisation of Education of the NAES of Ukraine.

One of the key aspects that sets CoSinE apart is its strong emphasis on real-world applications of computer simulation in education. The workshop encourages contributors to demonstrate the practical utility and impact of their proposed solutions, whether through case studies, experimental studies with usable learning applications, or surveys revealing new modeling tools in educational research and practice. This focus on tangible outcomes ensures that the insights and methodologies shared at CoSinE have the potential to directly enhance teaching and learning practices across various disciplines.

CoSinE topics of interest since 2019 [2, 3, 4, 5, 6] are:

- Computer simulation in STEM education
- 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 11th Illia O. Teplytskyi Workshop on Computer Simulation in Education (CoSinE 2024), held in Kryvyi Rih, Ukraine, on May 15, 2024. It comprises 10 contributed papers that were carefully peer-reviewed and selected from 12 submissions. Each submission was reviewed by 3 program committee members. The accepted papers present the state-of-the-art overview of successful cases and provides guidelines for future research.

2. Program committee

2.1. Program committee co-chairs

- *Arnold Kiv*, Ben-Gurion University of the Negev, Israel & South Ukrainian National Pedagogical University named after K. D. Ushynsky, Ukraine [7]
- *Serhiy Semerikov*, Kryvyi Rih State Pedagogical University, Ukraine [8]
- *Andrii Striuk*, Kryvyi Rih National University, Ukraine [9]



Figure 1: CoSinE logo.

2.2. Program committee members

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- *Michail Kalogiannakis*, University of Thessaly, Greece [11]
- *Piotr Lipiński*, Lodz University of Technology, Poland [12]
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- *Yuliia Yechkalo*, Kryvyi Rih National University, Ukraine [35]

3. Proceedings overview

The CoSinE 2024 proceedings showcase a diverse array of research contributions that push the boundaries of computer simulation in education. The article by Vakaliuk et al. [36] work on selecting cloud-based learning technologies for developing professional competencies of statistics majors exemplifies the workshop’s focus on practical applications (figure 2). By defining evaluation criteria and applying expert evaluation, they identify the most suitable technologies for enhancing students’ skills and readiness for the modern workforce.

Similarly, approach to teaching statistics to future programmers using real data sets and the R programming language proposed by Pavlenko et al. [37] aligns with CoSinE’s emphasis on authentic learning experiences. By using data-driven tools and methodologies, they aim to increase students’ motivation and equip them with valuable practical skills.

The application of data science tools in economics education, as explored by Rizun et al. [38], showcases the interdisciplinary nature of the research presented at CoSinE. Their demonstration of text mining and topic modeling techniques for analyzing public perception and opinion differences

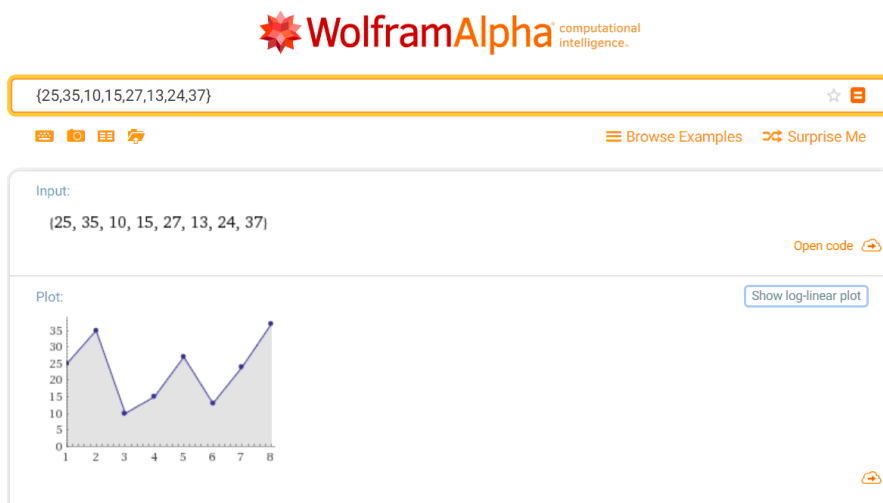


Figure 2: Cloud calculations in the Wolfram|Alpha service [36].

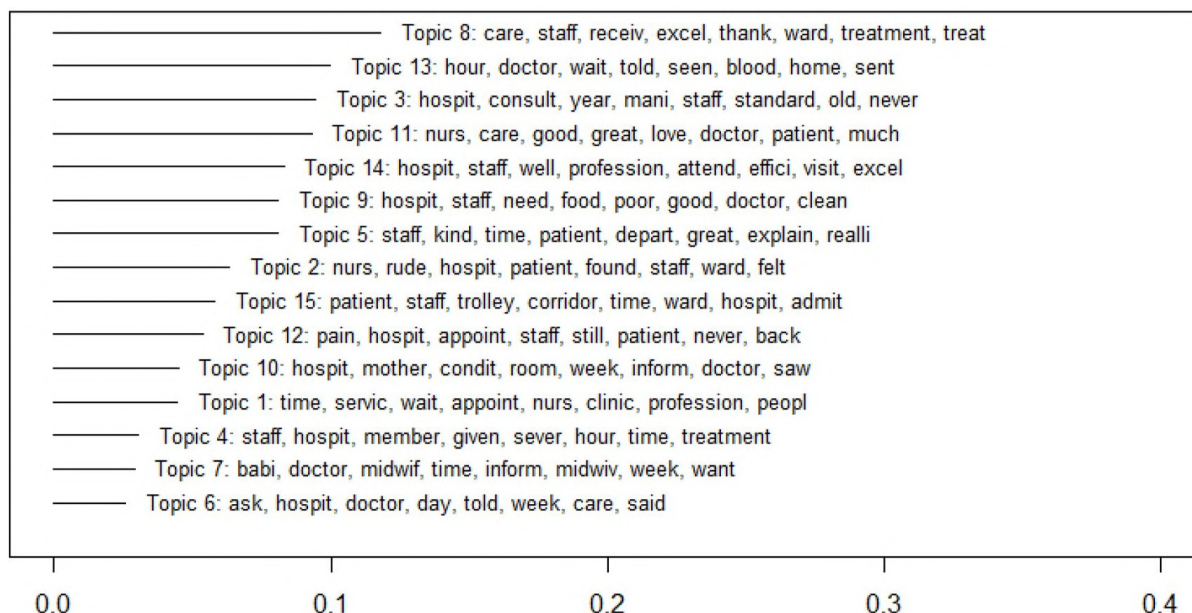


Figure 3: Expected topic proportions over corpus [38].

based on metadata highlights the potential of computational methods to shed light on complex social and economic phenomena (figure 3).

Beyond higher education, CoSinE 2024 also features research focused on school-level initiatives. Slipukhina et al. [39] analyse the distribution of STEM-STEAM-STREAM and Montessori pedagogy centers in Ukraine using web mapping data (figure 4). This research provides valuable insights into the landscape of innovative educational approaches in the country. By comparing the principles and didactic features of these approaches, they contribute to the ongoing discourse on effective teaching strategies.

The prospect of introducing quantum informatics in school courses, as discussed by Shokaliuk and Lehka [40], showcases CoSinE’s commitment to exploring emerging areas of computer science education. Their proposal of an experimental content adapted for high school students, along with suggestions for software tools and Internet services (figure 5), lays the groundwork for future research and implementation efforts.

In the realm of mathematics education, Bilousova et al. [41] propose innovative approach to enhancing

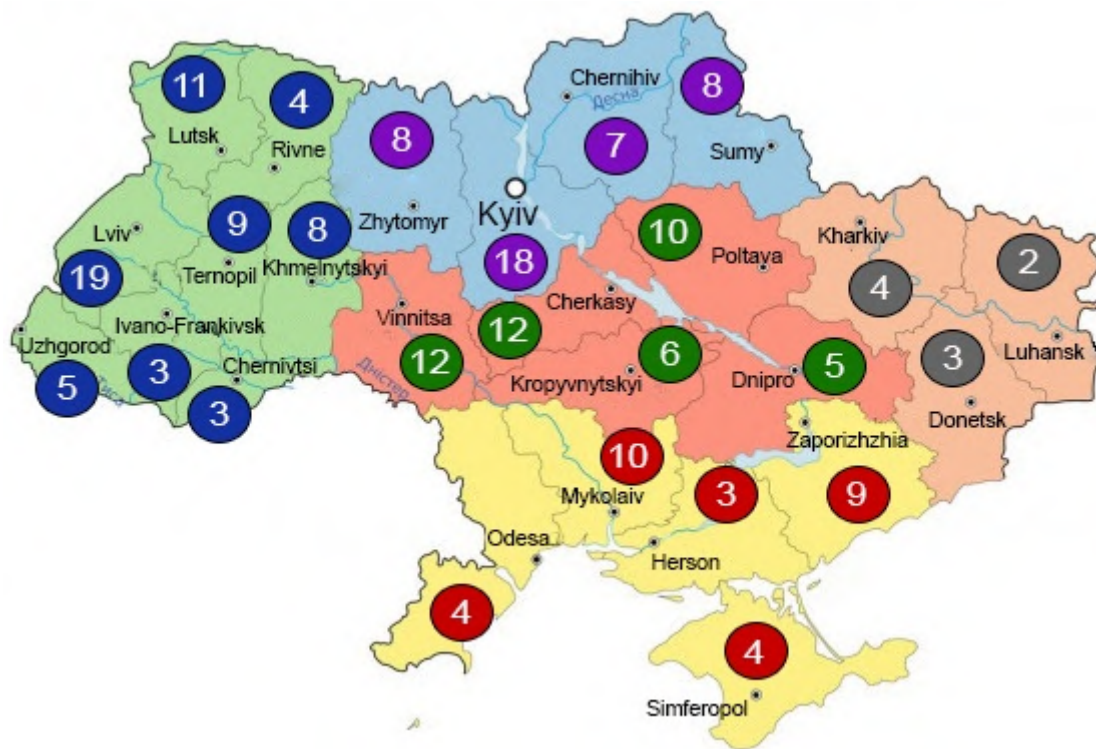


Figure 4: STEM-STEAM-STREAM centers in Ukraine [39].

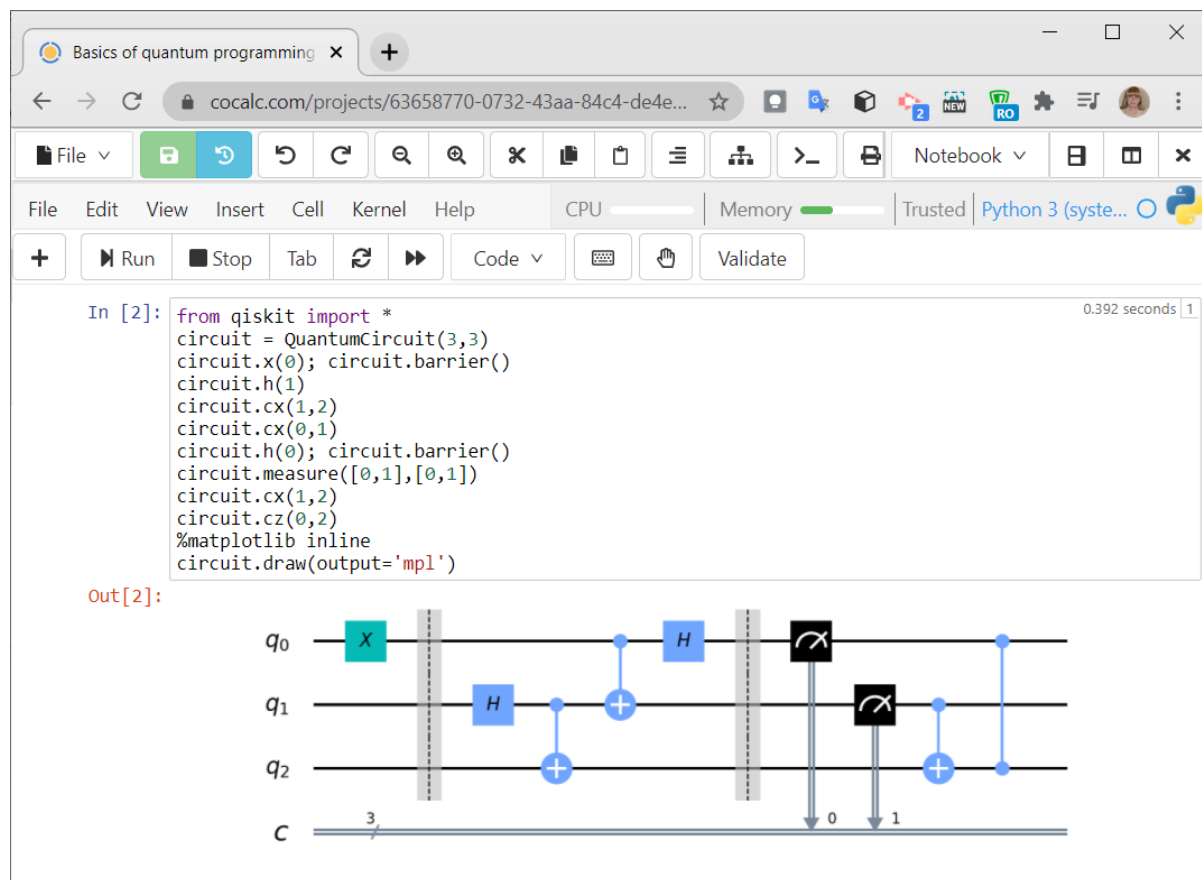


Figure 5: Jupyter notebook page in the CoCalc cloud environment [40].

mathematical understanding through dynamic GeoGebra modeling exemplifies the workshop’s emphasis on holistic educational principles. Their comprehensive complex of models and supporting pedagogical framework demonstrate the potential of technology-enhanced learning to foster deeper conceptual understanding and engagement.

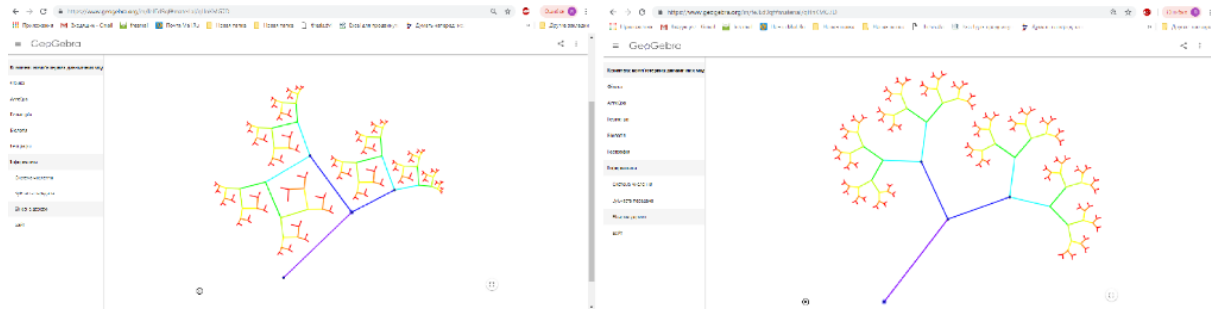


Figure 6: Fractal modelling in GeoGebra [41].

Several papers at CoSinE 2024 focus on the crucial task of preparing future computer science teachers. Oleksiuk et al. [42] propose model for the application and learning of cloud technologies, consisting of target, content, operational, and effective components (figure 7). This model provides a structured framework for integrating these technologies into teacher education programs. The stages of using cloud technologies and examples of implementation offer valuable guidance for educators and researchers alike.

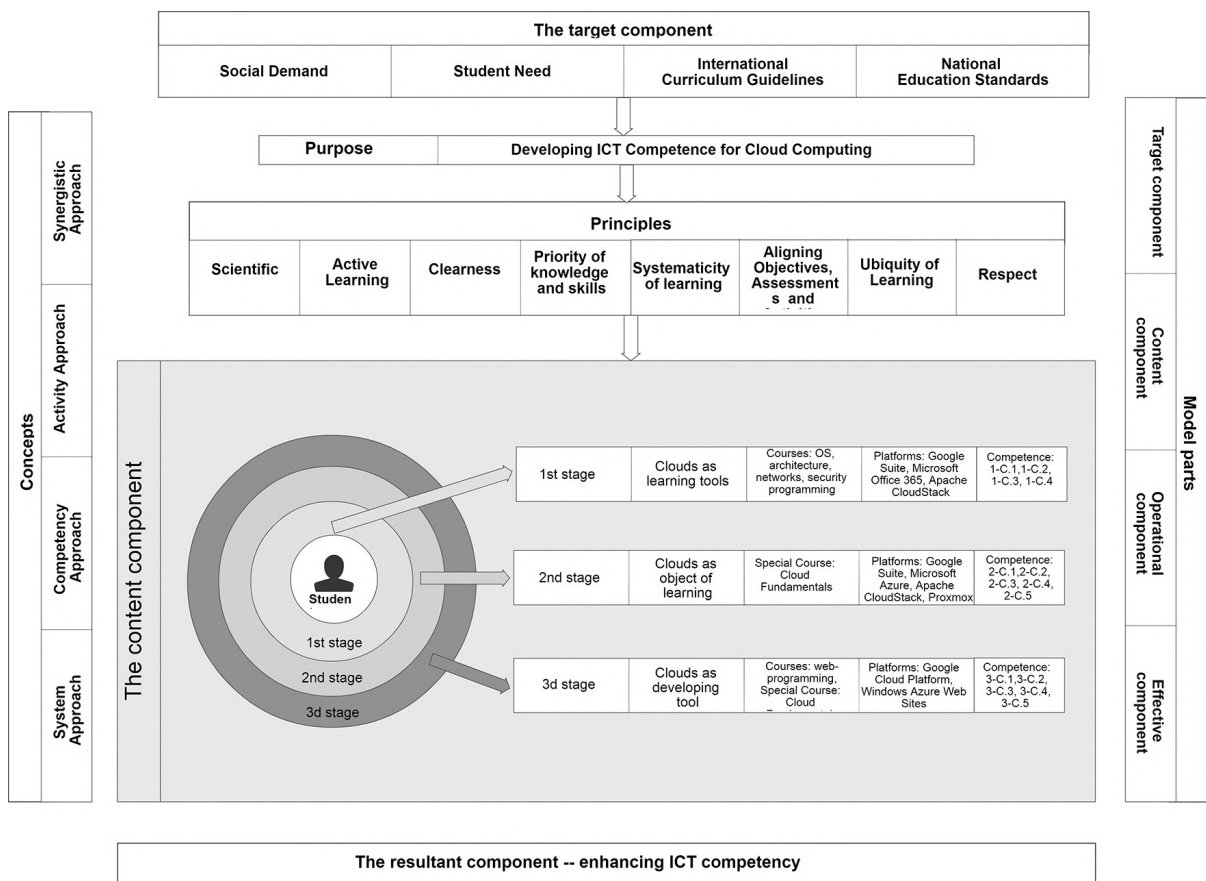


Figure 7: The model for learning cloud computing [42].

The use of ontologies for representing and designing subject domains in computer science education, as explored by Tsidylo and Kozibroda [43], represents another innovative approach showcased at

CoSinE. Their ontology schema (figure 8), criteria for selecting ontology systems, and methodology for constructing subject domain ontologies using the Protégé environment contribute to the growing body of knowledge on knowledge representation and management in educational contexts.

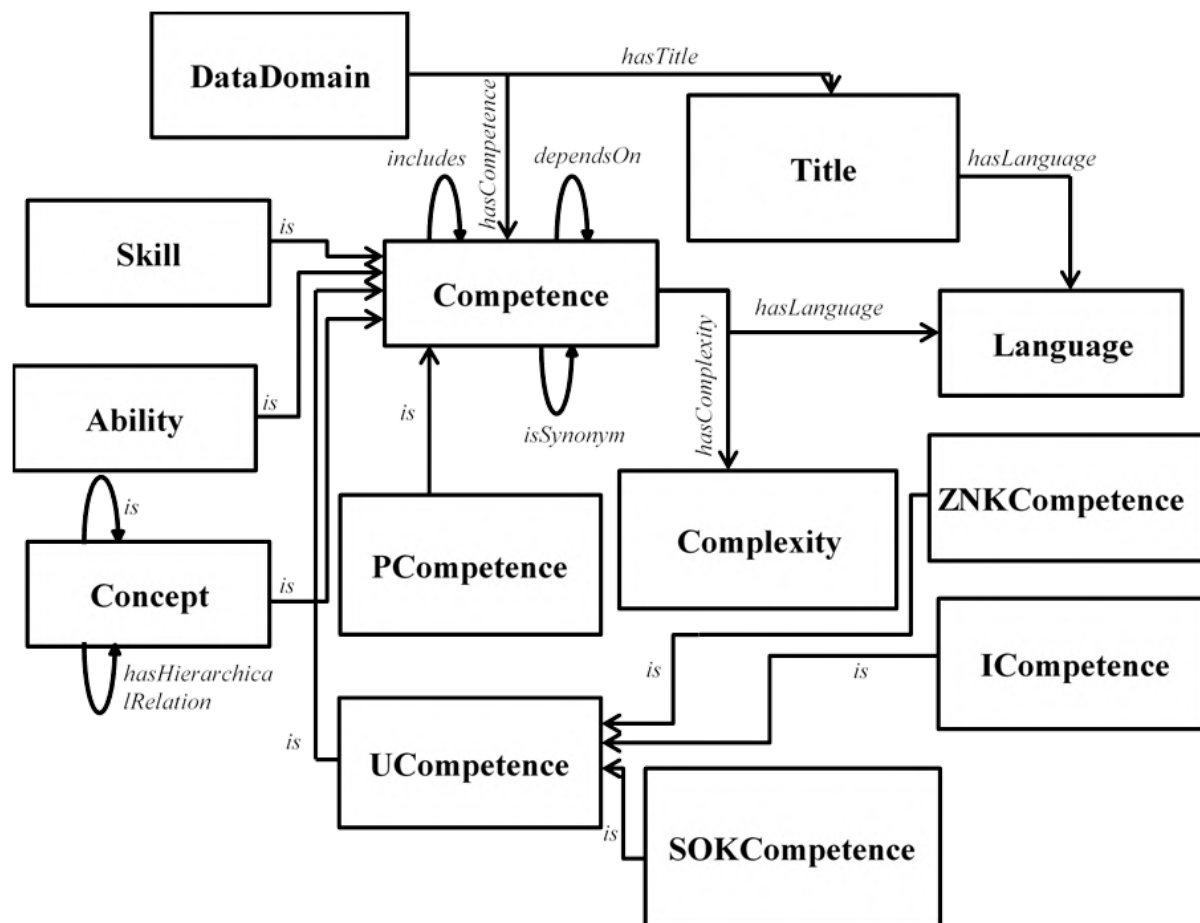


Figure 8: Ontology schema for subject domains [43].

Methodology for teaching the development of web-based augmented reality applications with integrated machine learning models developed by Semerikov et al. [44] highlights the workshop’s focus on cutting-edge technologies and their educational applications. By detailing the technical implementation using WebAR tools, providing examples of created models (figure 9), and discussing the pedagogical aspects of their application, they offer a comprehensive framework for incorporating these advanced technologies into the curriculum.

Finally, linguistic perspective on emoji as an artificial digital language by Makhachashvili et al. [45] adds a unique dimension to the research presented at CoSinE. Their application of frame semantics to study the perception and interpretation of emoji signs contributes to the broader discourse on the role of digital communication in education and society (figure 10).

4. Conclusion

The papers presented at CoSinE 2024 collectively demonstrate the immense potential of computer simulation and related technologies to transform education across various domains and levels. The workshop’s emphasis on real-world applications, interdisciplinary research, and innovative methodologies positions it as a vital platform for advancing the field and fostering collaboration among researchers, educators, and practitioners.

As the world continues to grapple with the challenges posed by the ongoing war in Ukraine, CoSinE



Figure 9: Face meshes [44].

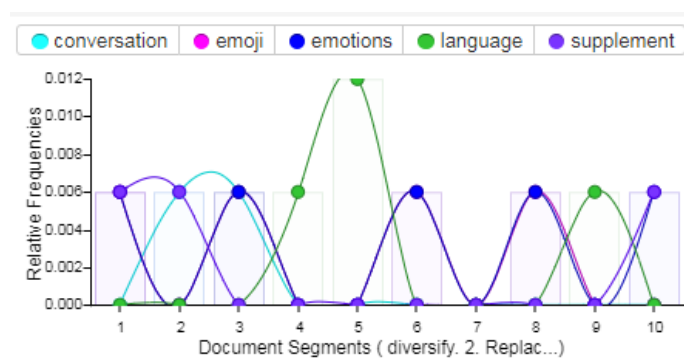


Figure 10: Digital content analysis: key words frequency [45].

2024's hybrid format ensures that the valuable insights and experiences shared by participants can reach a global audience, regardless of their ability to attend in person. The workshop's commitment to inclusivity and accessibility reflects the resilience and adaptability of the educational research community in the face of adversity.

We are grateful to all authors who submitted papers and to the delegates for their participation and interest in CoSinE as a platform for sharing their ideas and innovations. We also thank all program committee members for their continuous guidance and the efforts of peer reviewers who helped improve the quality of papers. The constructive criticism, improvements, and corrections provided to authors are greatly appreciated for their contribution to the success of the workshop. We hope all participants enjoy this conference and meet again in more peaceful, hilarious, and happiness of further CoSinE 2025.

Since CoSinE 2019, our workshop is **sponsored** by the CEUR Workshop Proceedings (CEUR-WS.org), the world's best Diamond Open-Access proceedings publisher for Computer Science workshops. Long live CEUR-WS.org!

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