

Transformation of Teaching through Co-Teaching and Innovative Methods

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Received: September 13, 2024; received in revised form: October 18, 2024;
accepted: October 21, 2024

Abstract:

Introduction: The integration of digital technologies and virtual co-teaching has become a common practice in education. This was accelerated by the COVID-19 pandemic. These innovations play a key role in addressing global challenges and are a response to digital advances to which primary and secondary schools need to adaptively respond.

Methods: The study used thematic analysis and a scoping review to investigate the effectiveness of virtual co-teaching in primary and secondary schools, with a focus on new digital technologies and artificial intelligence.

Results: The results show that virtual co-teaching supported by the use of artificial intelligence is an effective alternative to traditional teaching methods that increases both the efficiency and flexibility of the learning process. Further research is necessary to show new possibilities and optimize the use of this method in formal education.

Discussion: Pupils should be divided into smaller groups, respecting their individual needs, abilities, and speed of learning. Artificial Intelligence assistants should be involved to support teachers and pupils.

Limitations: Experiments should be implemented in other subjects in primary and secondary schools.

Conclusions: Virtual co-teaching has a strong potential to contribute to future innovations in education, especially when combined with artificial intelligence to

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enable more personalized learning. It extends the pedagogical space with a virtual component – a virtual teacher or subject matter expert.

Key words: artificial intelligence, COVID-19 pandemic, digital technologies, innovative teaching methods, virtual co-teaching.

Introduction

The integration and use of digital technologies in primary and secondary schools has become standard practice. Along with this technological expansion, virtual co-teaching has been incorporated into school environments. This teaching method is emerging as a crucial tool, not only in response to global societal changes – such as wars, escalating political tensions, or migration and refugee crises – but also due to technological advancements associated with the concepts of Industry 4.0 and, more recently, Industry 5.0. These developments signal the next wave of global industrial transformation, which will inevitably impact school education (cf. Leng et al., 2022).

The most significant shift in the integration of digital technologies into formal education can be traced back to the spring of 2020 when schools were closed in most countries due to the COVID-19 pandemic. Schools were repeatedly closed and reopened, leading teachers to navigate previously untried combinations of face-to-face, hybrid, and distance learning. Educators were compelled to adapt to unprecedented conditions, employ synchronous and asynchronous teaching methods, and grapple with maintaining connections with students, families, and colleagues (Sokal et al., 2020). This period naturally sparked a need for research that would explore the effects of this atypical time on education, students, and teachers.

On the one hand, research has demonstrated a negative impact on student learning (e.g., Spiteri et al., 2022); on the other hand, it has highlighted the necessity for teachers to adopt innovative approaches in the new educational contexts and make extensive use of digital technologies (e.g., Berry, 2020; Ivori et al., 2020; Pokhrel & Chhetri, 2021).

The pandemic also underscored the importance of focusing education on the broad development of competencies, relationships, and human values (Sakalli et al., 2021). Based on a survey of 1,045 teachers, Zamaro et al. (2021) found that approximately 30% of these teachers taught remotely for most of the 2020–2021 school year; a total of 49% reported teaching in a hybrid model; and 21% reported teaching face to face. A large majority (71%) indicated that they had to modify their teaching methods at least once during the 2020–2021 school year, with an average of two changes per teacher. Similar shifts in pedagogical methods have been reported, along with increased use of digital technologies and

innovative approaches to student engagement (e.g., Barnum, 2021; Chizhik & Brandon, 2020; Steiner & Woo, 2021).

In 2020 and 2021, the focus shifted toward methods that allowed for flexible responses to changing teaching conditions, student and teacher quarantines, and other unexpected events. As teachers could not rely on the standard progression of the school year or their physical presence in classrooms, they were compelled to devise new ways to motivate themselves and their student to ensure continuity of teaching under nonstandard conditions. In this nontraditional environment, nontraditional approaches gained prominence. The interpretation and delivery of knowledge shifted to virtual instruction, which could be recorded and asynchronously accessed, thereby laying the groundwork for flipped classroom models.

During the initial phase of the post-COVID-19 era, it was assumed that certain limitations might persist in subsequent years. In response, the Ministry of Education, Youth, and Sports of the Czech Republic initiated a project to pilot distance and hybrid teaching approaches. The practical implications of distance education were also examined by the Czech School Inspectorate (2020), which, in a series of thematic reports, highlighted the need for flexible teaching methods, including support for group work in online environments, the implementation of social games, and careful consideration of traditional didactic approaches (e.g., reports, presentations; Experience of Primary School Pupils and Teachers with Distance Education in the Second Half of the 2019/2020 School Year, 2020).

The Czech School Inspectorate further noted that teachers often employed methods and formats that did not facilitate active student participation in the learning process. It emphasized the importance of using engaging teaching methods and adapting instructional content accordingly.

The Ministry of Education, Youth, and Sports of the Czech Republic repeatedly emphasized the necessity of new teaching methods in its methodological recommendations for distance education, both in regular primary and secondary education and for students with special educational needs (Ministerstvo školství, mládeže a tělovýchovy ČR, 2020).

Current projections suggest that the ongoing turbulent period –including challenges associated with the post-COVID-19 era, the war in Ukraine, and the influx of refugee children into Czech schools – will lead to further shifts in pedagogical processes at all levels, particularly in the realm of didactics, with a strong emphasis on transforming teaching methods. Activating teaching methods that effectively alternate during instruction and maintain student motivation to learn are now preferred (Czech School Inspectorate, 2021).

In this context, the demands on teaching staff and the practical application of teaching methods are also evolving. The current era has opened the door to

educational innovations with the potential to transform traditional teaching practices, with digital technologies and artificial intelligence becoming integral components of the educational process.

1 Review of research findings in the field of virtual co-teaching

An innovative solution for teachers during the pandemic and related quarantines was the implementation of virtual co-teaching. This method was based on the collaboration between one educator who was physically present in the classroom and another who was virtually connected, and it allowed teaching to continue under nearly any pandemic conditions. During this period, our team initiated a research project funded by the Czech Technology Agency titled “A New Method of Education for the 21st Century: Virtual Co-Teaching.” The very concept of co-teaching in pedagogical practice, however, lacks a uniform definition.

In a global context, the term “co-teaching” is often associated with the concept of inclusion, whereby the traditional classroom environment is regarded as the most appropriate setting for most students, thus necessitating the provision of ample support (Wilson & Blednick, 2011).

Additionally, the literature defines co-teaching as a method in which two or more educators collaborate to teach in conventional classroom settings (cf. Bacharach et al., 2010; Murawski, 2017). In our research, we extended this definition beyond special education, drawing on a broader concept that involves the collaboration of two educators (Veteška et al., 2020). Our study focused on incorporating a virtual component as a novel extension of the co-teaching model. The primary aim was to introduce innovative solutions for school education, particularly at the primary and secondary levels. The initial phase of the research involved a scoping review to analyze co-teaching as an innovative instructional method with the potential to enhance pupils' learning outcomes and key competencies. This review identified six central themes related to co-teaching: effectiveness, challenges, teaching methods, teacher roles and relationships, collaboration, and special educational needs. These themes subsequently formed the foundation for our research activities.

Our findings suggest that by addressing both technical and human readiness challenges, co-teaching – including its virtual form – can significantly contribute to the effectiveness of the educational process and foster the acquisition of competencies essential for student success (Svobodová, 2023; Veteška et al., 2020).

This project did not merely involve the addition of a virtually connected educator in a random manner; rather, it integrated the virtual teacher as a fully embedded component of the teaching process. Research methodologies were employed to evaluate the effectiveness of virtual co-teaching as well as to identify its potential opportunities, challenges, and barriers. Based on the research findings, virtual

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co-teaching was optimized and procedures were established to enhance its positive impact on learners. In parallel, the research also examined specific areas, such as the education of pupils with special educational needs and issues faced by novice and future teachers.

The project rigorously tested the effectiveness of virtual co-teaching and identified its possibilities, limitations, and barriers. The outcomes of these research activities are summarized in Table 1.

Table 1

Overview of outputs from the Czech Technology Agency project focused on the research of the virtual co-teaching method (2021-2023)

	<u>Title</u>	<u>Methodology</u>	<u>Citation</u>
2 0 2 1	Co-teaching: Advantages and disadvantages	thematic analysis and scoping review	Kursch, M., & Veteška, J. (2021). Co-teaching: Advantages and disadvantages. In Z. Szarota and Z. Wojciechowska (Eds.). <i>Learning never ends... Spaces of adult education: Central and Eastern European perspectives</i> (pp. 93-107). Warsaw: Faculty of Education, University of Warsaw. https://doi.org/10.31338/uw.9788323552062 .
2 0 2 1	Problems and obstacles of distance learning in the point of view of primary school teachers in the "Covid period"	qualitative research, semi-structured interviews	Svobodová, Z., Kursch, M., & Veteška, J. (2021). Problems and obstacles of distance learning in the point of view of primary school teachers in the "COVID period." In I. A. Sánchez, P. Kommers, T. Issa, and P. Isaías (Eds.). <i>Proceedings of the international conferences mobile learning and educational technologies 2021</i> (pp. 83-90).
2 0 2 1	Virtual co-teaching in primary school – a case study	quantitative research, experiment	Svobodová, Z., Kursch, M., & Veteška, J. (2022). Virtual co-teaching in primary school – a case study. In J. Kříž, and Z. Svobodová, <i>Adult education 2021 - In diverse learning environments</i> . (pp. 13-31). Prague: Czech Andragogy Society.
2 0 2 2	Longitudinal Co- teaching projects: scoping review	scoping review	Veteška, J., Kursch, M., Svobodova, Z., Tureckiova, M., & Paulovcakova, L. (2022). Longitudinal co-teaching projects: Scoping review. In: D. Ifenthaler, P. Isaías, and D. G. Sampson (Eds.). <i>Orchestration of Learning Environments in the Digital World. Cognition and Exploratory Learning in the Digital Age</i> . Springer. https://doi.org/10.1007/978-3-030-90944-43

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2	Longitudinal co-teaching projects: scoping review	scoping review	Veteška, J., Kursch, M., & Svobodova, Z. (2022). Longitudinal co-teaching projects: Scoping review. In D. Ifenthaler, P. Isaías, and D. G. Sampson (Eds.). <i>Orchestration of Learning Environments in the Digital World. Cognition and Exploratory Learning in the Digital Age</i> . Springer. https://doi.org/10.1007/978-3-030-90944-4_3
0	teaching projects:		
2	scoping review		
2			
2	Efficiency of virtual co-teaching	quantitative research, experiment	Kursch, M., Liška, R., Tureckiová, M., & Kříž, J. (2022). Efficiency of virtual co-teaching. In B. Pitula and M. Kowalski (Eds.). <i>Co-Teaching – Everyday Life or Terra Incognita of Contemporary Education?</i> (pp. 145-159). V&R Unipress.
0			
2			
2			
2	Virtual co-teaching through the eyes of primary and secondary school students	qualitative research, experiment	Svobodová, Z., Veteška, J., & Dvořáková, D. (2022). Virtual co-teaching through the eyes of primary and secondary school students. In B. Pitula and M. Kowalski (Eds.). <i>Co-Teaching - 228 Everyday Life or Terra Incognita of Contemporary Education?</i> (pp. 125-143). V&R Unipress.
0			
2			
2			
2	Efficiency of virtual co-teaching	experiment	Kursch, M., & Veteška, J. (2022). Výzkum efektivity virtuálního co-teaching. In M. Krystoň (Ed.). <i>Andragogické štúdie 2022</i> (pp. 44-53). Belianum.
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2			
2			
3		qualitative research	Svobodová, Z., Kursch, M., & Veteška, J. (2023). Virtual co-teaching and future teachers. In J. Veteška and J. Kříž (Eds.). <i>Adult Education 2022 - Balance in the Context of Strategic Changes: Proceedings of the 12th International Adult Education Conference</i> (pp. 222–228). Czech Andragogy Society.

Research results based on pedagogical experimentation have confirmed that virtual co-teaching can be considered an extension of the educational space into environments that schools would not typically be able to access. However, it is also a method that places high demands on other teachers, particularly in terms of their collaboration and preparedness. Ensuring that teachers have adequate time for preparation is critical to the success of co-teaching. In addition to preparation time, access to appropriate technical equipment is a key determinant of the effectiveness of virtual co-teaching (Veteška et al., 2020). Virtual co-teaching also presents an opportunity to enhance the appeal of the subject matter by involving experts who may otherwise be unavailable due to time constraints, distance, or concerns regarding student safety in specific environments.

This teaching method thus opens new possibilities to make subjects, such as technical education, chemistry, physics, and foreign languages, more engaging. Several measurements conducted to assess the effectiveness of virtual co-teaching have demonstrated that it is a fully viable alternative to traditional, in-person co-teaching. Our experiments convincingly showed that students' test results from virtual co-teaching were not statistically different from those in classical, frontal co-teaching.

However, in an evaluation of teaching effectiveness—which we define as achieving the intended learning outcomes while considering associated costs—virtual co-teaching appears to be even more efficient. This increased efficiency is attributed to lower transportation costs, minimized time loss, and positive effects on scheduling due to flexibility in the virtual teacher's availability (cf. Kursch et al., 2022; Svobodová, 2023; Svobodová et al., 2022).

Based on these findings, virtual co-teaching was then optimized, and procedures were established to further enhance its positive impact on students. The research also explored specific areas, including the education of students with special educational needs and the challenges faced by novice and future teachers.

The project outcomes were designed for practical implementation in educational settings and were intended to have a tangible impact on the teaching reality in Czech schools. To ensure this, all results were integrated into teaching practices through collaboration with the project's application sponsors, namely two secondary and two primary schools. The results were also continuously reviewed in consultation with the Czech School Inspectorate, and any feedback was incorporated throughout all phases of the project.

The research findings indicate that virtual co-teaching has the potential to be as effective as traditional co-teaching while offering several advantages unique to the virtual environment. These advantages include:

- Enhanced student engagement: Unlike distance learning, virtual co-teaching benefits from the presence of a physically situated teacher who can provide immediate feedback and respond to changes in students' concentration, alertness, and interest.
- Flexible use of recorded lessons: Virtual co-teaching offers the potential for lessons to be recorded and reused, allowing for the possibility of a virtual teacher who operates asynchronously.
- Cost-efficiency: Virtual co-teaching is less costly than traditional co-teaching, providing a competitive edge in terms of efficiency for future educational use.
- Technological advancements: The virtual aspect of co-teaching continues to improve with developments in information and communication technology (ICT), such as enhanced image and audio quality, motion capture for

feedback, and the use of sports cameras for improved image capture and recording.

Looking ahead, virtual co-teaching could potentially support fully virtual teachers, such as educational robots adapted to assist in the teaching process. However, virtual co-teaching also presents certain challenges and barriers, such as:

- Higher costs compared to single-teacher instruction,
- Complex and demanding planning processes,
- The ad-hoc nature of virtual co-teaching as permanent implementation is often not feasible,
- High equipment costs necessary for effective virtual co-teaching,
- The need for specialized teacher training to deliver effective virtual co-teaching sessions.

In conclusion, virtual co-teaching has substantial potential and is likely to continue developing due to its significant benefits for both students and teachers. It can also serve as a more effective bridge between theory and practice in many schools or educational institutions, opening doors that traditional co-teaching methods cannot.

2 Methodology

The aim of this article is to describe and evaluate recent changes and innovations in teaching methods, with a special focus on innovative approaches involving virtual co-teaching, digital technologies, artificial intelligence (AI), and virtual environments as well as to predict their future development and potential integration into the educational process. The study employed the Delphi method as the primary tool for identifying and forecasting trends and innovations in virtual co-teaching and its prospective applications. The Delphi method is a qualitative research technique that enables the structured and iterative gathering of expert opinions to achieve consensus (Hodyakov et al., 2023; Linstone & Turoff, 1975, in Svobodová, 2023).

This method is particularly well-suited for research areas involving complex problems that lack definitive solutions and in which rapid advancements are anticipated, such as educational technology. Evidence for this study was systematically collected during the research project from experts associated with the Department of Andragogy and Educational Management at the Faculty of Education, Charles University, as well as from participating primary and secondary schools (see Svobodová, 2023 for further details).

Thematic analysis was used to analyze the data gathered through the Delphi method to identify key themes and trends in virtual co-teaching. This approach not only enabled the identification of current innovations but also facilitated the prediction of future developments. Thematic analysis was conducted in several

stages, including data coding, the identification of patterns, and the synthesis of key themes. To further complement the findings of the Delphi study, a scoping review was conducted, which involved the systematic search, selection, and synthesis of existing studies on virtual co-teaching, digital technologies, and AI in education. This methodology provided a comprehensive overview of the current state of research in the field and highlighted areas requiring further exploration (Arksey & O'Malley, 2005).

Key search terms included "virtual co-teaching," "artificial intelligence," "AI in education," "digital technologies," and "virtual learning." The search for studies was conducted across databases, such as Web of Science, Scopus, and ERIC, with studies selected based on their relevance to the topic after considering both theoretical and empirical contributions.

By combining the Delphi method with thematic analysis, this methodological approach not only identified current trends and innovations in virtual co-teaching but also predicted its future evolution and highlighted areas in need of further research. This comprehensive approach provided a robust foundation for future research and the practical application of virtual co-teaching.

3 Results and current possibilities for virtual co-teaching

In the analysis of research articles, several new innovations in virtual co-teaching were identified. The first innovation was presented by Velentz, Lefkos, and Fachantidis (2022), who explored the integration of a humanoid robot in virtual co-teaching. Their study was inspired by previous research, including outcomes from our project that demonstrated the positive impact of co-teaching and virtual co-teaching on both students and teachers. The aim of their study was to investigate the effect of a humanoid robot acting as a co-teacher on students' comprehension of the material and their overall enjoyment of the learning process. The research compared the effectiveness of and student satisfaction with the instruction conducted by a human-human co-teaching tandem and a human-robot tandem. The results indicated that students perceived the contributions of the humanoid robot and the human educator as equally positive.

A second study, by Barron et al. (2022), analyzed selected learning platforms – specifically Google Meet, MS Teams, and Zoom – and their potential for use in virtual co-teaching. The study also examined the integration of additional applications to enhance student engagement and maximize the potential of co-teaching. The focus was on the active role of educators in virtual environments, which is moving away from traditional frontal teaching (i.e., "talking heads"), with an emphasis on the importance of student-driven activities, which are central to all innovative educational methods.

One of the major challenges faced by many countries is the shortage of qualified teachers. An intriguing project from China (Guo et al., 2022) addressed the

severe lack of qualified teachers in remote areas. With the development of ICT, China launched a remote ICT intervention program for rural classrooms and established a "virtual co-teaching classroom" in which rural teachers collaborate with qualified educators from distant cities. As depicted in Figure 1, a remote teacher can simultaneously teach multiple rural classes, providing a solution to the shortage of teachers in these areas.

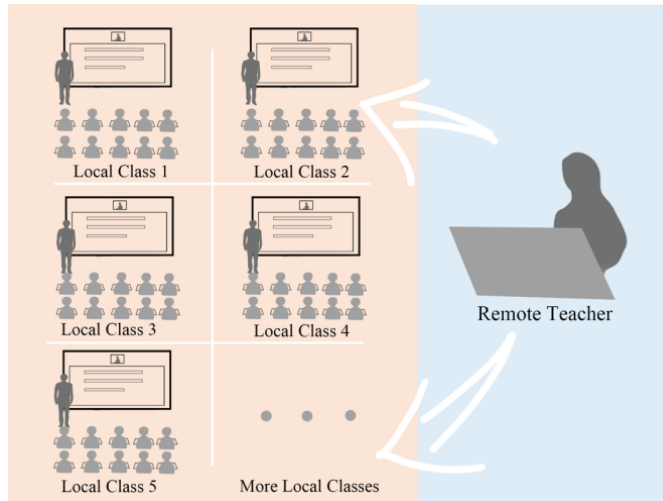


Figure 1. Teaching as a remote teacher in multiple classrooms (Guo et al., 2022).

The study employed a qualitative methodology to describe co-teacher collaboration practices and assess the impact of this project on the quality of teaching. The authors conducted semi-structured interviews with nine remote urban teachers and twelve local rural teachers to investigate the standard practices in remote classrooms for co-teaching and the collaborative processes between co-teachers. Based on the interviews, it was reported that rural teachers were actively involved in the process by contributing to the teaching and adapting resources provided by remote teachers to suit the capabilities of their students. While the rural teachers subjectively evaluated the increase in the quality of teaching, they also highlighted several challenges, including technical difficulties encountered during the project (Guo et al., 2022).

Virtual co-teaching has also been applied in unforeseen contexts, such as the war in Ukraine where it became the primary means of maintaining international collaboration and teaching connections with foreign countries. Oleksiyenko,

Shchepetylnykova, and Furiv (2023) reported on several specific educational activities based on virtual co-teaching in higher education, thereby demonstrating its adaptability in crisis situations.

Virtual co-teaching also holds significant potential for the integration of AI. With AI becoming increasingly embedded in various sectors, including education, the next steps for research will likely involve deepening the understanding of how AI technologies, such as ChatGPT, can be incorporated into pedagogical methods. ChatGPT, which has rapidly evolved and which gained over one million users shortly after its launch (cf. Haque et al., 2022), has sparked discussions among educators regarding its impact on teaching professions and student learning outcomes.

Glaser (2023) noted that ChatGPT, in particular, can be used to address individual student needs and preferences by providing personalized content and feedback (Chan & Zary, 2019; Zhai, 2023). This approach can enhance student engagement with the material and improve learning outcomes. For instance, teachers can submit student essays, discussion board responses, and other assignments to ChatGPT for comparison with assignment criteria to identify areas where additional instruction or intervention may be necessary. While such applications have been considered in the past (e.g., Uto & Okano, 2020; Warschauer & Grimes, 2008), earlier efforts faced technological limitations that ChatGPT has since addressed (Vijaya Shetty et al., 2022).

This new perspective in virtual co-teaching opens up possibilities for personalized learning tailored to the specific needs and preferences of students. With the aid of advanced algorithms and AI, educators can adjust lesson content in real time, thereby increasing the effectiveness of the learning process.

Conclusions

Virtual co-teaching supported by digital technologies and artificial intelligence has shown significant potential to revolutionize education, especially in response to challenges like the COVID-19 pandemic and teacher shortages in remote areas. Research confirms that virtual co-teaching is an effective alternative to traditional methods as it increases both the flexibility and efficiency of the learning process. By dividing students into smaller groups and incorporating AI-powered co-teachers, this approach allows for more personalized support tailored to individual learning needs, ultimately enhancing student engagement and outcomes. AI offers new opportunities for the development of soft skills through virtual co-teaching. For instance, AI can simulate scenarios that require teamwork, conflict resolution, or communication, which can be incorporated into virtual co-teaching environments where both teachers and AI collaboratively guide students toward achieving soft skill development goals. AI can further provide personalized feedback and advice to help students better understand their

strengths and weaknesses and improve in areas essential for their future professional lives.

However, several limitations need to be addressed for this method to reach its full potential. The key barriers are the high cost of necessary equipment, the complexity of planning, and the requirement for specialized teacher training. Additionally, the research presented in this article was limited to specific subjects and educational settings, which calls for further exploration to optimize and extend its use across a wider range of contexts.

Despite these challenges, virtual co-teaching, when fully integrated and refined, has the potential to become a transformative tool in education. In combination, the strengths of human and AI-driven teaching can bridge gaps between theory and practice, offering a more flexible, scalable, and innovative approach to teaching that meets the evolving demands of modern education.

Acknowledgements

This work was supported by the Cooperation Program (Faculty of Education, Charles University, Czech Republic, 2022-2026), research area General Education and Pedagogy.

References

- Arksey, H., & O'malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology*, 8(1), 19-32. <https://doi.org/10.1080/1364557032000119616>
- Bacharach, N., Heck, T. W., & Dahlberg, K. (2010). Changing the face of student teaching through coteaching. *Action in Teacher Education*, 32(1), 3-14. <https://doi.org/10.1080/01626620.2010.1046353>
- Barnum, M. (2021). *Despite Pandemic, There's Little Evidence of Rising Teacher Turnover – Yet*. Chalkbeat. Retrieved from <https://www.chalkbeat.org/2021/4/6/22368846/-teacher-turnover-quitting-pandemic- data-economy>
- Barron, T., Friend, M., Dieker, L., & Kohnke, S. (2022). Co-teaching in uncertain times: Using technology to improve student learning and manage today's complex educational landscape. *Journal of Special Education Technology*, 37(3), 439-446. <https://doi.org/10.1177/01626434211033579>
- Berry, B. (2020). Teaching, learning, and caring in the post-COVID era. *Phi Delta Kappa*, 102(1), 14-17. <https://doi.org/10.1177/0031721720956840>
- Chan, K. S., & Zary, N. (2019). Applications and challenges of implementing artificial intelligence in medical education: Integrative review. *JMIR Medical Education*, 21(6), e13930–e13930. <https://doi.org/10.2196/13930>
- Chizhik, E. W., & Brandon, R. R. (2020). Making virtual co-teaching work in a Covid-19 environment. *Issues in Teacher Education*, 29(1-2), 142-148.
- Czech School Inspectorate. (2020). *Experience of Primary School Pupils and Teachers with Distance Education in the Second Half of the 2019/2020 School Year*. Czech School Inspectorate.

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- Czech School Inspectorate. (2021). *Annual Report of the Czech School Inspectorate for the School Year 2020/2021*. Czech School Inspectorate.
- Česká školní inspekce. (2020). *Zkušenosti žáků a učitelů základních škol s distanční výukou ve 2. pololetí školního roku 2019/2020*.
- Česká školní inspekce. (2021). *Výroční zpráva České školní inspekce za školní rok 2020/2021*.
- Glaser, N. (2023). Exploring the potential of ChatGPT as an educational technology: An emerging technology report. *Technology, Knowledge and Learning*, 28(4), 1945-1952. <https://doi.org/10.1007/s10758-023-09684-4>
- Guo, S., Sun, T., Gong, J., Lu, Z., Zhang, L., & Wang, Q. (2022). Remote co-teaching in rural classroom: Current practices, impacts, and challenges. *ArXiv.org*. <https://doi.org/10.48550/arxiv.2203.16042>
- Haque, M. U., Dharmadasa, I., Sworna, Z. T., Rajapakse, R. N., & Ahmad, H. (2022). I think this is the most disruptive technology: Exploring sentiments of ChatGPT early adopters using Twitter data. *ArXiv, abs/2212.05856*
- Iivari, N., Sharma, S., & Ventä-olkkonen, L. (2020). Digital transformation of everyday life – How COVID-19 pandemic transformed the basic education of the young generation and why information management research should care? *International Journal of Information Management*, 55, 102183-102183. <https://doi.org/10.1016/j.ijinfomgt.2020.102183>
- Kiger, M. E., & Varpio, L. (2020). Thematic analysis of qualitative data: AMEE guide no. 131. *Medical Teacher*, 42(8), 846-854. <https://doi.org/10.1080/0142159X.2020.1755030>
- Kursch, M. (2019). Trendy v digitalizaci metod vzdělávání. In J. Veteška (Ed.), *Vzdělávání dospělých 2018 – transformace v éře digitalizace a umělé inteligence* (Adult education 2018 – Transformation in the era of digitization and artificial intelligence: Proceedings of the 8th International Adult Education Conference; pp. 199–210). Česká andragogická společnost (Czech Andragogy Society).
- Kursch, M., Liška, R., Tureckiová, M., & Kříž, J. (2022). Efficiency of virtual co-teaching. In B. Pitula and M. Kowalski (Eds.), *Co-teaching – Everyday life or terra incognita of contemporary education?* (pp. 145-159). V&R Unipress.
- Ministerstvo školství, mládeže a tělovýchovy ČR. (2020). *Methodological Recommendations for Distance Education*.
- Murawski, W. W. (2017). *Beyond Co-Teaching Basics: A Data-Driven, No-Fail Model for Continuous Improvement*. ASCD.
- Oleksiienko, A., Shchepetylnykova, I., & Furiv, U. (2023). Internationalization of higher education in tumultuous times: Transformative powers and problems in embattled Ukraine. *Higher Education Research and Development*, 42(5), 1103-1118. <https://doi.org/10.1080/07294360.2023.2193727>
- Pokhrel, S., & Chhetri, R. (2021). A literature review on impact of COVID-19 pandemic on teaching and learning. *Higher Education for the Future*, 8(1), 133-141. <http://doi.org/10.1177/2347631120983481>
- Sakalli, Ö., Altınay, F., Altınay, M., & Dagli, G. (2021). How primary school children perceive tolerance by technology supported instruction in digital transformation

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Volume 14, 2024, Issue 3

- during Covid 19. *Frontiers in Psychology*, 12, 752243-752243. <https://doi.org/10.3389/fpsyg.2021.752243>
- Sokal, L., Trudel, L. E., & Babb, J. (2020). Canadian teachers' attitudes toward change, efficacy, and burnout during the COVID-19 pandemic. *International Journal of Educational Research Open*, 1, 100016. <https://doi.org/10.1016/j.ijedro.2020.100016>
- Spiteri, J., Deguara, J., Muscat, T., Bonello, C., Farrugia, R., Milton, J., & Said, L. (2022). The impact of COVID-19 on children's learning: A rapid review. *Educational and Developmental Psychologist*, 40(1), 5-17. <https://doi.org/10.1080/20590776.2021.2024759>
- Steiner, E. D., & Woo, A. (2021). Job-related stress threatens the teacher supply: Key findings from the 2021 State of the U.S. Teacher Survey. *RAND Corporation*. <https://doi.org/10.7249/RR1108-1>
- Svobodová, Z. (2023). *Virtuální co-teaching jako součást inovativních metod 21. století*. Prague: Pedagogická fakulta, Univerzita Karlova.
- Svobodová, Z., Kursch, M., & Veteška, J. (2021). Problems and obstacles of distance learning in the point of view of primary school teachers in the "COVID period." In I. A., Sánchez, P. Kommers, T. Issa, and P. Isaías (Eds.), *Proceedings of the International Conferences on Mobile Learning and Educational Technologies* (pp. 83-90). IADIS.
- Svobodová, Z., Veteška, J., & Dvořáková, D. (2022). Virtual co-teaching through the eyes of primary and secondary school students. In B. Pitula and M. Kowalski (Eds.), *Co-Teaching – 228 Everyday Life or Terra Incognita of Contemporary Education?* (pp. 125-143). V&R Unipress,
- Uto, M., & Okano, M. (2020). Robust neural automated essay scoring using item response theory. In H. U. Hoppe, G. Agnello, J. K. T. Tang, S. S. C. Young, T. Y. Liu, and R. H. Huang (Eds.), *Artificial Intelligence in Education* (pp. 549-561). Springer. https://doi.org/10.1007/978-3-030-52237-7_44
- Velentza, A.-M., Fachantidis, N., & Lefkos, I. (2022). Human-robot interaction methodology: Robot teaching activity. *MethodsX*, 9, 101866-101866. <https://doi.org/10.1016/j.mex.2022.101866>
- Veteška, J., & Kursch, M. (2021). Research on gamification usage in distance learning during the COVID-19 period. In J. Veteška and M. Kursch (Eds.), *Vzdělávání dospělých 2020 – reflexe, realita a potenciál virtuálního světa* (Adult education 2020 – Reflection, reality and potential of the virtual world: Proceedings of the 9th international adult education conference; pp. 46-56). Česká andragogická společnost,
- Veteška, J., Kursch, M., Svobodová, Z., & Paulovcakova, L. (2022). Longitudinal co-teaching projects: Scoping review. In D. Ifenthaler, P. Isaías, D. G. Sampson (Eds.), *Orchestration of Learning Environments in the Digital World. Cognition and Exploratory Learning in the Digital Age*. Cham: Springer. <https://doi.org/10.1007/978-3-030-90944-43>
- Veteška, J. et al. (2020). Longitudinal co-teaching projects – scoping review. In *Proceedings of the 17th International Conference on Cognition and Exploratory Learning in the Digital Age* (pp. 115-123). CELDA.

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Volume 14, 2024, Issue 3

- Vijaya Shetty, S., Guruvyas, K. R., Patil, P. P., & Acharya, J. J. (2022). Essay scoring systems using AI and feature extraction: A review. In *Proceedings of Third International Conference on Communication, Computing and Electronics Systems: ICCCES 2021* (pp. 45-57). Springer Singapore.
- Warschauer, M., & Grimes, D. (2008). Automated writing assessment in the classroom: Integrative review. *Pedagogies: An International Journal*, 3(1), 22-36. <https://doi.org/10.1080/15544800701771580>
- Wilson, B. G., & VanBershot, J. L. (2014). Co-teaching an online action research class (Co-enseignement et classe de recherche-action en ligne). *Canadian Journal of Learning and Teaching*, 40(2), 1-18. <https://doi.org/10.21432/T2KW20>
- Zamarro, G., Camp, A., Fuchsman, D., & McGee, J. B. (2021). Understanding how COVID-19 has changed teachers' chances of remaining in the classroom. *Education Reform Faculty and Graduate Students Publications*.
- Zhai, X. (2023). ChatGPT for next generation science learning. *Crossroads*, 29(3), 42-46. <https://doi.org/10.1145/3589649>