"We Need More Than Tools": Examining AI-Focused Professional Development Challenges Through the DigCompEdu AI Supplement Framework

Maayan Shay Sayag
The Open University of Israel
maayan.sayag@gmail.com

Ina Blau
The Open University of Israel
inabl@openu.ac.il

Orit Avidov-Ungar
Achva Academic College
The Open University of Israel
avidovo@achva.ac.il

"אנחנו צריכים יותר מכלים": בחינת האתגרים בפיתוח מקצועי ממוקד בינה מלאכותית באמצעות מודל DigCompEdu AI Supplement

מעיין שי סייג
האוניברסיטה הפתוחה
maayan.sayag@gmail.com

אינה בלאו
האוניברסיטה הפתוחה
inabl@openu.ac.il

אורית אבידב-אונגר
המכללה האקדמית אחוה
האוניברסיטה הפתוחה
avidovo@achva.ac.il

Abstract

This study investigates the challenges that emerge in AI-focused teacher professional development (TPD) programs and their impact on teachers' AI competency development within the DigCompEdu AI Supplement framework. Utilizing semi-structured interviews with 22 high school teachers in Israel who participated in an entry-level AI-focused TPD program in their subject teaching area, the research identifies key themes affecting competency development: content-related barriers, critical content gaps, and operational challenges. Findings reveal that technical limitations, lack of subject-specific relevance, insufficient guidance on assessment practices and ethical considerations, and inadequate program structure hinder successful AI integration in teaching. The study proposes three significant modifications to the DigCompEdu AI Supplement framework: expanding existing assessment-related challenges to reflect developmental stages of AI integration, adding a new challenge category under Assessment for "Ensuring Authenticity and Originality of Students' Work", and introducing a new challenge category under Professional Engagement for "Differentiated Professional Development." These modifications address both theoretical gaps in the framework and practical needs in AI-focused TPD implementation. The results emphasize the importance of a staged approach to AI integration, beginning with fundamental challenges before advancing to more sophisticated applications, while underscoring the need for differentiated learning paths, greater emphasis on ethics and assessment, appropriate program timing and structure, and subject-specific content in TPD programs. These insights advance both the theoretical understanding of AI integration challenges and inform the development of more effective TPD programs that align with teachers' actual needs and readiness levels.

Proceedings of the 20th Chais Conference for the Study of Innovation and Learning Technologies: Learning in the Digital Era
D. Olenik-Shemesh, I. Blau, N. Geri, A. Caspi, Y. Sidi, Y. Eshet-Alkalai, Y. Kalman, E. Rabin (Eds.), Ra'anana, Israel:
The Open University of Israel

Keywords: Teacher Professional Development, Artificial Intelligence in Education, DigCompEdu AI Supplement Framework, AI Competency Development, Educational Technology.

Literature review

The emergence of Generative Artificial Intelligence (GenAI) has created unprecedented changes in educational practices and teacher responsibilities. This transformation requires teachers to develop new competencies to effectively utilize AI tools, while maintaining academic integrity and student well-being (Langran et al., 2024; Liu & Gu, 2024). As primary agents in developing students' AI literacy and preparing them for an AI-prevalent future, teachers face increasingly complex demands in their professional roles (NG et al., 2023).

The successful integration of AI in education demands more than basic technical skills from teachers. Current research emphasizes that AI literacy encompasses essential knowledge, skills, and ethical principles needed to effectively use and critically evaluate GenAI tools in teaching practices (UNESCO, 2023). Teachers must understand AI capabilities and limitations, develop data literacy, and consider ethical implications in educational contexts (Langran et al., 2024). However, developing these comprehensive competencies presents significant challenges that require targeted professional development solutions (Bekiaridis & Attwell, 2024).

The AI supplement to the DigCompEdu framework, developed as part of the AI Pioneers project, builds upon the European Digital Competence Framework for Educators by integrating AI-specific competencies across its six key areas: Professional Engagement, Digital Resources, Teaching and Learning, Assessment, Empowering Learners, and Facilitating Learners' Digital Competence (Bekiaridis & Attwell, 2024).This framework highlights the interconnected nature of technical skills, pedagogical implementation, and ethical considerations in AI integration. Within each area, the model identifies various challenges, from data privacy concerns and technological barriers to algorithmic bias issues, with teacher preparedness emerging as a critical challenge across all categories.

Teachers' Professional development (TPD) plays a vital role in supporting teachers' AI competency development. Effective TPD programs incorporate key characteristics such as content focus, active learning, coaching and expert feedback, alignment with school goals, sustained duration, and joint participation (Darling-Hammond et al., 2017). Recent approaches emphasize personalization, suggesting that program effectiveness improves through dedicated practice time, ongoing post-training support, and strong institutional backing (Avidov-Ungar, 2024). The rapid advancement of GenAI technologies further emphasizes the importance of thoughtful TPD design and implementation, requiring programs to address both technical proficiency and pedagogical integration while considering teachers' attitudes and organizational support (Skantz-Åberg et al., 2022).

Early studies of AI-focused TPD programs reveal significant implementation challenges. While these programs successfully enhance teachers' theoretical understanding of AI concepts and ethical awareness, they often struggle to support practical classroom implementation (Kong & Yang, 2024). Teachers frequently report difficulties translating theoretical knowledge into teaching practices, particularly when designing innovative AI-integrated lessons (Ding et al., 2024; Meli et al., 2024).

A critical gap exists in understanding how TPD programs affect the development of teachers' AI competencies in educational contexts. Current research primarily focuses on short-term outcomes or specific technical AI-related skills (Chiu et al., 2023; Ding et al., 2024; Kong & Yang, 2024), leaving broader questions about AI competency development unexplored. Notably

absent is a comprehensive examination of the challenges that emerge in AI-focused TPD programs and their impact on teachers' AI competency development through systematic theoretical frameworks, such as the recently developed DigCompEdu AI Supplement.

This study addresses this gap by investigating the specific challenges that emerge in AI-focused TPD programs and their effect on teachers' AI competency development through the lens of the DigCompEdu AI Supplement. The study explored the following **research question**: What challenges emerge in AI-focused TPD programs that affect the development of teachers' AI competencies as conceptualized in the DigCompEdu AI Supplement?

Methodology

This qualitative study utilized semi-structured interviews to examine teachers' experiences in an AI-focused TPD program. This approach was chosen for its ability to provide an in-depth understanding of teachers' experiences and the complexities of developing AI competencies in educational settings (Creswell & Poth, 2018).

Participants and Context

This study examined an entry-level AI-focused TPD program conducted by the Israeli Ministry of Education's Pedagogical Secretariat. The program was implemented through multiple parallel courses across various subject areas. While based on a generic curriculum designed by educational technology and AI integration experts, each course was adapted by subject-area instructors (experienced teachers and pedagogical mentors) to meet the specific needs of different disciplines. Course sizes varied, ranging from approximately 30 to 60 participants per subject area, with hundreds of teachers participating across all courses. Each course comprised 30 hours of instruction delivered through both synchronous and asynchronous sessions. The curriculum covered fundamental GenAI concepts, text-to-text and text-to-image tools, GenAI applications in educational design software, and subject-specific implementations, emphasizing responsible AI use in education. The participants completed the program during spring-summer 2024.

From this broader sample, 22 high-school teachers were selected for in-depth interviews using purposive sampling to ensure representation across different disciplines (sciences, humanities, and social sciences). The participants represented varied career stages: early career (0-5 years, n=5), middle career (6-12 years, n=7), and late career (13 or more years, n=10). Many held additional leadership roles within their schools, such as subject-matter or pedagogical coordinators. The sample also represented various geographic regions across Israel and different socioeconomic contexts, with teachers working in schools classified as high (n=9), medium-high (n=9), and medium-low (n=5) socioeconomic status. While a few participants had limited initial experience with AI tools, for the vast majority this TPD program served as their entry point into AI integration in education.

Research Tools and Procedure

Semi-structured interviews were conducted via Zoom videoconferencing within three weeks of program completion. The interviews, lasting 40-60 minutes, explored participants' experiences with the TPD program, development of AI competencies, and their implementation attempts.

Data analysis followed a hybrid approach combining inductive and deductive thematic analysis (Fereday & Muir-Cochrane, 2006). Initial inductive analysis followed Braun and Clarke's (2006) six-phase method, identifying emerging themes related to challenges in AI-focused TPD. This was followed by deductive analysis using the DigCompEdu AI Supplement framework

(Bekiaridis & Attwell, 2024) to categorize challenges within the framework's competency areas. The unit of analysis was a statement (rather than a participant). The coding was not exclusive, allowing for mapping of challenges across multiple framework categories when relevant. To ensure inter-rater reliability, 20% of the data was independently analyzed by a second rater, with Cohen's Kappa coefficient of 0.73 indicating substantial agreement between raters.

Findings and Discussion

This study examines the challenges that emerge in AI-focused TPD programs through the lens of the DigCompEdu AI Supplement (Bekiaridis & Attwell, 2024), which specifically addresses educators' AI competencies. Analysis of the interview data yielded 338 unique statements that were categorized into three major themes: content-related barriers (49.1%, n=166), critical content gaps (32.2%, n=109), and operational challenges (18.6%, n=63). While most statements were coded to a single category, some challenges exhibited interconnections, particularly within operational challenges where aspects of group size, depth of content, and program structure frequently co-occurred. Each theme is analyzed in relation to the framework's designated challenge categories, highlighting how these obstacles manifest across different competencies and impact teachers' ability to effectively integrate AI in their professional practice.

Theme 1: Content-Related Barriers in AI-Focused TPD

Analysis of teachers' experiences revealed that the learning content in AI-focused TPD - specifically the AI tools introduced and their potential applications both generally and within specific subject areas - significantly affected their AI competency development. Two distinct but interrelated challenges emerged: *Tools Limitations and Usage Barriers*, and *Perceived Lack of Value and Relevance Barriers*. These challenges align with multiple categories in the DigCompEdu AI Supplement, particularly within Digital Resources and Teaching & Learning domains. Table 1 presents representative quotes illustrating these content challenges and their mapping to the competency areas.

Table 1. Content-Related Barriers in AI-Focused TPD (n=166)

DigCompEdu AI Supplement Challenges	**Representative Quote**
Sub-category 1.1: Tools Limitations & Usage Barriers (n=114)	
Digital Resources: • Technical Limitations and Reliability • Quality and Relevance of AI-Driven Content • Teacher Preparedness and Training Teaching & Learning: • Quality and Relevance of AI-Driven Content	"I tried asking the chat to find another enzyme with a simpler measurement method... all the expected results were completely wrong." (T5) "Adapting it for civics can create much more work in lesson preparation than even relying on Google itself, mainly because the subject is very specific to Israel." (T22) "It couldn't create a proper pie chart - even for simple numbers like 30 versus 5 people. It's too much investment for something a child could easily understand." (T15)

Sub-category 1.2: Perceived Lack of Value and Relevance Barriers (n=64)	
Professional Engagement: • Resistance to Change and Technological Integration Teaching & Learning: • Teacher Preparedness and Training • Integrating AI with Existing Practices	"I have plenty of materials. Editing an existing exam takes less time than creating something new with GPT and checking all its nuances." (T7) "For physics in grades 11-12, you need deep understanding of the material and knowledge of students' difficulties. I don't need AI for that... I won't use it extensively in physics." (T12) "I have excellent presentations that are didactically sound and appropriate for what I teach. I can't say I'll use AI for that." (T14) "The image generation tools are good for backgrounds and aesthetics, but not for actual teaching material in physics." (T18)

The findings highlight two key barriers that reflect core challenges identified in the DigCompEdu AI Supplement. First, *Tools Limitations and Usage Barriers* manifest in Hebrew language processing and generating accurate visual content across all subject areas, aligning with the framework's "Technical Limitations and Reliability" challenge. Additionally, the "Content Quality and Relevance" challenge emerged as a significant concern, with AI-generated materials often failing to meet curricular requirements across different subjects—from sciences to humanities. These challenges created significant time burdens through an iterative process of correction and adaptation, reflecting the "Teacher Preparedness and Training" challenge, and highlighted the complexity of preparing educators to effectively use AI tools in teaching practices (Kong & Yang, 2024).

The second barrier, *perceived lack of value and relevance*, reflected challenges across multiple DigCompEdu AI Supplement competency areas - "Resistance to Change and Technological Integration" under Professional Engagement, and both "Integrating AI with Existing Practices" and "Teacher Preparedness and Training" under Teaching and Learning. Experienced teachers particularly questioned AI's pedagogical value, preferring existing materials over investing time in mastering AI tools and expressing skepticism about AI's ability to enhance teaching practices. This resistance was especially pronounced in subject-specific contexts, where the perceived investment in developing AI proficiency outweighed uncertain benefits. These findings align with research on teachers' challenges in translating AI knowledge into meaningful applications (Ding et al., 2024; Kong & Yang, 2024) and concerns about AI integration among experienced educators (Langran et al., 2024).

Theme 2: Critical Content Gaps in AI-Focused TPD

Analysis of teachers' experiences revealed three significant gaps in the TPD program content: *Need for Training in AI-Adapted Assessment Practices*, *ethical considerations*, and *Lack of Pedagogical Guidelines for Classroom Implementation*. These missing components significantly impacted teachers' ability to develop comprehensive AI competencies and effectively implement AI tools in their teaching practice. These challenges align with multiple categories in the DigCompEdu AI Supplement, particularly within Professional Engagement, Assessment and

Teaching & Learning domains. Table 2 presents representative quotes illustrating these content gaps and their mapping to the framework.

Table 2. Critical Content Gaps in AI-Focused TPD (n=109)

DigCompEdu AI Supplement Challenges	**Representative Quote**
Sub-category 2.1: Need for Training in AI-Adapted Assessment Practices (n=47)	
Assessment: • Professional Development for Educators • Integration with Traditional Assessment Methods • *Ensuring Authenticity and Originality of Students' Work*	"If the Ministry of Education includes assignments with AI, it could work. But if I have to create an AI-based assignment myself, I'm not sure how." (T16) "We can't match students' knowledge with their work anymore. We need new assessment methods to evaluate what they actually know." (T10) "I definitely didn't tell them they could use AI. I was surprised to see the wording wasn't authentic. Then I realized it was AI-generated." (T21)
Sub-category 2.2: Insufficient Coverage of Ethical Issues (n=37)	
Professional Engagement: • Ethical Considerations Teaching & Learning: • Teacher Preparedness and Training Digital Resources: • Data Privacy and Security Concerns	"We didn't learn about ethical issues in the training. If they do come across ethical issues, I'll guide them towards biology." (T7) "Just like with Instagram and TikTok, they could misuse AI too." (T13) "I don't know enough... if they really do enter their name, their ID, that's already a problem." (T9)
Sub-category 2.3: Lack of Pedagogical Guidelines for Classroom Implementation (n=38)	
Teaching & Learning: • Teacher Preparedness and Training • Integrating AI with Existing Practices Empowering Learners: • Teacher Preparedness and Training	"We raised questions about how to develop students' AI competencies and precision with the tools but received no practical guidance." (T1) "It was just brainstorming ideas. I can't actually use what I learned in a lesson plan." (T5) "I have some puzzle pieces but don't know how to use the tools effectively in my teaching." (T19)

The findings highlight three critical gaps that align with and extend key challenges in the DigCompEdu AI Supplement. First, teachers reported a significant lack of guidance regarding assessment practices in an AI-enhanced learning environment. While the framework includes assessment-related challenges such as "Professional Development for Educators" and "Integration with Traditional Assessment Methods", these focus primarily on advanced stages of AI

integration, such as using AI for grading and data analysis. However, our findings reveal that teachers face more immediate and fundamental challenges that are not addressed in the current framework. This suggests the **need to expand these existing categories** to reflect different stages of AI integration, from basic implementation to advanced applications. Moreover, the findings suggest the need for a **new challenge category under Assessment**: "*Ensuring Authenticity and Originality of Students' Work*". This prominent challenge, which includes developing strategies to identify AI-generated work and creating appropriate assessment methods for an AI-enabled environment, represents a distinct concern that is currently absent from the framework's categories (Langran et al., 2024; UNESCO, 2023).

The second gap centered on insufficient ethical guidance, leaving teachers without a clear understanding of AI-specific privacy concerns and ethical implications. This aligns with recent literature emphasizing the need for comprehensive AI literacy among educators that goes beyond technical skills to include ethical considerations (UNESCO, 2023). The absence of structured ethical guidelines left teachers equating AI-related challenges with general technology issues, highlighting a critical gap in current TPD programs.

Finally, teachers emphasized the lack of pedagogical guidelines for classroom implementation. While they gained familiarity with various AI tools, they lacked concrete strategies for meaningful integration into their teaching practices. This gap was particularly evident in their struggle to move beyond surface-level applications to develop pedagogically sound, subject-specific implementations, echoing findings about the challenges teachers face in translating theoretical knowledge into effective teaching practices (Ding et al., 2024; Kong & Yang, 2024).

Theme 3: Operational Challenges in TPD Structure and Timing

Analysis of teachers' experiences revealed significant operational challenges that hindered their AI competency development in the TPD program. These challenges centered around three main areas: *group size and participant heterogeneity*, *limited depth and focus on training content*, and *TPD structure, duration, and timing*. The findings highlighted a critical gap in the DigCompEdu AI Supplement regarding *differentiated professional development*, specifically, the need to address varying technical proficiencies, learning paces, and professional needs within AI-focused TPD programs. Table 3 presents representative quotes illustrating these operational challenges and their mapping to the framework competency areas.

Table 3. Operational Challenges in TPD Structure and Timing (n=63)

DigCompEdu AI Supplement Challenges	**Representative Quote**
Sub-category 3.1: Group Size and Participant Heterogeneity (n=24)	
Professional Engagement: • *Differentiated Professional Development* Digital Resources: • Teachers' Preparedness and Training	"The group was too heterogeneous - from tech experts to complete beginners like me." (T3) "With 60 people at different levels discussing different topics, from technical issues to curriculum, it was really challenging." (T16)

Sub-category 3.2: Limited Depth and Focus on Training Content (n=36)	
Professional Engagement: • *Differentiated Professional Development* Digital Resources: • Teachers' Preparedness and Training	"There wasn't enough time to go deeper. One session per tool is just a taste - you can't really master it." (T15) "I need to focus on one tool until I master it. Learning multiple tools makes me lose interest." (T10) "Every session covered 2-3 tools. It was impressive but I could only do the basic assignments." (T13)
Sub-category 3.3: TPD Structure, Duration, and Timing (n=33)	
Professional Engagement: • Lack of Training and Technical Expertise • *Differentiated Professional Development*	"We needed more time for questions and individual practice with immediate feedback." (T22) "All these attempts require free time, patience, and quiet space." (T7) "The timing was problematic - during exam period I was overloaded, and during summer vacation it's hard to stay motivated." (T4) "Being late in the year means no chance to experiment with students, and summer engagement is challenging." (T2)

The data analysis revealed that these operational challenges align primarily with existing challenges in the Professional Engagement and Digital Resources domains of the DigCompEdu AI Supplement, particularly regarding "Teacher Preparedness and Training". However, while the framework acknowledges basic training and resource challenges, our findings revealed three key operational challenges that demonstrate the limitations of current framework categories. First, large, heterogeneous groups with varying levels of technical proficiency struggled to benefit from the standardized training format. Second, the program's structure provided insufficient opportunities for individualized support and practice, extending beyond the framework's existing "Teacher Preparedness and Training" challenge. Finally, the short duration and scheduling during high-stress academic periods further complicated teachers' ability to engage meaningfully with the content. These challenges align with recent approaches emphasizing the importance of personalization in TPD programs (Avidov-Ungar, 2024) and the need for flexible and sustained professional development (Skantz-Åberg et al., 2022).

These findings suggest the need for **a new challenge category under Professional Engagement**: "*Differentiated Professional Development*." This proposed addition would specifically address the unique complexities of delivering AI-focused TPD to diverse groups of educators. Moreover, with emerging AI capabilities for personalization, future TPD programs could benefit from more adaptive approaches that better align with both the technology being taught and the diverse needs of participating educators.

Conclusions

This study examined the challenges emerging in AI-focused TPD programs and their impact on teachers' AI competency development through the lens of the DigCompEdu AI Supplement. The

findings reveal complex interrelationships between content-related barriers, critical content gaps, and operational challenges that extend beyond current frameworks and practices. Most notably, the study proposes three significant modifications to the Assessment area of the DigCompEdu AI Supplement: (1) expanding existing assessment-related challenges to better reflect the developmental stages of AI integration, from fundamental implementation to advanced applications, (2) adding a new challenge category under the Assessment area for "*Ensuring Authenticity and Originality of Students' Work*", and (3) introducing a new challenge category under Professional Engagement for "*Differentiated Professional Development*" to address the unique complexities of delivering AI-focused TPD to diverse groups of educators.

The study makes two key contributions. Theoretically, it expands the DigCompEdu AI Supplement by identifying gaps in its current conceptualization of AI-related challenges, particularly in assessment practices and TPD approaches. The proposed additions and modifications provide a more comprehensive and nuanced understanding of the challenges educators face when integrating AI into their practice. Practically, these findings highlight the need to begin with fundamental challenges such as managing AI-generated content, before advancing to more sophisticated applications. This understanding can help educational institutions design more effective TPD programs that align with teachers' actual needs and readiness levels.

Limitations and Future Research

This study's findings are limited by its focus on high school teachers in Israel who participated in an entry-level AI-focused TPD program. Reliance on self-report data may introduce biases like social desirability or recall inaccuracies. While demographic data including teaching experience and prior AI exposure was collected, detailed analysis of how these characteristics might influence teachers' experiences with AI-focused TPD is beyond the scope of this paper.

Future research should broaden the scope to include teachers from diverse educational levels and cultural contexts. They may also employ mixed-methods instead of relying solely on qualitative research. In addition, evaluating different TPD models can help identify best practices for developing AI competencies. Finally, longitudinal studies could explore the long-term impacts of differentiated professional development on teachers' AI competencies and classroom practices.

References

Avidov-Ungar, O. (2024). *The Personalized Continuing Professional Learning of Teachers: A Global Perspective (1st ed.)*. Routledge. https://doi.org/10.4324/9781003424390

Bekiaridis, G., & Attwell, G. (2024). *Supplement to the DigCompEDU Framework Introduction to AI in Education*. Retrieved from https://aipioneers.org/supplement-to-the-digcompedu-framework/

Braun, V., & Clarke, V. (2006). *Using thematic analysis in psychology*. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Chiu, T. K. F. (2023). The impact of Generative AI (GenAI) on practices, policies and research direction in education: a case of ChatGPT and Midjourney. *Interactive Learning Environments*, 1–17. https://doi.org/10.1080/10494820.2023.2253861

Darling-Hammond, L., Hyler, M. E., Gardner, M. (2017). *Effective Teacher Professional Development*. Palo Alto, CA: Learning Policy Institute. https://doi.org/10.54300/122.311.

Ding, A.-C. E., Shi, L., Yang, H., & Choi, I. (2024). Enhancing teacher AI literacy and integration through different types of cases in teacher professional development. *Computers and Education Open*, *6*, 100178. https://doi.org/10.1016/j.caeo.2024.100178

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International journal of qualitative methods*, 5(1), 80-92.

Kong, S.-C., & Yang, Y. (2024). A Human-Centred Learning and Teaching Framework Using Generative Artificial Intelligence for Self-Regulated Learning Development through Domain Knowledge Learning in K–12 Settings. *IEEE Transactions on Learning Technologies*, 1–13. https://doi.org/10.1109/TLT.2024.3392830

Langran, E., Searson, M., & Trumble, J. (2024). Transforming Teacher Education in the Age of Generative AI. *Exploring New Horizons: Generative Artificial Intelligence and Teacher Education*, *2*. Retrieved August 13, 2024 from https://www.learntechlib.org/primary/p/224054/

Liu, C. C., & Gu, X. Q. (2024). Developing Frames for Change: The Impact Of Generative AI on the Broad Practices of Teacher Educators. *Exploring New Horizons: Generative Artificial Intelligence and Teacher Education*, *225*. https://doi.org/10.13140/RG.2.2.35653.26088

Meli, K., Michalakis, K., & Papadopoulou, A. (2024). *Empowering educators with generative AI: The GenAI education frontier initiative*. In ResearchGate. Retrieved July 30, 2024 from https://bit.ly/3xr36XJ

Ng, D. T. K., Leung, J. K. L., Su, J., Ng, R. C. W., & Chu, S. K. W. (2023). Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world. *Educational Technology Research and Development*, 71(1), 137–161. https://doi.org/10.1007/s11423-023-10203-6

Skantz-Åberg, E., Lantz-Andersson, A., Lundin, M., & Williams, P. (2022). Teachers' professional digital competence: an overview of conceptualisations in literature. *Cogent Education*, *9*(1), 2063224. https://doi.org/10.1080/2331186X.2022.2063224

UNESCO. (2023, September 7). *Guidance for generative AI in education and research.* Retrieved July 30, 2024 from: https://www.unesco.org/en/articles/guidance-generative-ai-education-and-research