

From Logistics to Cognition: A Review of *Digital Technology and Artificial Intelligence in Mathematics Education Assessment*

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Book Information

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Introduction

As a secondary mathematics leader for a large urban school district in the United States, my work involves both policy and classroom reality. In our current climate, the discussion of digital learning is frequently reduced to logistical decisions, such as procuring hardware or selecting software. However, choosing digital tools for mathematics education carries far broader cognitive implications. As Pea (1985) observed, technology is not a neutral delivery mechanism; rather, "it becomes an indispensable instrument of mentality, and not merely a tool" (p. 175). Consequently, the dialogue surrounding digital integration must extend beyond administrative logistics to examine how these technologies fundamentally reshape instructional design and assessment. *Digital Technology and Artificial Intelligence in Mathematics Education Assessment* (2026), edited by Eirini Geraniou, Cosette Crisan, and Manolis Mavrikis, offers a vision for the future of digital learning in mathematics that extends far beyond this limited view. This compilation of international research, comprising 15 chapters by contributors from 11 countries, argues that moving from paper to screen is not merely a lateral shift; it fundamentally reshapes how students explore, manipulate, and communicate mathematical ideas.

Central Themes: Beyond Efficiency

Digital Technology and Artificial Intelligence in Mathematics Education Assessment (2026) is framed by several thought-provoking questions: How do we identify evidence of learning in the digital era? What does it mean to see the trail of learning a student leaves behind? A central theme throughout the 15 chapters is preserving mathematical inquiry in a context that prioritizes scoring efficiency. The authors warn that whereas digital tools expand opportunities for deep thinking, they also tempt educators and administrators to emphasize what is measurable over what is significant (p. 58).

The text identifies four pillars that resonate deeply with current school challenges:

1. The Nature of the Transition: Shifting to digital assessment changes the tools and techniques students choose to employ.
2. Conceptual Assessment: Platforms can now assess students' questions and thought processes, not just their final solutions.
3. Human-AI Complementarity: While Large Language Models (LLMs), such as OpenAI's ChatGPT, excel at communicating ideas, technical tools like Computer Algebra Systems (CAS) that enable software to manipulate and solve mathematical expressions symbolically remain necessary for mathematical precision.
4. Equity and Access: Digital tools can bridge the feedback gap in large classrooms but simultaneously risk widening the divide for those without consistent infrastructure.

Discussion of Interconnected Themes and Ideas

The transition from paper to digital platforms is far from a neutral act of digitizing worksheets. This shift affects more than just the format of a response by fundamentally altering the cognitive utilization schemes students employ to solve problems (Iannone et. al, 2026, Chapter 2; Winnberg, et. al., 2026, Chapter 3). This evolution creates a central tension between assessing students' understanding of mathematical concepts and their technical proficiency, raising a critical question for educators: to what extent does the tool itself define the significance of the task (Winnberg, et. al., 2026, Chapter 3; Vikberg, 2026, Chapter 4)? In Finland, for example, the move to digital high-stakes testing has highlighted that for assessment to be valid, technology must be deeply embedded in the curriculum and instruction well in advance of the exam (Vikberg, 2026, Chapter 4).

A theme developed over multiple chapters and various contexts is that when technology is successfully embedded, it moves beyond a simple interface and becomes a window into student cognition. Digital platforms offer a dashboard view of thinking, eliminating the traditional lag of manual marking and providing immediate, actionable data. Tools such as GeoGebra allow educators to monitor the live manipulation of geometric figures, revealing individualized needs in real-time (Ayoob & Olsher, 2026, Chapter 5), whereas sophisticated multiple-choice designs can pinpoint misconceptions and reduce cognitive load for multilingual learners (Barzel et. al., 2026, Chapter 9). This efficiency is particularly transformative in large-scale university settings, where digital systems allow instructors to facilitate open-ended, example-eliciting tasks that would be logistically impossible to mark manually (Fahlgren & Brunström, 2026, Chapter 10).

However, the visibility of student data is only as useful as the feedback it triggers. Black & Wiliam (1998) emphasize that, "feedback to any pupil should be about the particular qualities of his or her work, with advice on what he or she can do to improve, and should avoid comparisons with other pupils." (p. 143). Effective digital feedback must therefore strike a delicate balance: it must support the student without giving away the solution. Research from the Netherlands recommends a tiered approach that incorporates error-specific hints followed by worked solutions to foster self-guidance (van der Hoek et al., 2026, Chapter 11). Furthermore, Interactive Learning Environments can now detect whether a student is engaging deeply or merely taking a surface approach (Margeti & Mavrikis, 2026, Chapter 13). While the emergence of atomic feedback (reusable, bite-sized units of commentary) allows for more elaborate responses, the human element remains vital; teachers must remain central to the feedback process to ensure guidance is tailored and nuanced (Moons, 2026, Chapter 14).

The frontier of this partnership between technology and teachers lies in machine learning and artificial intelligence (AI), which offer personalized tutoring but introduce new challenges regarding noise and randomness. Whereas AI has made strides in the automated scoring of open-ended

questions through semantic representation, it still struggles with complex mathematical syntax and student-generated imagery (Baral et al., 2026, Chapter 7). This technological uncertainty requires a reconceptualization of the student's role; they must be intentionally taught to handle the hallucinations of AI to avoid unproductive conversational loops that lead to dead ends rather than legitimate problem-solving guidance (Cusi & Contel, 2026, Chapter 8) and to approach dialogue with AI thoughtfully rather than uncritically accepting outputs (Thomsen et al., 2026, Chapter 15).

Ultimately, the goal is to ensure mathematics education does not devolve into mere button pushing. Pinkernell and Weigand (2026, Chapter 6) emphasize the importance of assessing conceptual knowledge through basic mental models that represent core mathematical understanding. Building on this, Thomsen, Misfeldt, & Jankvist, (2026, Chapter 15) discuss how CAS and LLMs support student tasks through three distinct types of mediation: pragmatic, which involves the use of AI as a problem-solving tool; epistemic, in which AI helps a student understand a concept; and justificational, wherein the output of the tool serves as the main justification of a mathematical claim. As students learn to navigate these technologies, educators must encourage critical questioning of AI-generated responses rather than allowing outputs to become "techno-authoritarian proof schemes" accepted without scrutiny.

Reflective Analysis for Mathematics Leaders

In a traditional setting, summative assessment has largely been post-mortem, a term coined by Douglas Reeves (2005). Whereas traditional assessment reveals what the student did not know after the instruction was already concluded, this text calls upon educators to re-evaluate the purpose of assessment. Digital platforms shift the purpose from summative evaluation to live navigation. Modern digital dashboards promise to empower educators with timely, customized feedback. Moons (2026, Chapter 14) describes how AI-teacher partnerships can generate feedback based on structural errors in math classrooms. As these tools improve, digital assessment will increasingly be used to adjust instruction live rather than retrospectively. For teacher educators, this requires a shift in how we prepare pre-service teachers to "read" a classroom, as using mathematical software demands balancing real-time observational attentiveness with digital dashboard fluency.

The text also challenges educators to consider what counts as mathematical skill. Digital assessments now measure both mathematics concepts and technological literacy, such as AI prompting or CAS manipulation. This presents a curricular dilemma: if a CAS-enabled calculator is allowed on all items, we may unintentionally stop assessing manual algebraic manipulation. As described by Stacey (2024) mathematical "invisibility" presents a very real challenge, as calculations are increasingly "outsourced" to machines" (p. 226). We must therefore intentionally decide which skills, both mathematical and technological, we value most. The book challenges us to consider whether prompt engineering is becoming a subset of mathematical communication. If so, our assessment frameworks must evolve to give credit for the logic of the query, not just the accuracy of the result.

A key emphasis of the text is its timely discussion of *Instrumental Genesis*, the idea that our tools fundamentally change our mental schemas. Digital task design dictates how students conceptualize ideas. We must shift our focus from easy-to-automate tasks to conceptual tasks that require deeper understanding. This requires curriculum designers and mathematics leaders to shift their own thinking from marking the answer to evaluating the relationship between the student and the digital environment. This is a profound shift in teacher professional development, moving from how to use the tool to how the tool uses the student's mind.

The persistent challenge of equity presents another critical question for educators. Gottschalk and Weise (2023) define digital equity as the state in which “all individuals have the digital capacity (including access and skills) to fully participate in society” (p. 8), emphasizing that, “The rapid shift to digital learning was more difficult for particular student groups, especially those from vulnerable or disadvantaged backgrounds, and for those who lacked the requisite access and infrastructure” (p. 11). Chapter 12 (Sangwin & Oyengo, 2026) highlights the ability to provide feedback to hundreds of students simultaneously, potentially improving equity in resource-strapped environments. However, this assumes access to digital infrastructure and high-speed connectivity. For a leader in a large urban district, the most pressing takeaway is that expanding digital instruction risks widening the gap between those with stable access and those without. Digital equity is not just about having a laptop; it is about having the digital capital to navigate complex AI interfaces without becoming frustrated or lost in unproductive loops.

Limitations

As a compilation of international research grounded in varied institutional contexts, the text presents a natural trade-off: practitioners will find certain chapters immediately actionable, while others feel distant from everyday school realities. Furthermore, the volume’s academic density may prove daunting to time-pressed leaders seeking a straightforward entry point into AI’s influence on local mathematics instruction. Practitioners and administrators will likely gain the most value by using the introductory chapter summaries to curate a targeted reading path tailored to their district’s specific needs. Finally, while the text offers exceptional theoretical depth regarding the mechanics and implications of digital assessment, its concrete roadmap for under-resourced K–12 leaders remains limited, leaving open critical questions about how to operationalize this vision within large, complex public school systems.

Conclusion

Although the text is academically rigorous and filled with technical terminology such as ILEs (Interactive Learning Environments), its heart is the daily life of teachers and students. It acknowledges that digital assessment creates a new form of work involving technical orchestration and question authoring. We cannot expect teachers to navigate this without dedicated, sustained professional development.

This book is indispensable for educators, researchers, and leaders at the intersection of mathematics and technology. It provides empirical evidence and theoretical grounding to ensure that, as we move into an automated future, we do not lose the human trail of learning that makes mathematics vital. It is a call to action for the mathematics education community to take the lead in defining AI’s role in the classroom, rather than letting the technology companies define it for us.

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References

- Ayoob, H. & Olsher, S. (2026). AI-driven example generation and feedback provision. In E. Geraniou, C. Crisan, & M. Mavrikis (Eds.), *Digital technology and artificial intelligence in mathematics education assessment* (pp. 73–90). Routledge. <https://doi.org/10.4324/9781003533764-5>
- Baral, S., Cheng, L., Botelho, A., & Heffernan, N. (2026). Advancing automated assessment for open-ended questions in mathematics. In E. Geraniou, C. Crisan, & M. Mavrikis (Eds.), *Digital technology and artificial intelligence in mathematics education assessment* (pp. 109–126). Routledge. <https://doi.org/10.4324/9781003533764-7>
- Barzel, B., Hagenkötter, R., Klingbeil, K., Rösken, F., Stemmer, & Tyrichter. (2026). The power of well-designed multiple-choice items to enhance mathematics teaching and learning. In E. Geraniou, C. Crisan, & M. Mavrikis (Eds.), *Digital technology and artificial intelligence in mathematics education assessment* (pp. 145–162). Routledge. <https://doi.org/10.4324/9781003533764-9>
- Black, P., & Wiliam, D. (1998). Inside the black box: Raising standards through classroom assessment. *Phi Delta Kappan*, 80(2), 139–148.
- Cusi, A. & Contel, F. (2026). A reconceptualisation of the instrumental genesis process in the context of human–LLM interactions: exploring students’ perspective on their use of GPT-4o as a tool to support self-assessment. In E. Geraniou, C. Crisan, & M. Mavrikis (Eds.), *Digital technology and artificial intelligence in mathematics education assessment* (pp. 127–144). Routledge. <https://doi.org/10.4324/9781003533764-8>
- Fahlgren, M. & Brunström, M. (2026). Example-generation tasks for computer-aided assessment. In E. Geraniou, C. Crisan, & M. Mavrikis (Eds.), *Digital technology and artificial intelligence in mathematics education assessment* (pp. 163–180). Routledge. <https://doi.org/10.4324/9781003533764-10>
- Geraniou, E., Crisan, C., & Mavrikis, M. (Eds.). (2026). *Digital technology and artificial intelligence in mathematics education assessment*. Routledge. <https://doi.org/10.4324/9781003533764>
- Gottschalk, F., & Weise, C. (2023). Digital equity and inclusion in education: An overview of practice and policy in OECD countries. *OECD Education Working Papers*, No. 299. OECD Publishing. <https://doi.org/10.1787/7cb15030-en>
- Iannone, P., Lemmo, A., & Kinnear, G. (2026). The transfer of assessment from pen and paper to e-assessment: Two case studies from one theoretical perspective. In E. Geraniou, C. Crisan, & M. Mavrikis (Eds.), *Digital technology and artificial intelligence in mathematics education assessment* (pp. 21–36). Routledge. <https://doi.org/10.4324/9781003533764-2>
- Margeti, M. & Mavrikis, M. (2026). Study approaches in interactive learning environments for formative assessment: detecting patterns aligned with Entwistle’s theory. In E. Geraniou, C. Crisan, & M. Mavrikis (Eds.), *Digital technology and artificial intelligence in mathematics education assessment* (pp. 217–234). Routledge. <https://doi.org/10.4324/9781003533764-13>

Moons, F. (2026). Introducing atomic, re-usable feedback for the semi-automated assessment of mathematics tasks. In E. Geraniou, C. Crisan, & M. Mavrikis (Eds.), *Digital technology and artificial intelligence in mathematics education assessment* (pp. 235–252). Routledge. <https://doi.org/10.4324/9781003533764-14>

Pinkernell, G. and Weigand, H. (2026). Adaptive feedback and (digital) assessment of conceptual knowledge. In E. Geraniou, C. Crisan, & M. Mavrikis (Eds.), *Digital technology and artificial intelligence in mathematics education assessment* (pp. 91–108). Routledge. <https://doi.org/10.4324/9781003533764-6>

Reeves, D. (2005). Putting it all together: Standards, assessment, and accountability in successful professional learning communities. In R. DuFour, R. Eaker, & R. DuFour (Eds.), *On common ground: The power of professional learning communities* (pp. 45–63). Solution Tree Press.

Sangwin, C. & Oyengo, M. (2026). Using computer algebra to support automatic assessment of mathematics. In E. Geraniou, C. Crisan, & M. Mavrikis (Eds.), *Digital technology and artificial intelligence in mathematics education assessment* (pp. 199–216). Routledge. <https://doi.org/10.4324/9781003533764-12>

Stacey, K. (2024). Mathematical competencies in the digital era. *Journal of Research and Advances in Mathematics Education*, 8(4), 225–232. <https://doi.org/10.23917/jramathedu.v8i4.3096>

Thomsen, M., Misfeldt, M., & Jankvist, U. T. (2026). Developing mathematical competencies to assess ChatGPT-generated outputs: Three forms of mediations. In E. Geraniou, C. Crisan, & M. Mavrikis (Eds.), *Digital technology and artificial intelligence in mathematics education assessment* (pp. 265–281). Routledge. <https://doi.org/10.4324/9781003533764-15>

Pea, R. D. (1986). *Cognitive technologies for mathematics education* (Technical Report No. 37). Bank Street College of Education, Center for Children and Technology. HAL Open Science. <https://telearn.hal.science/hal-00190536>

Van der Hoek, G., Heeren, B., Bos, R., Drijvers, P., & Jeuring, J. (2026). Students' interaction with and appreciation of automated informative tutoring feedback. In E. Geraniou, C. Crisan, & M. Mavrikis (Eds.), *Digital technology and artificial intelligence in mathematics education assessment* (pp. 181–198). Routledge. <https://doi.org/10.4324/9781003533764-11>

Vikberg, T. (2026). The use of AI for automated diagnosis in mathematics education. In E. Geraniou, C. Crisan, & M. Mavrikis (Eds.), *Digital technology and artificial intelligence in mathematics education assessment* (pp. 55–72). Routledge. <https://doi.org/10.4324/9781003533764-4>

Winnberg, M., Sollerman, S., & Van Steenbrugge, H. (2026). Designing multiple-choice items for digital mathematics assessment. In E. Geraniou, C. Crisan, & M. Mavrikis (Eds.), *Digital technology and artificial intelligence in mathematics education assessment* (pp. 37–54). Routledge. <https://doi.org/10.4324/9781003533764-3>