

Equitable Integration of Technology for Mathematics Learning

A Position of the National Council of Teachers of Mathematics

Using the capabilities of technology is essential for educators and learners to inform and transform how they learn, experience, communicate, assess, and do mathematics. Technology should be used to develop and deepen learner understanding, stimulate interest in the mathematics being learned, and increase mathematical proficiency. When technology is used strategically, it provides more equitable access and opportunities for each and every learner to actively engage and participate in the learning of mathematics.

Catalyzing Change Through Equitable Technology Integration

Mathematical experiences are interwoven with various aspects of life as outlined by National Council of Teachers of Mathematics (NCTM) Catalyzing Change series (NCTM, 2018; NCTM, 2020). Consistent with the goals set forth by NCTM to engage, empower, and elevate students, technology can and should play a large role in opportunities to “identify, interpret, evaluate, and critique the mathematics embedded in social, scientific, commercial, and political systems” (NCTM, 2018, p. 11). Technology is a catalyst for change and innovation in our global society. Technology advancements have led to transformations in fields such as medicine, communication, and science, and it allows for building mathematical models as well as exploring large data sets in ways that seemed inconceivable even a decade ago. Such advances in technology must be reflected in mathematics programs and classrooms in ways that are thoughtful and keep the learning of mathematics at the forefront of students’ experiences (NCTM, 2020).

Many different types of technologies used in mathematics teaching and learning each serve different purposes (Dick & Hollebrands, 2011; McCulloch et al., 2021). For example, conveyance technologies are those that are used to convey information and allow students and teachers to present, communicate, and collaborate with one another. These technologies can be used for many different purposes, including communicating, collaborating, assessing, and monitoring, as well as bringing real and interesting contexts to students through video, online data sets, or virtual reality. Math action technologies offer students opportunities to interact with mathematical objects in ways that are impossible with paper and pencil and have the potential to allow students to focus on reasoning and sense making and explore relationships and patterns in mathematical or statistical behavior by acting on the mathematical objects themselves.

The goals set by NCTM to engage and empower learners and educators can be met through collaborative experiences that are also consistent with considerations stated by the International Society for Technology in Education (ISTE), including the standards for Educators (2017) emphasizing the importance of collaboration and communication among learners, educators, and family. Educators

must attend to equitable considerations for access, design, and use of technologies to enhance the range of learning opportunities when teaching mathematics (TODOS, 2020).

Declarations

We must intentionally center the voice and experiences of learners and promote equitable technology integration in mathematics education to—

- **Humanize mathematical learning experiences through the intentional use of technology to showcase the brilliance of learners through inclusive and accessible ways.** Technological tools can provide access to tasks as well as opportunities for learners to engage in mathematical experiences that warrant collaborative questioning, mathematizing, validating, analyzing, refining, and investigating experiences (Safi et al., 2022). Valuing the insights and perspectives of students by leveraging technological tools is important to make their brilliance visible, acknowledged, and effectively sharable in learning spaces. Technology should elicit and use evidence of student thinking to communicate positive messages about learners' mathematical identities. For this reason, remembering that “mastery of skills should not be a prerequisite for using technology” is important; rather, when using technology the focus should be on developing understanding and interpreting results (NCTM, 2018, p. 42). Technology can play a pivotal role in establishing and sustaining a classroom culture that values students engaging in mathematical discussions with their peers and educators. In addition, by carefully selecting the appropriate technology for your goal, technology can play a role to break power dynamics between who is doing the mathematics (Krutka et al., 2022; Yadav & Lachney, 2022).

Question to Consider: How does our use of technology position each and every student as a powerful doer of mathematics?

- **Leverage technologies for collaborations and communication to increase opportunities for authentic learning experiences that promote learners' success.** Technology should be used by educators to collaborate with colleagues to create authentic learning experiences and communicate with learners, parents, and colleagues and engage with them as co-collaborators (Howard, 2015; Howard et al., 2018). Teachers must set norms with students that promote safe and productive interaction in digital environments (TODOS, 2020), such as privacy, security, and preventing cyberbullying, to ensure safety when collaborating online through authentic, real-world learning experiences. Provide families with resources for how to use the various technologies, keeping in mind the particular needs of your families, and use technology to communicate with learners and their family.

Question to Consider: How can we use technology in transformative ways to communicate safely and productively about mathematics, within and across different mathematics education communities (e.g., among students, with colleagues, with parents)?

- **Technology should play a role in creating opportunities to support the reasoning and sense making of relevant social contexts connected to relevant issues facing our communities.** Technology can support reasoning and sense making toward identifying, interpreting, evaluating, and critiquing the mathematics embedded in social, scientific, commercial, and political systems. Technology should be used not only to develop and deepen student understanding, but also to stimulate interest in mathematics and the manner in which mathematics is being learned as well as to increase mathematical proficiency. A powerful way to

stimulate engagement and interest through the use of technology involves the connection to authentic and relevant contexts—for example, using technology to model and produce graphs from applied situations with problems of life and society (NCTM, 2018). As such, learners are more likely to actively engage in their communities and their potential power to challenge injustices and contribute to societal improvement (Gutstein & Peterson, 2013).

Question to Consider: How can we use technology to support students' interest in and sense making about relevant social contexts facing our communities?

- **Develop systems of reflective practice to support educators as they plan for and use technology in their instruction.** Educators having the knowledge that different types of technology serve different purposes can inform how to intentionally plan for lessons that optimize the mathematical learning for each and every student. The complexity of knowing when, what, how, and why to integrate technology involves thinking about technological choice, curriculum goals, and pedagogical considerations (Borthwick et al., 2020) and relates to technology pedagogical content knowledge (TPACK; Mishra & Koehler, 2006). TPACK emphasizes how three knowledge bases—technology knowledge, pedagogical knowledge, and content knowledge—influence one another when planning and implementing technology in the mathematics classroom. Effective use of technology requires careful planning with appropriate professional development to learn how to use technology effectively and equitably (Suh et al., 2022) and to develop specialized knowledge and skills (NCTM, 2020).

Question to Consider: How can teachers and teacher leaders support one another as we continue to develop and reflect on our deepening TPACK and a vision of high-quality, equitable instruction with technology that is aligned with NCTM's (2014; 2018) effective and equitable teaching practices?

Embracing the continuous advancement in technology in mathematics education is important as is considering new technologies with respect to each of the four points above. In summary, technology must be integrated with intentionality to value and make visible the brilliance of each and every learner in classroom settings in authentic and inclusive ways.

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