Association of Mathematics Teacher Educators
c/o Michigan Technological University, Department of Cognitive and Learning Sciences
1400 Townsend Dr., Houghton, MI 49931
www.amte.net

Position of the Association of Mathematics Teacher Educators on Technology

One goal of AMTE is to improve mathematics teacher education and K12 education by recognizing the ever-increasing impact of technology on our field. Our organization is thus committed to critically examining how technology intersects our work as Mathematics Teacher Educators (MTEs) and supporting research-based incorporation of technology in our work.

AMTE defines technology as digital tools and resources that allow teachers and students to engage with mathematics in ways that promote conceptual understanding (AMTE, 2017). Familiar examples include calculators, computers, virtual manipulatives, electronic textbooks, interactive applets, programming platforms, block-based coding, virtual and physical robotics, online curricula, learning management systems, virtual collaboration tools, and software for conducting statistical and mathematical inquiry.

AMTE's stance on technology rests on five interconnected ways MTEs should incorporate technology to align with research-based recommendations:

1. **Using technology to advance equity and equitable teaching practices**

Technology can play an integral part in promoting equitable teaching practices by providing additional ways to value and make visible students' brilliance and diverse perspectives while providing further access and opportunity. Relating to AMTE's mission of supporting equity in mathematics teacher education, teachers and MTEs should interrogate the role of technology in providing access and equity to students, schools, communities, and partners (Barlow et al., 2020, Gomez et al., 2021). Rich tasks and dynamic mathematical tools and apps have opened up possibilities for digital technology to be used as a lever for equitable instruction and provide equitable participation structures (NCTM, 2020). Mathematical action technologies allow students to explore mathematical ideas and observe, make, and test conjectures about mathematical relationships while other conveyance technologies (Dick & Hollebrands, 2011) such as presentation, communication and collaborative technologies provide opportunities for student to revisit, reflect, and revise initial thoughts and to build collective knowledge. In addition, assessment and monitoring digital dashboards allow for teachers to select, sequence, and connect diverse student strategies while elevating students who may be often marginalized in the classroom and assign students' competencies. It is critical for teachers and MTEs to be supported in order to integrate intentional use of technology tools and resources to provide greater access to rich and meaningful mathematics. In this manner, MTEs can support equitable practices by using lesson analyses that encourage teachers to be judicious and deliberate when planning lessons using technological tools (Thomas & Edson, 2017; Suh et al., 2022).

2. Supporting teachers in using technology to develop their mathematical content knowledge

Technology remains a necessary component to the effective learning and teaching of mathematics. MTEs should ensure coursework provides opportunities for teacher candidates to effectively use technology to engage in mathematics and statistics concepts, deepen their understanding of mathematics, and apply mathematical ideas (NCTM & CAEP, 2012; NCTM & CAEP, 2020). These opportunities should be present in all mathematics content areas such as Number, Algebra and Functions, Geometry and Measurement, Calculus, and Probability and Statistics, as well as in the Mathematical Practices (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Teacher candidates need opportunities to become familiar with a variety of technological tools in meaningful ways, including graphing tools, dynamic mathematics and statistics tools, spreadsheets, Computer Algebra Systems, virtual manipulatives, computer programming, robotics, modeling tools, and simulations. "For example, visualizations of a data set can help students better understand patterns within a data set, and spreadsheets can help students create models of mathematical situations, thus supporting the development of mathematical practices and processes" (AMTE, 2017, p. 31). Conceptual understanding of mathematics can be supported by "mathematical action technologies" used to "perform mathematical tasks" or "respond to the user's actions in mathematically defined ways" (Dick & Hollebrands, 2011, p. xii). NCTM's (2015) position statement on technology provides further guidance on how technology can and should be used to support the teaching and learning of K12 mathematics.

3. Supporting teachers in using technology to help their students learn mathematics

Similar to how MTEs support the development of both content and pedagogical content knowledge, AMTE recognizes teaching mathematics using technology requires attending to and developing technological pedagogical content knowledge (Koehler & Mishra, 2009). This flexible knowledge is needed by teachers to effectively integrate technology to help their students learn mathematics. MTEs should ensure coursework supports the development of teachers who are proficient with tools and technology designed to support mathematical reasoning and sense making, both in doing mathematics themselves and in supporting student learning of mathematics. In particular, it is important for teachers to "develop expertise with spreadsheets, computer algebra systems, dynamic geometry software, statistical simulation and analysis software, and other mathematical action technologies as well as other tools, such as physical manipulatives" (AMTE, 2017, p. 125). In addition to mathematical action technologies (Dick & Hollebrands, 2011), some conveyance technologies can be instrumental in teaching mathematics and monitoring and formatively assessing students as they collaboratively problem solve (Cohen & Hollebrands, 2011; Glassmeyer & Paurowski, 2021). Furthermore, with the inclusion of computer science curriculum in K-12 education (Computer Science Teachers Association, 2017; K-12 Computer Science Framework, 2016) and the availability of low cost or free programming platforms, new opportunities arise for "computer science and coding to increase student understanding of important mathematics, develop productive practices, and introduce students to computational thinking in a supportive, concept-based environment" (NCSM, 2018).

When planning to integrate technology MTEs should use research-based frameworks to guide the design of learning experiences supporting teachers' specialized knowledge for teaching mathematics with technology (McCulloch et al., 2021). When supporting teacher candidates to use technology, the goal should be to help them become judicious users of technology so that they can learn to

identify the technology that is appropriate for a given task as well as the moment and way to use it to support students' mathematics learning and understanding.

4. Supporting teachers with online, hybrid, and distance education

Supporting effective practices in teaching and learning mathematics through multiple modalities of instruction became profoundly important during the pandemic. The knowledge needed to support instruction with the use of technology in an online, hybrid and distance education setting is a form of specialized knowledge that is important for all educators particularly with the increased prevalence of online and distance education. Guidance on instructional adjustments needed to support mathematical learning at a distance have been made by AMTE's Online Mathematics Teacher Education Task Force and by the field during the pandemic. There needs to be continuous improvement to retool and learn how to better design online courses (Fernandez et al., 2021; Kochmanski, 2021); how to support effective practices in teaching and learning mathematics in synchronous formats (Wills et al., 2021), in asynchronous formats, and in blended and Flipped Classroom models. In addition, MTEs should consider high leverage practices in these different modalities of instruction (Wills, 2021) and how to support and mentor teachers and mathematics leaders in online programs (Baker et al., 2021).

5. Evaluating Technology-Supported Teaching and Learning

To ensure technology use remains focused on the teaching and learning of mathematics in ways supported by research, MTEs must be reflective practitioners and researchers by self-evaluating the technology used in their work (McCulloch et al., 2021). This involves evaluating the technology both in terms of available features and how the technology is being implemented (or designed) using established guidelines in the mathematics education community. For example, MTEs can use existing frameworks to evaluate technology by assessing digital instructional materials (Thomas & Edson, 2019) or interactive geometry software (Sherman & Cayton, 2015). MTEs should also support teachers' evaluation of technology (SPTM, 2017). For example, frameworks such as the Pedagogical, Mathematical, and Cognitive fidelity (Dick, 2008) can be adapted so teachers can assess their use of technology using a series of "questions to consider when evaluating or selecting technology tools" (Shin et al., 2018, p. 158). These efforts can develop teachers' knowledge to "make sound decisions about when such tools enhance teaching and learning, recognizing both the insights to be gained and possible limitations of such tools" (NCTM & CAEP, 2012, p. 3).

References

Association of Mathematics Teacher Educators. (2017). *Standards for preparing teachers of mathematics*.

Baker, C., Ellington, A., & Haver, W. (2021). Mathematics teacher leaders preparation, mentorship and service: Communities of practice through online modalities. *Journal of Mathematics and Science: Collaborative Exploration* 17(1) Retrieved from https://scholarscompass.vcu.edu/jmsce_vamsc/vol17/iss1/1

Computer Science Teachers Association (2017). CSTA K-12 Computer Science Standards, Revised 2017. Retrieved from http://www.csteachers.org/standards.

Barlow, A. T., Edwards, C. M., Robichaux-Davis, R., & Sears, R. (2020). Enhancing and transforming virtual instruction. *Mathematics Teacher: Learning and Teaching PK-12, 113*(12), 972-982.

Cohen, J. & Hollebrands, K. (2011). Technology tools to support mathematics teaching. In T. Dick & K. Hollebrands (Eds.). *Focus in high school mathematics: Technology to support*

reasoning and sense making (pp. 105-122). Reston, VA: National Council of Teachers of Mathematics.

Dick, T. (2008). Keeping the faith: Fidelity in technology tools for mathematics education. In Heid, M. K. & G. W. Blume (Eds.), *Research on technology and the teaching and learning of mathematics: Volume 2. Cases and perspectives* (pp. 333-340). Charlotte, NC: Information Age.

Dick, T., & Hollebrands, K. (2011). *Focus in high school mathematics: Technology to support reasoning and sense making*. Reston, VA: National Council of Teachers of Mathematics.

Fernandez, M.L., Fatima, S., Forde, E., Park, J. (2021). Tech lessons learned through COVID 19. *Association of Mathematics Teacher Educators Technology Blog*. https://amte.net/tech-talk/2021/08/tech-lessons-learned-through-covid-19

Glassmeyer, D. & Paurowski, M. (2021). Using interactive whiteboards with mathematics teachers and students. *Association of Mathematics Teacher Educators Technology Blog*. https://amte.net/tech-talk/2021/10/using-interactive-whiteboards-mathematics-teachers-and-students

Gomez, K., Gomez, L. M., & Worsley, M. (2021). Interrogating the role of CSCL in diversity, equity, and inclusion. In Cress, U., Oshima, J., Rosé, C. & Wise, A. (Eds.), *International handbook of computer-supported collaborative learning* (pp. 103-119). Springer, Cham.

K–12 Computer Science Framework. (2016). Retrieved from http://www.k12cs.org

Kochmanski, N. (2021). Strategies for using Google Slides to facilitate online discussions. *Association of Mathematics Teacher Educators Technology Blog*. https://amte.net/tech-talk/2021/07/strategies-using-google-slides-facilitate-online-discussions

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education, 9*(1), 60-70.

McCulloch, A., Leatham, K., Bailey, N., Cayton, C., Fye, K., & Lovett, J. (2021). Theoretically framing the pedagogy of learning to teach mathematics with technology. *Contemporary Issues in Technology and Teacher Education, 21*(2), 325-359.

NCTM (2015). *Strategic use of technology in teaching and learning mathematics*: A position of the National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics (2020). *Catalyzing change in early childhood and elementary mathematics initiating critical conversations.* Reston VA, USA: NCTM.

National Council of Teachers of Mathematics and the Council for the Accreditation of Educator Preparation (NCTM & CAEP). (2012). *NCTM CAEP standards—middle grades (Initial preparation)*.

National Council of Teachers of Mathematics and the Council for the Accreditation of Educator Preparation (NCTM & CAEP). (2020). *Standards for the preparation of secondary mathematics teachers*.

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards for Mathematics*. Washington, DC: Authors.

NCSM (2018). *Computer Science and K-12 Mathematics.* Retrieved from https://www.mathedleadership.org/docs/resources/positionpapers/NCSMPositionPaper18.pdf

Suh, J., Roscioli, K., Morrow-Leong, K., Tate, H. (2022). Transformative technology for equity-centered instruction. *Proceedings of the Society for Information Technology & Teacher Education International Conference*, San Diego, CA, USA.

Sherman, M., & Cayton, C. (2015) Using appropriate tools strategically for instruction. *Mathematics Teacher, 109*(4), 306–310. https://doi.org/ 10.5951/mathteacher.109.4.0306

Thomas, A., & Edson, A. J. (2017). A framework for mathematics teachers' evaluation of digital instructional materials: Integrating mathematics teaching practices with technology use in K-8 classrooms. In P. Resta & S. Smith (Eds.), Proceedings of *Society for Information*

Technology & Teacher Education International Conference (pp. 11-18). Association for the Advancement of Computing in Education (AACE).

Wills, T., Crawford, D., Roscioli, K. & Sanghavi, S. (2021). Mathematical Representations in a Synchronous Online Mathematics Specialist Preparation Program. *Journal of Mathematics and Science: Collaborative Exploration* 17(1) Available at: https://scholarscompass.vcu.edu/jmsce_vamsc/vol17/iss1/9

Wills, T. (2021). *Teaching math at a distance: A practical guide to rich remote instruction K-12*. Corwin Press.