Shown below is the teacher-generated framework for evaluating digital instructional materials and integrating technology to enhance effective mathematics teaching practices. The framework is accompanied by class discussion prompts and implementation guidance.

**Implementation Guidance and Class Discussion Prompts**

Course instructors may want to familiarize students with this framework during a class session, perhaps one focused on technology for teaching and learning mathematics. The following context, activity description, and discussion prompts are intended to support in-class implementation. The authors chose to introduce the framework approximately 1/3 of the way through the semester, after candidates had had an opportunity to learn more about effective teaching practices for mathematics and while they were planning their second Lesson Plan assignment. Incorporation of the framework as a lens for technology use was optional for the planning and teaching of candidates’ Lesson Plan 2 assignments, but was required for the reflection component of that assignment. Some mathematics teacher educators might choose to introduce the framework earlier in a course.

*Description and context of the framework:* This framework combines two dimensions: Effective mathematics teaching practices as articulated by NCTM (2014) and levels of integration of technology use (Hughes, Thomas & Scharber, 2006). Indicators within the framework were generated by groups of practicing teachers and represent how those teachers evaluated possible technologies for use in mathematics teaching. The indicators and examples are suggestions from teachers in relation to their own mathematics teaching practice. They are not intended to be comprehensive of all possibilities or fixed in time. A useful classroom discussion might engage candidates in adding new indicators or examples based on their contexts and experiences with technologies.

*Learning activity description:* During a class session focused on technology in mathematics teaching and learning, teacher candidates can examine and evaluate a variety of websites, apps, and technologies. Initially, candidates work in small groups to identify and discuss the strengths and limitations of several technology apps/tools and what they might use in their own practice. After small group discussions, the whole group discusses which of the technology tools/apps they thought were the most/least useful and why. These discussions might be grounded in the content of math methods textbook chapters that focus on technology (e.g., Chapter 7 of *Elementary and Middle School Mathematics: Teaching* Developmentally, van de Walle, Karp, & Williams, 9th edition), supplementary books (e.g., *Focus in High School Mathematics: Technology to Support Reasoning and Sense Making*, NCTM, 2011), online resources (e.g., <http://www.ipads4teaching.net/>), or practitioner articles focus on technology for mathematics teaching (e.g., Harrison, T.R. (2018) There’s an app for that. *Mathematics Teaching in the Middle School, 24*(2), 98-103).

Next, the instructor distributes the Framework for Evaluating Digital Instructional Materials Student Handout and explains the context and dimensions. (Additional background information about the framework and its’ dimensions can be found in the Thomas & Edson (2017) paper, referenced below.) Teacher candidates are then asked to consider the technology tools/apps they evaluated as most useful and evaluate them within this framework. Depending on their previous discussions and evaluations, candidates may find that the technologies they initially evaluated favorably do not align with any of the teaching practices (e.g., very basic drill and practice games, websites that are deemed “fun” but offer little to engage students in learning mathematics) or that some of the technologies serve primarily to *replace* what could be done without technology. Introducing the framework in this manner can set the stage for rich conversations about the purposes of technology use in mathematics classrooms.

*Discussion Prompts:*

After examining the framework and the teacher-generated indicators and examples, where would you place some of the technology tools/apps you evaluated earlier? To what extent does evaluating technology through this lens change your original evaluations of particular tools/apps?

Discuss why some of the indicators include the same tools as replacement, amplification, and transformation.

What types of technology integration are most desirable? Can “replacement” be a worthwhile goal for technology integration in math lessons and why or why not? Should all technology use strive to be transformative; why or why not?

Are there particular mathematics teaching practices that you think might be more challenging to amplify or transform through technology integration? Which ones and why?

**Framework for Evaluating Digital Instructional Materials**

|  |  |
| --- | --- |
|  | **Integration of Technology Use from RAT Framework (Hughes, Thomas, & Scharber, 2006)** |
| **Replacement (R)**Description: “Involves technology used to replace and, in no way change established instructional practices, student learning processes, or content goals” (p. 2). | **Amplification (A)**Description: “Use that amplified current instructional practices, student learning, or content goals. Increased efficiency and productivity are major effects” (p. 2). | **Transformation (T)**Description: Through comparison with pencil/paper or something that is newly possible, “Use that transforms the instructional method, the students’ learning processes, and/or the actual subject matter” (p. 3). |
| **Research-Informed Teaching Practices from *Principles to Action: Ensuring Mathematical Success for All* (NCTM, 2014)** | 1. **Establish Mathematics Goals to Focus Learning**

Description: *Establish clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses the goals to guide instructional decisions (p. 10).* | * Display data, learning targets, and class information digitally
* Show students the “plan” for the week, including objectives and big picture
* Project goals and objectives with technology instead of posting them on the board or having students write them

*Possible Technologies** Planbook.com
 | * Use videos to launch lessons
* Show students and teachers the learning goals
* Keep track of the progress of students on each slide to get closer to the learning target.
* State or explain the objective and goal for the lesson

*Possible Technologies** CCSSM Look-For App
* Xtramath
* PowerPoint
* Keynote
* Educreations
* ShowMe
 | * The tool or device adds to or changes the goals of the learning
* Goals are updated or changed based on individual student progress
* Students assess themselves before, during, and after the lesson to guide instruction
* Have students look at lesson or objective and then write what they think they are learning that day
* Have students create their own goals

*Possible Technologies** Google Form
 |
| 1. **Implement Tasks That Promote Reasoning and Problem Solving**

Description: *Engage students in solving and discussing tasks that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies (p.10).* | * PDF or static screen rendering of textbook pages or worksheets

*Possible Technologies:** Whiteboard App
* Online Computational Games or Skills
 | * Web tools to investigate and present solutions to tasks
* Teacher shows instructional video that explains concept being taught

*Possible Technologies** Tiggly
* Osmos
* MathTwitterBlogosphere
* Interactive Whiteboard Apps
* LearnZillion
 | * Student investigates videos to launch lessons or presents problems
* Student leads video of work on device
* Use what was created with Whiteboard App to provoke students’ discussion
* Show multiple strategies and errors for students to explain or reason about
* Real world problems
* Allow students to tinker

*Possible Technologies** Desmos
* Dynamic Geometry Software
* Computer Algebra Systems
* Screencast Software
* Dan Meyer Videos
 |
| 1. **Use and Connect Mathematical Representations**

Description: *Engage students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving (p.10).* | * Have access to virtual forms of student materials or teacher instructional materials
* Students explain their thinking by projecting manipulatives
* Use document camera or Smartboard instead of writing on white board

*Possible Technologies** Virtual Manipulatives
 | * Connecting a mathematical concept to a technological tool
* Share access and collaboration
* Show a visual to help explain a concept

*Possible Technologies** SolveMe Mobile
* Pieces Basic
* Algebra Tiles
* Touch Counts
* Braining Camp
* Osmo
* Google Image and Video
* Tiggly
 | * The tool allows for student to explore and/or discover relationships independently or in small groups
* Write over pictures taken
* Multiple representation comparison through student explanations
* Present the concept and have students interact with it

*Possible Technologies** Desmos
* Dynamic Geometry Software
* Computer Algebra System
* NearPod
* PearDeck
* Screencast Software
 |
| 1. **Facilitate Meaningful Mathematical Discourse**

Description: *Facilitate discourse among students to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments (p. 10).* | * Launch images and maybe videos to set the context for problems
* Use discussion boards especially in online environments
* Build taken-as-shared understanding using student questions

*Possible Technologies** Formative Assessment tools such as Clickers
 | * Orchestrate discussions using digital photos of student work
* Access to other student thinking in a gallery walk
* Students to comment and give feedback to others
* Digital tools to help scribe student thinking
* Build taken-as-shared understanding using student questions
* Access student responses quickly

*Possible Technologies** Screencast Software
* Educreations
* VoiceThread
* Plickers
 | * Shared student workspaces
* Collaborative environments with many “hands” on the work
* Get at relationships and different representations
* Have students discuss answers and why they got them
* Collaboratively work out the problem and explain/justify answers

*Possible Technologies** Google Docs
* Groupboard
* Mathematical Tools
* Plickers
* Interactive Whiteboard App
 |
| 1. **Pose Purposeful Questions**

Description: *Use purposeful questions to assess and advance students’ reasoning and sense making about important mathematical ideas and relationships (p. 10).* | * Using a virtual version of asking questions
* Video of modeling effective questions
* Posting on document camera or Smartboard

*Possible Technologies** Edmodo
* Socrative
* #mtbos Scavenger Hunt
* Online Webquest
* Project Sentence Stems
 | * Real-time summary data
* Ask questions
* Present math images to students to form questions

*Possible Technologies** Clickers
* Discussion boards
* Plickers
* Wouldyourathermath.com
 | * User-controlled scaffolding
* Advancing students based on thinking and reasoning
* Students pose purposeful questions and decide which questions have value
* Interactive presentations
* Supports for students to develop questions
* Allow students to ask questions they were not able to ask without the technology
* Show pictures and have students develop questions

*Possible Technologies** Three Act Math
* Gfletchy.com
* Dan Meyer’s blog
* Nearpod
* PearDeck
* 101 Questions
* GeoGebra
* TinkerPlots
* Number Talk Images
 |
| 1. **Build Procedural Fluency from Conceptual Understanding**

Description: *Build fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve contextual and mathematical problems (p. 10).* | * Individual manipulatives to see number partners

*Possible Technologies** Virtual Manipulatives
* Drill and Practice Apps
* Base 10 Block App
* XtraMath
* Math Playground
* Quizlet
* IXL
 | * Include a variety of models and representations with accompanying facts
* Teacher use manipulatives to show student work or to manipulate blocks in more than one way

*Possible Technologies** Base 10 Block App
* Llama Drama
* Todo math
 | * Students procedural fluency leads to discussion of properties
* Allow students to lead discussions about their processes or to new concepts
* Show and discuss different student strategies to see how they relate, different, or have errors
* Use sliders with mathematical tools
* Students are the teacher – record themselves doing a problem and explaining it to others

*Possible Technologies** Base 10 Block App
* Braining Camp
* Ten-frame Fill
* GeoGebra
* Desmos
 |
| 1. **Support Productive Struggle in Learning Mathematics**

Description: *Consistently provide students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships (p. 10).* | * Allows students to interact with a problem
* Challenging problems online
* Warm up task or brainteasers projected on screen

*Possible Technologies** Desmos
* Openmiddle.com
* Visualpatterns.org
 | * Graduate release of guiding information
* Support for individual and group work for all levels
* Allow predictions, conjectures, and discussions

*Possible Technologies** SolveMe Mobiles
* Number Puzzles – Which One Doesn’t Belong?
* Video Brainteasers
* Three Act Math
 | * Tools that give different levels of “hints” depending on how much information is provide – user controlled scaffolding
* Gamification or games that could change individual pacing

*Possible Technologies** Three Acts
* Solve Me Mobiles
 |
| 1. **Elicit and Use Evidence of Student Thinking**

Description: *Use evidence of student thinking to assess progress toward mathematical understanding and to adjust instruction continually in ways that support and extend learning (p. 10).* | * Use of tablet as personal whiteboard
* Replace paper and pencil time tests

*Possible Technologies** Drill and Skill Apps
 | * Immediate student feedback

*Possible Technologies** Clickers
* Teachers dashboards associated with textbooks
 | * Students create own prompts
* Allows instructional change in the moment or during the lesson for whole group or individually
* Students discuss mistakes
* Students justify their reasoning
* Sherpa-at-work/spot-and-show orchestration types (Drijvers, et al., 2010)

*Possible Technologies** ActivePrompt
* Screencast Software
* Would you rather/Which one doesn’t belong?
 |

Dick, T., & Hollebrands, K. (2011). *Focus in High School Mathematics: Technology to Support Reasoning and Sense Making*. Reston, Virginia, USA: National Council of Teachers of Mathematics.

Harrison, T.R. (2018) There’s an app for that. *Mathematics Teaching in the Middle School, 24*(2), 98-103

Hughes, J., Thomas, R., & Scharber, C. (2006). Assessing Technology Integration: The RAT-Replacement, Amplification, and Transformation-Framework. SITE In C. Crawford, R. Carlsen, K. McFerrin, J. Price, R. Weber, & D. Willis (Eds.), *Proceedings of SITE 2006-Society for Information Technology & Teacher Education International Conference* (pp. 1616-1620). Orlando, Florida, USA: Association for the Advancement of Computing in Education (AACE).

National Council of Teachers of Mathematics. (2014). *Principles to Actions: Ensuring Mathematical Success for All*. Reston, Virginia, USA: Author.

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 2017* (pp. 11-18). Chesapeake, VA: Association for the Advancement of Computing in Education (AACE).

Van de Walle, J., Karp, K.S., & Bay-Williams, J.M. (2016). *Elementary and Middle School Mathematics: Teaching Developmentally.* Upper Saddle River, New Jersey, USA: Pearson Education, Inc.