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Grounded Tech Integration:

By Neal Grandgenett, Judi Harris, and Mark Hofer



Teachers today can choose from a variety of technologies for teaching mathematics. Drill-and-practice software, virtual manipulatives, real-life data sets, interactive geometry programs, graphing calculators, robots, and computer-based laboratories are just a few of the options available. But it can be difficult for mathematics teachers to know just which technologies to choose to support student learning in particular lessons.

One way to help teachers integrate technologies effectively is to match technology integration strategies to how teachers plan, rather than asking teachers to plan instruction that exploits the opportunities offered by particular educational technologies. For more about a curriculum-based, pedagogical approach to technology integration, see our previous article (*L&L*, September/October 2009, “Grounded Tech Integration,” page 2).

The new conceptual tool that we offer to assist with technology integration is a comprehensive set of learning activity types for each curriculum area, with suggestions for specific educational technologies that can best support the types of learning for each activity. As we have identified many learning activity types for each curriculum area, we have organized them into subcategories so that each content-based collection of learning activity types forms an informal taxonomy.

Once teachers have determined the learning goals for a particular lesson, project, or unit, they review the activity types in the taxonomy for that

content area, selecting and combining the learning activities that will best help students achieve the selected learning goals. Because the list includes suggested educational technologies for each learning activity type, choosing the activities to use helps teachers select technologies to support the plan in sensible, practical, and usable ways. We think of this as “grounded” technology integration because it is based in content, pedagogy, and how teachers plan instruction, rather than the features of particular educational technologies.

Learning Activity Types in Math

We designed mathematics activity types to be catalysts to thoughtful and creative instruction. We have conceptualized 31 activity types, in seven genres, derived from the National Council of Teachers of Mathematics’ process standards. Although we provide just two samples per genre here (see tables on pages 25 and 26), a complete taxonomy of mathematics activities is available on the Activity Types Wiki (<http://activitytypes.wmwikis.net>).

Combining Activity Types: An Example

Some of the most effective learning that a mathematics teacher might facilitate uses a combination of activity types that are carefully interwoven. Combinations of learning activities are also typically needed to engage students in higher-level activities, such as problem solving, divergent thinking, or mathematical modeling.

Interfacing a graphing calculator with a mechanical robot makes

possible some innovative combination lessons. Several companies have recently developed inexpensive robots that connect to popular graphing calculators. With these two newly linked technologies, a teacher might ask students in a mathematics class to first use their graphing calculators to interpret a representation of a mathematical expression, such as $\text{distance} = \text{rate} \times \text{time}$, or at higher levels, perhaps a sine curve. Then, by attaching robots to their graphing calculators, the students use what they have learned to create a process that involves programming the robot’s movements around strategically placed cones and using calculator commands to move the robot. The students might make video clips of their efforts using digital video cameras, then demonstrate their strategies for moving the robots to the class. They could even use the video camera to more closely examine the robot’s speed or help troubleshoot problems. Using this combination of three learning activities, students can build a much better understanding of the mathematical relationships involved while learning a bit more about the technologies used in the learning activities.

Invitation for Collaboration

The activity types approach is not an instructional planning model per se. It is a way of using key instructional planning resources within existing planning models. We acknowledge that both the range of mathematics

The Consider Activity Types

Six of the 31 mathematics activity types are primarily receptive, asking students to consider foundational knowledge that is often presented directly. For example:

Activity Type	Brief Description	Example Technologies
Attend a Demonstration	Student gains information from a presentation, video clip, animation, etc.	PowerPoint, iMovie, Smartboard, videoconferencing
Read Text	Student extracts information from textbooks or other materials, in either print or digital form	Electronic textbooks, websites, PDFs

The Practice Activity Types

Three of the 31 mathematics activity types involve practicing computational techniques or other algorithm-based strategies to strengthen students' foundational skills. For example:

Activity Type	Brief Description	Example Technologies
Computation	Student undertakes computation-based strategies using numeric or symbolic processing	Scientific/graphing/online calculators, spreadsheets
Drill and Practice	Student rehearses a mathematical strategy or technique, perhaps using computer feedback	Drill-and-practice software, online textbooks, websites

The Interpret Activity Types

Six of the 31 mathematics activity types focus on interpretation, during which students deduce and explain mathematical relationships. For example:

Activity Type	Brief Description	Example Technologies
Categorize	Student examines a concept or relationship to categorize it into various categories	Online databases, concept mapping software, drawing software
Interpret a Representation	Student explains relationships in a mathematical representation (table, formula, chart, graph, picture, etc.)	Data visualization software, 2D and 3D animations, GPS devices

The Produce Activity Types

Five of the 31 mathematics activity types get students involved in producing mathematical works. For example:

Activity Type	Brief Description	Example Technologies
Develop a Problem	Student poses a problem that illustrates a concept, relationship, or question	Word processing, online discussions, Wikipedia, e-mail
Demonstrate a Concept	Student demonstrates a concept to illustrate understanding of a mathematical idea	Smartboard, digital camera, presentation software, podcasts

The Apply Activity Types

Three of the 31 mathematics activity types help students apply mathematics in the real world. For example:

Activity Type	Brief Description	Example Technologies
Test	Student applies knowledge within the context of a testing environment	Test-taking software, survey software, response systems
Apply a Representation	Student applies a mathematical representation to a real-life situation (table, formula, chart, diagram, graph, etc.)	Spreadsheets, robotics, computer-aided laboratories

The Evaluate Activity Types

Four of the 31 mathematics activity types focus on evaluation, during which students evaluate others' mathematical works or their own work. For example:

Activity Type	Brief Description	Example Technologies
Compare and Contrast	Student compares and contrasts different strategies or concepts	Inspiration, Web searches, Mathematica, MathCad
Test a Solution	Student systematically tests a solution and examines the feedback	Scientific/graphing calculators, spreadsheets, Mathematica

The Create Activity Types

Four of the 31 mathematics activity types involve students in higher-level mathematical learning, where they engage in creative and imaginative thinking. For example:

Activity Type	Brief Description	Example Technologies
Create a Product	Student imaginatively engages in the development of a project, invention, or artifact	Word processor, animations, MathCad, Geometer's Sketchpad
Create a Process	Student creates a mathematical process that others might use, test, or replicate	Programming, robotics, Mathematica, iMovie

learning activity types and the ways in which educational technologies can support each will change over time. We invite you to help us expand, refine, and further develop this evolving resource for teachers. To help shape the taxonomy of activity types in mathematics, please visit the Activity Types Wiki at <http://activitytypes.wmwikis.net/Mathematics> and share your ideas via the online survey.



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