Implementing Performance-Based Technology Standards in Mathematics Education Courses

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Complete handout has been posted at:
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**Technology and Teacher Education**

Following are the areas in the NCATE accreditation standards with expectations for knowledge and use of technology:

NCATE’s accreditation Standard I.C.1, *Content Studies for Initial Teacher Preparation*, expects candidates to "complete a sequence of courses and/or experiences to develop an understanding of the structure, skills, core concepts, ideas, values, facts, methods of inquiry, and uses of technology for the subjects they plan to teach."

NCATE’s accreditation Standard I.D.2, *Professional and Pedagogical Studies*, expects that professional studies for all teacher candidates include knowledge and experiences with "educational technology, including the use of computer and related technologies in instruction, assessment and professional productivity."

In NCATE’s Standard III.A, *Professional Education Faculty Qualifications*, an indicator has been added stating that "faculty are knowledgeable about current practice related to the use of computers and technology and integrate them in their teaching and scholarship."

Standard IV.B, *Resources for Teaching and Scholarship*, expects that "higher-education faculty and candidates have training in and access to education-related electronic information, video resources, computer hardware, software, related technologies, and other similar resources," and "media, software, and materials collections are identifiable, relevant, accessible, and systematically reviewed to make acquisition decisions."

Standard IV.C, *Resources for Operating the Unit*, expects that equipment and budgetary resources are sufficient to fulfill the mission of the school of education and to offer quality programs. An indicator states that "facilities and equipment are functional and well maintained. They support computing, educational communications, and educational and instructional technology at least at the level of other units in the institution."

In addition to these standards for the entire school of education, NCATE recognizes three sets of technology standards for use in accredited institutions. In 1991, the new standards of the International Society for Technology in Education (ISTE) were approved for the preparation of school computer literacy teachers and specialists. These standards set high expectations for the preparation of computer science and computer literacy teachers, as well as for preparation of individuals for technology leadership positions at the district, state or regional level. NCATE has also recognized the standards of the Association for Educational Communications and Technology (AECT) as they prepare professionals to help teachers integrate technology into their work, and the International Technology Education Association/Council on Technology Teacher Education (ITEA/CTTE) for their work in preparing technology education teachers. Too, new standards for educational administrators, recently developed under the auspices of the National Policy Board for Educational Administration, include specific expectations for the use of technology in instruction, evaluation, and administration.
The Technology Principle

**Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students’ learning.**

Electronic technologies—calculators and computers—are essential tools for teaching, learning, and doing mathematics. They furnish visual images of mathematical ideas, they facilitate organizing and analyzing data, and they compute efficiently and accurately. They can support investigation by students in every area of mathematics, including geometry, statistics, algebra, measurement, and number. When technological tools are available, students can focus on decision making, reflection, reasoning, and problem solving. »

Students can learn more mathematics more deeply with the appropriate use of technology (Dunham and Dick 1994; Sheets 1993; Boers-van Oosterum 1990; Rojano 1996; Groves 1994). Technology should not be used as a replacement for basic understandings and intuitions; rather, it can and should be used to foster those understandings and intuitions. In mathematics-instruction programs, technology should be used widely and responsibly, with the goal of enriching students’ learning of mathematics.

The existence, versatility, and power of technology make it possible and necessary to reexamine what mathematics students should learn as well as how they can best learn it. In the mathematics classrooms envisioned in *Principles and Standards*, every student has access to technology to facilitate his or her mathematics learning under the guidance of a skillful teacher.

**Technology enhances mathematics learning.**

Technology can help students learn mathematics. For example, with calculators and computers students can examine more examples or representational forms than are feasible by hand, so they can make and explore conjectures easily. The graphic power of technological tools affords access to visual models that are powerful but that many students are unable or unwilling to generate independently. The computational capacity of technological tools extends the range of problems accessible to students and also enables them to execute routine procedures quickly and accurately, thus allowing more time for conceptualizing and modeling.

Students’ engagement with, and ownership of, abstract mathematical ideas can be fostered through technology. Technology enriches the range and quality of investigations by providing a means of viewing mathematical ideas from multiple perspectives. Students’ learning is assisted by feedback, which technology can supply: drag a node in a Dynamic Geometry® environment, and the shape on the screen changes; change the defining rules for a spreadsheet, and watch as dependent values are modified. Technology also provides a focus as students discuss with one another and with their teacher the objects on the screen and the effects of the various dynamic transformations that technology allows …

**Sample Reflection Paper Assignment**

Read the Principles (Chapter 2, pp. 11-27) from the NCTM (2000) Principles and Standards for School Mathematics. Write a 2-3 page reflection on what the six Principles imply for school mathematics. Compare these principles with your own mathematics experiences. Also, specifically reflect on the Technology Principles statement “technology is essential in teaching and learning mathematics.”

**Reflection Papers Reflection Grading Rubric**

<table>
<thead>
<tr>
<th>Score</th>
<th>Criteria for Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Reflection is clearly written and addresses all the requested components. There is evidence of thoughtful reflection that goes beyond just summarizing a reading or stating unlinked thoughts.</td>
</tr>
<tr>
<td>3</td>
<td>Either 1) the reflection addresses all the requested components, but the reflection is not as thoughtful and engaging, or 2) the reflection is thoughtful but does not address all the requested components.</td>
</tr>
<tr>
<td>2</td>
<td>Reflection addresses some but not all of the required components and is missing evidence of thoughtful reflection.</td>
</tr>
<tr>
<td>1</td>
<td>Reflection does not address any of the required components and was not thoughtfully done.</td>
</tr>
<tr>
<td>0</td>
<td>No Attempt at reflection.</td>
</tr>
</tbody>
</table>

**Journal Article Review**

The purpose of this assignment is to give you an opportunity to locate and read some of the professional literature related to mathematics content and teaching with technology. You are responsible for one journal abstract. It should be 2-3 pages in length, double-spaced and word-processed. Please attach a copy of the entire article to your review.

**Undergraduate Students** – A review of a practitioner article should include a brief summary of the article’s major points. Second, critique the article, indicating your assessment of the strengths and weaknesses of the article. Also, where do you stand on the methods or issues of teaching mathematics discussed in the article? That is, do you agree with the author, and why or why not? Some sources for articles are Mathematics Teacher, Mathematics Teaching in the Middle School, School Science and Mathematics and Learning and Leading with Technology.

**Graduate Students** – A review of a research article should include an overview of the article (a few paragraphs) that discusses the research question, methods and conclusion. But the bulk of the review should address the potential impact of the article on your teaching and/or on the teachers you work with. Some sources for articles are Journal for Research in Mathematics Education, School Science and Mathematics, Journal of Computers in Mathematics and Science Teaching, and International Journal of Computers in Mathematics Learning.
## Undergraduate Journal Article Review Grading Rubric

<table>
<thead>
<tr>
<th></th>
<th>Exceptional</th>
<th>Competent</th>
<th>Adequate</th>
<th>Fair</th>
<th>Unacceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Format (5)</strong></td>
<td>Uses correct font size, spacing, documentation and maintains appropriate length (5)</td>
<td>One mistake in format (4)</td>
<td>Two mistakes in format (3)</td>
<td>Three mistakes in format (2)</td>
<td>Does not follow prescribed format (0)</td>
</tr>
<tr>
<td><strong>Article (5)</strong></td>
<td>Selected article is appropriate for course; journal is acceptable; article is attached to review (5)</td>
<td></td>
<td></td>
<td></td>
<td>Article or journal is inappropriate. Article is not attached to review (0)</td>
</tr>
<tr>
<td><strong>Critique (40)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Summary (20)</strong></td>
<td>Clear, well-organized summary of article including main points and conclusions of author (20)</td>
<td>Reasonable, but not completely clear (15)</td>
<td>Vague; does not cover all main ideas of article (10)</td>
<td>Inaccuracies in summary; Conflict with author's intent (5)</td>
<td>Summary largely unrelated to article (0)</td>
</tr>
<tr>
<td><strong>Reaction (20)</strong></td>
<td>Reflects clear understanding of article and critical thinking about contents (20)</td>
<td>Reflects clear understanding of article and thought about content (15)</td>
<td>Reflects few misunderstanding of articles; little evidence of thought given to understanding (10)</td>
<td>Reflects only a basic understanding of article; many miscomputations evident (5)</td>
<td>Missing or evidence of understanding missing (0)</td>
</tr>
<tr>
<td><strong>Writing (27)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Expression (15)</strong></td>
<td>Ideas Clearly presented in professional tone; well-organized and easy to follow (15)</td>
<td>Ideas Clearly presented in professional tone; well-organized; may lack clarity or continuity in few places (12)</td>
<td>Ideas Clearly presented in professional tone; may lack organization, clarity or continuity (8)</td>
<td>Lacks professional tone or lack of organization and clarity interfere with meaning (4)</td>
<td>Incomprehensible with any errors in organization and continuity (0)</td>
</tr>
<tr>
<td><strong>Mechanics (12)</strong></td>
<td>Clear, accurate grammar and no spelling errors (12)</td>
<td>Few grammar errors and no consistent misspellings (9)</td>
<td>Grammar or spelling errors that do not significantly detract (6)</td>
<td>Occasional grammar or consistent spelling errors (3)</td>
<td>Errors that significantly interfere with understanding (0)</td>
</tr>
</tbody>
</table>

**Letter Grade Equivalencies:**

- A [77, 66]
- B [54, 65]
- C [42, 53]
- D [30, 41]
- F [0, 29]

**Comments:**
## Graduate Journal Article Review Grading Rubric

<table>
<thead>
<tr>
<th></th>
<th>Exceptional</th>
<th>Competent</th>
<th>Adequate</th>
<th>Fair</th>
<th>Unacceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Format (5)</strong></td>
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<td>Two mistakes in format (3)</td>
<td>Three mistakes in format (2)</td>
<td>Does not follow prescribed format (0)</td>
</tr>
<tr>
<td><strong>Article (5)</strong></td>
<td>Selected article is appropriate for course; journal is acceptable; article is attached to review (5)</td>
<td>Reasonable, but not completely clear or is missing one of the following: research questions, methodology, and conclusions of author (15)</td>
<td>Vague and/or is missing two of the following: research questions, methodology, and conclusions of author (10)</td>
<td>Inaccuracies in summary; Conflict with author’s intent (5)</td>
<td>Article or journal is inappropriate. Article is not attached to review (0)</td>
</tr>
<tr>
<td><strong>Critique (40)</strong></td>
<td>Clear, well-organized summary of article including research questions, methodology, and conclusions of author (20)</td>
<td>Clear, thoughtful discussion of how the ideas in the article would translate into a classroom (20)</td>
<td>Discussion of how the ideas in the article would translate into a classroom lacks clarity and thought (10)</td>
<td>Superficial discussion of how the ideas in the article would translate into a classroom (5)</td>
<td>Missing (0)</td>
</tr>
<tr>
<td><strong>Impact on Practice (20)</strong></td>
<td>Clear, thoughtful discussion of how the ideas in the article would translate into a classroom (20)</td>
<td>Clear discussion of how the ideas in the article would translate into a classroom (15)</td>
<td>Discussion of how the ideas in the article would translate into a classroom lacks clarity and thought (10)</td>
<td>Superficial discussion of how the ideas in the article would translate into a classroom (5)</td>
<td>Missing (0)</td>
</tr>
<tr>
<td><strong>Writing (27)</strong></td>
<td>Ideas Clearly presented in professional tone; well-organized and easy to follow (15)</td>
<td>Ideas Clearly presented in professional tone; well-organized; may lack clarity or continuity in few places (12)</td>
<td>Ideas Clearly presented in professional tone; may lack organization, clarity or continuity (8)</td>
<td>Lacks professional tone or lack of organization and clarity interfere with understanding (4)</td>
<td>Incomprehensible with any errors in organization and continuity (0)</td>
</tr>
<tr>
<td><strong>Expression (15)</strong></td>
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</tr>
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</tr>
</tbody>
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**Letter Grade Equivalencies:**

- A [77, 66]
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- C [42, 53]
- D [30, 41]
- F [0, 29]

**Comments:**
**Educational Software Evaluation Form**

<table>
<thead>
<tr>
<th>Reviewer's Name: ____________________________</th>
<th>Classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dated: ____________________________</td>
<td>Subject Areas: ____________________________</td>
</tr>
<tr>
<td>Title: ______________________________________</td>
<td>Topic: ____________________________</td>
</tr>
<tr>
<td>Publisher: ______________________________</td>
<td>Grade/ability Levels - <em>Circle the range</em></td>
</tr>
<tr>
<td>Copyright: _____________ Version: ___________</td>
<td>PK  K  1  2  3  4  5  6  7  8  9  10  11  12</td>
</tr>
<tr>
<td>Platform/version: __ Mac __ Windows</td>
<td>______Teacher also ______Teacher only</td>
</tr>
<tr>
<td>Media: __ Diskette __ CD-ROM __ DVD</td>
<td>Readability Level - <em>Circle one</em></td>
</tr>
<tr>
<td>Also Needs: __ Internet __ Microphone</td>
<td>Easier     Consistent with grade     More difficult</td>
</tr>
<tr>
<td>__ Other ____________________</td>
<td>Student Grouping</td>
</tr>
<tr>
<td>Cost: School License: ____________</td>
<td>_____Individuals _____Groups of 3 or 4</td>
</tr>
<tr>
<td></td>
<td>____Pairs     _____Whole group</td>
</tr>
<tr>
<td>Lab License: ____________</td>
<td></td>
</tr>
<tr>
<td>School License: ____________</td>
<td></td>
</tr>
</tbody>
</table>

**Teacher Support**

Documentation: __Binder  __Booklet  __Included on media  __on Internet

Instruction Manual includes:

- _____Objectives  ____Lesson plans  ____Sample screens  ____Resource information
- _____Reproducible student pages  ____Student booklets
- ____Other ____________________________________________________________

**Content**

Material is presented impartially and without bias or distortion: ___Yes ___No

Compared to the standards from: __________________________________________

Meets these standards: (Mark only one)

- ____Inadequately    ____Minimally    ____Appropriately    ____Exceeds Them
- Content is current.  ____No    ____Some    ____Mostly    ____Yes
- Content is thorough.  ____No    ____Some    ____Mostly    ____Yes
- Content is age appropriate.  ____No    ____Some    ____Mostly    ____Yes
- Content is reliable.  ____No    ____Some    ____Mostly    ____Yes
- Content is clear.  ____No    ____Some    ____Mostly    ____Yes
- Content is fully referenced.  ____No    ____Some    ____Mostly    ____Yes

SOURCE: NETS FOR TEACHERS – PREPARING TEACHERS TO USE TECHNOLOGY
Describe the content:

Assessment

Has pretest. __Yes __No  Student journal  __Yes  __No
Has posttest. __Yes  __No  Email option  __Yes  __No
Has record keeping by student. __Yes  __No  Spreadsheet  __Yes  __No
Has record keeping by group. __Yes  __No  Calculator  __Yes  __No
Has assessment guidelines. __Yes  __No  Print options  __Yes  __No

Other _____________________

Technical Quality

Installation and Setup: __Difficult  __Time consuming  __Simple
Sound is: __Essential  __High quality  __Supplemental
Videos: __Run jerkily  __Run smoothly  __Are essential  __Not essential

Final Report Card

Teacher support A  B  C  D  F
Content A  B  C  D  F
Assessment A  B  C  D  F
Technical quality A  B  C  D  F
Instructional design A  B  C  D  F

Your overall rating _____

SOURCE: NETS FOR TEACHERS – PREPARING TEACHERS TO USE TECHNOLOGY
Instructional Design

Promotes

___ Creativity   ___ Collaboration   ___ Discovery   ___ Remediation
___ Higher-order thinking   ___ Problem solving   ___ Memorization   ___ Practice
___ Other

Motivational

___ Student controls pacing   ___ Stimulates curiosity
___ Challenging   ___ Real-world connections

Strengths:

Weaknesses:

SOURCE: NETS FOR TEACHERS – PREPARING TEACHERS TO USE TECHNOLOGY
Describe the learning strategy incorporated in the design:

Recommendations:

How would you modify this Educational Evaluation Software Form?
Sample Course Project

The purpose of the course project is to synthesize what you have learned about teaching and learning mathematics, and the appropriate use of technology to enhance these processes. The project and presentation serve as a cumulative final exam and are worth 30% of your final grade.

An overview of the project:
You will create a 2-day investigation of a mathematics topic that utilizes at least one technology tool explored in this course. This will include a clearly written lesson plan and student worksheets, if needed. In addition to the investigation, you will need to write a paper that supports the methods used in teaching the topic and how technology is extending or enhancing the learning of this topic. You are required to use the NCTM Principles and Standards document and literature from books or journals to support your methods. (Graduate students must reference research literature.) Your paper will also include a reflections section about what you learned in creating your course project.

Each student will share the investigation in a 15-minute class presentation. At least 10 minutes of that presentation should engage other students in a "glimpse" of the mathematical investigation you have planned. The remaining time should be used to discuss your rationale for the methods and technology used, personal reflections, and questions/comments from the group.

Guidelines for Developing Your Investigation:

- Choose a "big idea" in mathematics that interests you (e.g., functions, similarity, rate of change). Make a list of some of the major concepts and skills within that "big idea." As you review the sources listed below, you should further refine and focus your "big idea" into a topic for a solid 2-day investigation at the grade level of your choice.

- Look through the website supporting the NCTM Principles and Standards (http://standards.nctm.org/) for suggestions related to your topic of study, including the Illuminations site (http://illuminations.nctm.org/) and the Electronic Examples (http://standards.nctm.org/document/eexamples/index.htm). You will need to cite which of the 6 Principles and 10 Standards you address in your investigation.

- Undergraduate Students: Do a search on your topic both on the internet AND in print journals such as Mathematics Teacher, Mathematics Teaching in the Middle School, School Science and Mathematics and Learning and Leading with Technology. Look for suggested ways to teach your topic. You are required to reference at least 3 print journal sources.

- Graduate Students: Do a search on your topic both on the internet AND in books or print journals such as Journal for Research in Mathematics Education, School Science and Mathematics, Journal of Computers in Mathematics and Science Teaching, International Journal of Computers in Mathematics Learning. These are only suggested resources. I suggest you do a comprehensive library search. You are required to reference at least 5 research-based articles.

- Look through textbook and workbook materials for suggested activities that address your topic.

And, most importantly, keep asking yourself critical questions about HOW and WHY technology enhances or extends the teaching and learning of your topic. You need to formulate a solid rationale in support of the teaching methods and technology you will use in your 2-day investigation of this mathematics topic. This rationale should already be in place BEFORE you write your plan.
## Guide and Rubric for Grading Course Project

### Written Paper

<table>
<thead>
<tr>
<th>Section</th>
<th>Points Possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Describe your &quot;big idea&quot;, the important concepts and skills related to that big idea, and the focused topic for your investigation. Describe the grade level and course where your investigation could be taught. Also describe the prerequisite skills and concepts that are essential for students to be successful in your investigation. (1-2 paragraphs)</td>
<td>10</td>
</tr>
<tr>
<td>2. List and briefly discuss the NCTM Principles and Standards that are addressed in your investigation and support the methods and technology used. (1 page max)</td>
<td>15</td>
</tr>
<tr>
<td>4. Include a lesson plan that has enough detail about classroom procedures, guiding questions for students, and an outline of what you and the students will be doing throughout the investigation. Be sure to also include any worksheets or handouts that would be used by students.</td>
<td>30</td>
</tr>
<tr>
<td>5. Discuss a well-formulated rationale in support of your methods and technology used for investigating the mathematics topic. The rationale should contain evidence of a synthesis of the information you learned from the NCTM Principles and Standards, textbooks, and journal literature, as well as other sources you may have referenced (include proper citations). (UND 2-3 pages, GRAD 4-5 pages)</td>
<td>30</td>
</tr>
<tr>
<td>6. Write a reflection on developing the investigation. What did you learn about the mathematics topic? What did you learn about teaching this topic and students' understandings of this topic? What did you learn about the use of technology for this topic? (1 page)</td>
<td>15</td>
</tr>
</tbody>
</table>

**TOTAL** 100

### Presentation

<table>
<thead>
<tr>
<th>Part of Presentation</th>
<th>Possible Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide a clear &quot;glimpse&quot; at the investigation that actively engages the class in using technology. (10 minutes)</td>
<td>15</td>
</tr>
<tr>
<td>Provide a clear concise summary of your rationale for the methods and technology used. (5 minutes)</td>
<td>10</td>
</tr>
</tbody>
</table>

**TOTAL** 25
Additional Resources

Center for Technology and Teacher Education
http://www.teacherlink.org/content/math/activities/index.html

The Center's math group has developed activities that prepare teachers to use technology to enhance and extend students' learning of mathematics. Their focus has been to develop activities using graphing calculators, The Geometer's Sketchpad, Microsoft Excel, the ExploreMath.com website, Global Positioning Systems, and MicroWorlds logo for pre-service secondary mathematics students. Many activities address content spanning several years of secondary content; thus, some modifications may be necessary for classroom implementation.


Key College Publishing

Now for sale through your college bookstore: the Key Mathematics Education Bundle. This package includes student editions of Fathom Dynamic Statistics, The Geometer's Sketchpad, and Kaleidomania!, for only $49.95.

Probability Explorer
http://www.probexplorer.com

Probability Explorer (Stohl, 1999-2002) is a research-based software application designed with tools that enable students and teachers to design, simulate, and analyze a variety of probabilistic situations. The software environment can be used for activities from upper elementary grades through high school.

ExploreLearning
http://www.explorelearning.com

Formally known as ExploreMath.com, this updated website has over a hundred interactive math gizmos to help students understand and visualize several middle and high school mathematical concepts.