MATHEMATICS TEACHING, LEARNING AND ASSESSMENT USING TECHNOLOGY

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Abstract: *This paper describes the effects of using Technology as a teaching and learning aid for mathematics. Teachers feel it difficult while teaching mathematics to students using technology and integration of technology into pedagogical content knowledge which will improve student learning. While many educators have proposed changes the way mathematics is taught to students, the focus has often been only on Technological Pedagogical Content Knowledge (TPCK) rather than on pedagogy. Work from the mathematics education community across the world suggests that it could be beneficial to consider a broader notion of mathematics: mathematical thinking, the interdisciplinary usage of mathematics content knowledge. We would like students to learn to identify the problems and problem-solving strategies, use of resources, attitudes and practices. Using technology in Teaching and learning will help the students to understand the difficult tasks easily and further technology will engage students in learning process. This article further discusses each of these aspects of mathematical thinking and others examples of mathematical thinking practices based on the authors' previous empirical studies of students and practitioners uses of Technology in mathematics teaching and learning .This paper offer insights to inform the teaching of mathematics and incorporate technology in the context of teaching and learning mathematics using technology.*

1. Introduction

Teaching mathematics at any level has always been a challenging endeavor. Teaching mathematics with a focus on problem solving further increases this challenge. Adding to the equation the variety of new technologies available for classroom use, and even challenge the most accomplished teachers[1]. The demands of mathematics teachers in technology-rich environments focused on problem solving indicate a need for quality faculty development programs.

The term ''technology'' encompasses a broad spectrum of machines, software, and applications that provide tools for cognitive development, motivation, communication, assessment, and classroom management. The types and amount of technology available in mathematics classrooms can vary widely across institutions. In this article, we focus on those technologies the students use directly to enhance mathematical learning, reasoning, and problem solving. Examples include graphing calculators, spreadsheets, computer algebra systems (CAS), and software applications [2].

2. Technological Pedagogical Content Knowledge

In 1986, Shulman proposed a more in-depth study which teachers must do in order to teach, highlighting that future teachers need to be prepared to be able to transform subject matter content through teaching strategies to make that knowledge accessible to learners. To teach, teachers need to develope an integrated knowledge structure that incorporates knowledge about subject matter, learners, pedagogy, curriculum, and schools; they also need to develope a pedagogical content knowledge or PCK for teaching their subjects. But for technology to become an integral component or tool for learning the subject, teachers must also develop "an overarching conception of their subject matter with respect to technology and what it means to teach with technology – "Technological pedagogical content knowledge (TPCK)" (Niess, 2005, p. 510)[16].

To be prepared to teach mathematics then, teachers need an in-depth understanding of mathematics (the content), teaching and learning (the pedagogy), and technology. More importantly, however, they need an integrated knowledge of these different knowledge domains, the overlap and integration of these domains. TPCK for teaching with technology means that as they think about particular mathematics concepts, they are concurrently considering how they might teach the important ideas embodied in the mathematical concepts in such a way that the technology places the concept in a form understandable by their students. The challenge is to identify teacher preparation programs that lead toward the development of TPCK for teaching mathematics. Grossman (1989, 1991) developed four central components as a means of thinking about PCK; Niess (2005) extended these components as a means of clarifying TPCK development for teacher preparation programs [17].The components are as followed:

(a) An overarching conception of what it means to teach a particular subject such as mathematics ***integrating technology*** in the learning;

(b) knowledge of instructional strategies and representations for teaching particular mathematical topics ***with technology***;

(c) knowledge of students' understandings, thinking, and learning ***with technology*** in a subject such as mathematics;

(d) knowledge of curriculum and curriculum materials which ***integrates technology with learning mathematics***.

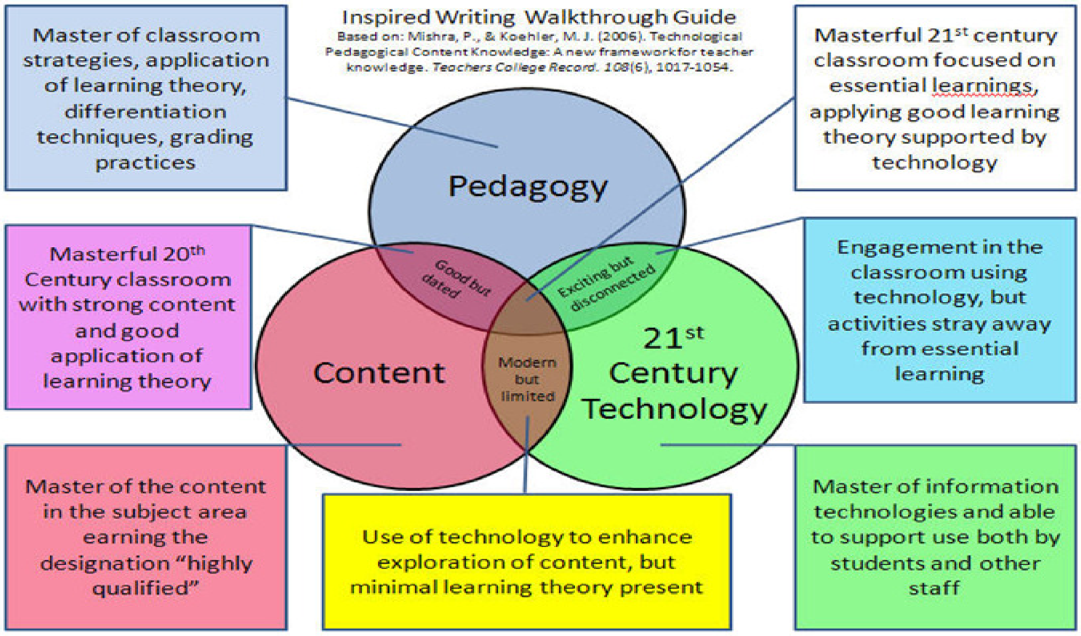

Figure 2.1: The TPCK Model (Koehler & Mishra, 2006)

3. Teaching Mathematics with Technology: Teacher's Outlook

These technologies are only examples. What other technologies are available or are emerging that might support learning mathematics? Teachers need to be prepared for exploring the current and emerging possibilities. They need to develop a professional attitude of evaluation and reflection about tools for teaching mathematics – a thoughtful visioning that investigates and considers the impact of the tools for teaching mathematics. Niess, Lee and Kajder (in press) identified six important areas of questions that teachers must be prepared for [17]. They are as followed:

3.1 Curricular needs in mathematics in the 21st century. Can the technology be used as a productivity, communication, research and or problem-solving and decision-making tool for learning in the subject area? Does the technology offer the capabilities to facilitate technology-enhanced experiences that address subject matter content standards and student technology standards? Does the technology offer capabilities that challenge the accepted standards, opening the possibility for a shift in what students need to know to be productive citizens in the 21st century?

3.2 Instructional needs in mathematics in the 21st century. Can the technology support learner-center strategies for learning the subject? Can use of the technology as a learning tool help students develop a more robust understanding of the content? Can the technology address the diverse needs of students in learning the subject? How must the instruction be scaffolded to guide student learning with and about the technology?

3.3 Student learning in the 21st century. Can the technology engage students in important experiences that support their learning? Can the technology provide multiple perspectives for the students to view of mathematics? Can the technology be applied to developing students' higher order thinking and reasoning skills? Can the technology maximize student learning?

3.4 Unique capabilities of the new tool. What are the capabilities of the tool? How are these capabilities useful in accomplishing 21st century skills? Do the capabilities challenge accepted ways of knowing and doing? What must be learned before incorporation of the tool as a learning tool?

3.5 Student knowledge, access and management concerns. Will inclusion of the new tool create student access issues? What preparation must be provided for students working with the technology as a tool for learning? What management issues need consideration if the tool is incorporated in the classroom situation?

3.6 Assessment and evaluation with the new tool. How will assessment of students' learning of mathematics be affected by the incorporation of the new tool? Will performance assessments be important to demonstrate students' knowledge of the content with use of the new tool?

4. The Aim of Research on Technology

The National Educational Technology Standards for Teachers (NETS•T, 2002) provide a framework for a research agenda around technology integration in teaching and learning mathematics. The question(s) are only provided to initiate discussions about theory, research, and projects in each standard:

1. Technology operations and concepts. What are the general operations and concepts for all technologies and how do they apply to mathematics-specific technologies? What mathematics-specific concepts are important in technologies?

2. Planning and designing learning environments and experiences. What strategies are essential when guiding students in learning particular mathematics concepts with specific technologies?

3. Teaching, learning and the curriculum. How should student learning about the technologies be scaffolding with learning mathematics? Should students learn mathematics concepts before using the technology tools?

4. Assessment and evaluation. How is assessment different in a technology-rich educational experience?

5. Productivity and professional practice. How do teachers' develop the professional attitude toward continuing to develop their TPCK?

6. Social, ethical, legal and human issues. How do mathematics teachers deal with a diversity of access to technologies?

The research agenda needs to consider each of these areas not in isolation along with learning and teaching mathematics if teachers are to develop a TPCK for teaching mathematics. Ultimately, mathematics teacher preparation programs must ensure that all mathematics teachers and teacher candidates have opportunities to acquire the knowledge and experiences needed to incorporate technology within the context of teaching and learning mathematics.

This section is designed to encourage the sharing of theory, research, and applications of results from innovative projects that result in the distribution of uses of information technology in mathematics teacher education along with instruction in preservice, inservice, graduate teacher education and faculty and staff development. The immediate concern is on teachers and teacher candidates who have primarily learned mathematics without the use of technologies as tools for exploring mathematics. However, as Everett Rogers (1995) explains[20], teachers need to progress through a five-step process in the process of facing the ultimate decision as to whether to accept or reject a particular innovation for teaching mathematics with technology:

4.1 Knowledge: where teachers become aware of integrating technology with learning mathematics and have some idea of how it functions;

4.2 Persuasion: where teachers form a favorable or unfavorable attitude toward teaching and learning mathematics with technology;

4.3 Decision: where teachers engage in activities that lead to a choice to adopt or reject teaching and learning mathematics with technology;

4.4 Implementation: where teachers actively integrate teaching and learning with technology;

4.5 Confirmation: where teachers evaluate the results of the decision to integrate teaching and learning with technology.

Thus, as more and more teachers teach mathematics with technology as a tool, the shift must be towards the evolving issues more directly focused on student learning of mathematics evaluating the results of the decision and its impact on the mathematics curriculum and instructional strategies needed so that all students are able to learn mathematics. Ultimately if technology is used to improve the learning of mathematics at all levels, students will be better prepared to use technology appropriately, fluently, and efficiently to do mathematics in techno-rich environments in which they will study and work in the future.

5. Conclusion

As institutions who prepare mathematics teachers continue to refine their programs to be more effective in the integration of technology and to more directly address the TPCK of their students, it will be important for these programs to be fully aware of what professional associations like NCTM and AMTE. Professional associations and coalitions of professional associations, such as the National Technology Leadership Coalition described in the Organizational Structures chapter of this monograph (Chapter 13, Bull, Bell, and Hamonds), are beginning to play a key leadership role in helping to advance an understanding of TPCK as these organizations facilitate collaborative dialogues among professionals. Such collaborative discussions will go a long way toward helping institutions to refine their programs related to technology integration, as we strive to be as effective as possible in preparing teachers for the technological and dynamic world of today.

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