Networking the Learner in Professional Development

A Study of Teachers' Use of math•ed•ology™

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Abstract: The 25-module math•ed•ology™ program was created to help primary (grades K-5) teachers in the United States learn and implement the teaching standards of the National Council of Teachers of Mathematics. This study of teachers' use of the program's first completed module suggests that an important amount of learning can occur in just under four hours of program use. Teachers gained knowledge of the teaching standards, and ability to implement them. Differences between elementary and secondary teachers' responses were noticeable, although less than expected, suggesting that the K-5 program offers a useful base for a similar program for secondary teachers (grades 6-12).

1. GOALS

This mixed method study had two goals: (a) summatively evaluate a program for helping primary teachers understand and implement national teaching standards K-12, and (b) formatively investigate ways in which the program should be changed to accommodate the preferences of secondary teachers, for a similar program to be developed for their grade levels. Building on an earlier investigation of teacher use of the program's pilot (Bitter and Pryor 1999) this exploratory study examined use of an interactive multimedia program, with video of classroom instruction, by 39 in-service teachers (K-12).

2. BACKGROUND TO STUDY

There is evidence that the U.S. National Council of Teachers of Mathematics (NCTM) standards for teaching are not being implemented (Ball 1993), and that typical in-service is ineffective at long term change of teaching behaviour (Ball 1996, Darling-Hammond 1994, Lieberman 1995). In-service teachers in the U.S. value opportunities to observe other teachers in practice, even more so than formal coursework (Sowell et al. 1995). But there are numerous limitations to observation, including the lack of easily available models of standards-based instruction (Ball 1990). Videotape offers a more feasible alternative without loss of effectiveness (Winitzky and Arends 1991), but Goldman and Barron (1990) found its linearity too inflexible for instruction. Interactive multimedia that includes video of standards-based classroom instruction, presents numerous advantages over these other means of observing, and studies have shown the effectiveness of interactive video in teacher education (e.g., Bitter 1993). The National Science Foundation funded the development of *math•ed•ology™*, an interactive multimedia program for professional development in mathematics education, currently available on the web or on CD-ROM [<http://www.thejournal.com>].

3. METHOD

3.1 Subjects

Subjects were 39 in-service teachers from the Phoenix, Arizona Metropolitan area, who were enrolled in two graduate classes at Northern Arizona University (NAU), ECI 675 Curriculum and Instruction, and EDF 670 Philosophy of Education. (NAU offers graduate coursework state-wide.) Subjects used the program over a four-hour period, as a part of class requirements. They represented all grades, K-12, and ranged from 1 to 17 years of teaching experience (mean = 5.9, median = 5 years). Their previous experience in using CD-ROM technology was higher than expected: On a 7-point scale (from 7 = high to 1 = low), subjects ranged from 7 to 1, with a mean of 5.26.

3.2 Apparatus

The module's software was programmed in Authorware, allowing use on Macintosh or Windows computers. The software used allows for expeditious

exploration, and review of the many program components. The entire program comprises 25 different modules, each of which includes edited full-motion video of an primary grade, NCTM standards-based mathematics lesson, supported by such materials as lesson overview, commentary, lesson plans, lesson concepts, and focus questions. An electronic notebook can be launched in the program, as an aid to reflection on the strategies being applied in the lesson. An assessment area allows users to gauge their increased understanding, and staff developers to assign school district credit for use.

3.3 Procedure

Subjects signed a registration sheet at the beginning of each NAU course to visit the study site for either a morning (8am-noon) or afternoon (1-6pm) session. Two subjects typically were in each session, along with an investigator. Each study session began with a brief welcome, explanation of procedures, opportunity for questions, and an introduction to the module. Subjects were asked to follow the suggested user path through the module for the first few sections. After they had attained sufficient familiarity with the module (typically about an hour), they were asked to choose their own paths through it.

3.3.1 Data sources

An observer took notes throughout the session and provided guidance as needed. At critical points in module use, the observer stopped the subjects to ask, and record on audiotape, their thoughts about the sections they had just been through. At the end of module use, the subjects were again interviewed and a questionnaire was administered. Subjects were assigned – by their NAU professor, Dr. C. R. Wactler – to write four lesson plans in which they were to demonstrate their understanding of the teaching standards studied with the module. The analysis of these lesson plans is not yet complete (Pryor 2000).

3.3.2 Data analysis

Quantitative data consisted mainly of 7-point bipolar evaluative and probability scales measuring variables that previous studies (Pryor and Bitter 1998) have shown to be important in the evaluation of interactive multimedia. (Open-ended items in the questionnaire allowed for the entry of new variables, as did the interviews.) These data were analysed using descriptive statistics, as well as chi-square, and *t*-test. These data, especially

those on knowledge gained from using the module, will be triangulated with data from interviews and the analyses of lesson plans (Wactler 1999).

4. RESULTS AND DISCUSSION

4.1 Overall

Overall responses to the module were quite positive, and most important, teachers learned from using it. Knowledge gain, in four areas, was assessed: (a) teaching standards, (b) ability to implement the standards, (c) ability to reflect on practice, and (d) ESL strategies. Scores on the two most critical areas are reported in Table 1.

Table 1. Mean Scores on Knowledge and Ability: Pre- and Post-use

	<u>Pre-use</u> (n=39)	<u>Post-use</u> (n=39)
Knowledge of NCTM teaching standards	2.6	5.4**
Ability to promote classroom discourse	5.1	6.2**

Note. Mean scores on 7-point scales scored from 7 to 1, through a neutral mid-point of 4. ** p.<.01

On 7-point bipolar probability and evaluative scales (scored from -3 to +3 through a neutral midpoint of zero), subjects rated the module on key variables, including the module's perceived utility, attitude toward the module, and ease of use, as reported in Table 2. The module's utility for learning the teaching standards was rated as 2.0 ('quite good'), attitude was 1.8 (nearly 'quite favourable'), and ease of use was 1.9. The interview data suggest that nearly all subjects learned from the module. Given this satisfactory summative conclusion about the module, the focus of the study moved to the investigation of any changes that might need to be made in the module (besides grade level of the lesson), to make it as well received by secondary level teachers as by primary teachers.

Table 2. Mean Responses on Major Variables

<u>Variable</u>	<u>$\bar{X}$</u>
Intention to use other modules	0.8
Subjective norm	1.3
Experience using module technology	1.3
Attitude to use other modules	1.4

Variable	$\bar{X}$
District support of NCTM standards	1.7
Attitude towards module	1.8
Ease of use	1.9
Utility of module	2.0
NCTM teaching standards increase students' achievement	2.2
Years of teaching experience	5.9
Knowledge of NCTM standards	5.4

Note. Mean scores on 7-point bipolar scales scored from +3 to -3, through a neutral mid-point of zero with the exception of 'years of teaching experience', and 'knowledge of NCTM standards'.

4.2 Primary-secondary differences

To accomplish this second study goal, the responses of K-6 teachers were separated from those of middle and secondary teachers (hereinafter referred to as 'secondary'), and are reported in Table 3. This beginning of the summative program evaluation found responses from primary subjects generally more positive than those of secondary subjects. The beginning of the formative evaluation for the secondary application, found those subjects less positive generally, in many cases due to curriculum differences at the different grade levels.

Table 3. Mean Responses to Major Variables: Primary vs. Secondary Teachers

Variable	Primary (n=23)	Secondary ^a (n=16)
Knowledge of NCTM discourse standards before	-1.0	-2.0*
Knowledge of NCTM discourse standards now	1.6	1.2
Understanding of ESL strategies before	0.2	-0.4
Understanding of ESL strategies now	1.7	1.7
Ability to reflect on teaching before	1.3	2.0*
Ability to reflect on teaching now	2.2	2.5
Ability to promote classroom discourse before	1.0	1.1
Ability to promote classroom discourse now	2.3	2.1
Value of Watching:		
Classroom observation	2.6	2.4
Video tape of a teacher teaching	1.3	1.8
Module-based video of a teacher teaching	2.3	1.9
Module more valuable than traditional in-service	1.6	0.8

Variable	Primary (n=23)	Secondary ^a (n=16)
Attitude toward the module	2.0	1.5
Attitude toward using other modules in program	2.0	0.4**
Utility of module for learning standards	2.4	1.3**
Intention to use other modules in program	1.6	-0.4**
Ease of use	2.0	1.7
Subjective norm	2.0	0.1**
District support of NCTM teaching standards	2.0	1.4
NCTM standards increase students' achievement	2.4	2.0
Experience using module technology	1.0	1.7
Years of teaching experience	5.6	6.4

Note. Mean scores on 7-point bipolar scales scored from +3 to -3, through a neutral mid-point of zero with the exception of 'years of teaching experience,' and 'knowledge of NCTM standards.'

^a 'Secondary' column includes scores of middle school teachers as well as high school teachers.

* $p < .05$

** $p < .01$

For example, as reported in Table 2, ratings on attitude toward the module, utility, and ease of use were quite positive, but as reported in Table 3, ratings were more favourable from primary subjects. The fact that the video showed a third grade lesson might have been influential in these differences.

Differences between the groups in knowledge and ability gain were also investigated. As illustrated in Tables 3 and 4, differences between primary and secondary subjects were dramatic. Primary subjects began module use with significantly higher ($p < .05$) levels of understanding of the standards, but secondary subjects ended with understanding that was not significantly lower than that of primary subjects. In their ability to implement the standards, primary subjects began module use not significantly lower than secondary subjects, but ended more highly, achieving more gain. Perhaps these differences are due to the different weight primary and secondary teachers attach to pedagogy and content.

Table 4. Mean Ratings of Module Components: Primary vs. Secondary Teachers

Module Components	Primary (n=17)	Secondary (n=11)	Overall (n=28)
Supplementary Material			
Introduction	1.4	1.2	1.3
NCTM Standards	2.5	1.4*	2.1
Bilingual/ESL	2.4	1.7	2.1
The Lesson			
Overview			
Setting & context	2.2	0.7*	1.6
Lesson Plan	2.4	1.3*	2.0
Mathematical concepts/animation	1.9	1.5	1.8
Language environment	1.9	1.2	1.7
Teacher interviews	2.4	1.2	1.9
Video of complete lesson	2.4	2.2	2.3
Lesson Parts			
Lesson part video with transcript	2.6	-0.2**	1.6
Teacher's commentary	2.1	1.3	1.8
Mathematics educator's commentary	1.8	1.0	1.5
Language specialist's commentary	1.8	1.5	1.7
Mathematician's commentary	1.2	0.9	1.1
Discourse standards	2.8	1.8*	2.4
Curriculum standards	2.5	1.7*	2.2
Bilingual/ESL	2.5	1.6	2.1
Student work	1.0	0.5	0.8
Focus questions	1.8	0.5	1.2
Assessment			
Reflect	1.3	0.8	1.1
Identify	1.5	0.8	1.4
Extend	1.6	1.0	1.4
Apply	1.9	1.2	1.6

Note. Mean scores on single-item scales scored from +3 to -3, through a neutral mid-point of zero.

* $p < .05$

** $p < .01$

Another aspect of this study goal was comparison of the two groups' ratings on the module's 23 components. Significant differences were found on five items within The Lesson component: Setting and context, Lesson plan, Lesson part video with transcript, Discourse standards, and Curriculum standards (see Table 4).

Table 5 illustrates changes in the value in-service teachers place on three methods of classroom observation, after using the module. An interesting change in value occurred. Teachers perceived a higher value in watching a

module-based video after only four hours of use. We found this result encouraging and anticipate further investigation into teachers' beliefs.

Table 5. Mean Responses to the Value of Three Learning Experiences on their Value for Learning

	<u>Pretest</u> (n=17)	<u>Posttest</u> (n=17)	<u>Posttest</u> <u>(all)</u> (n=39)
Classroom observation of a teacher teaching	2.5	2.6	2.5
Watching a video tape of a teacher teaching	0.9	0.9	1.5
Watching a module-based video of a teacher teaching	0.6	1.9*	2.1**

Note. Mean scores on 7-point bipolar scales scored from +3 to -3, through a neutral mid-point of zero. The pretest was implemented mid-way during the study, in response to comments made by subjects during the interviews.

* $p < .05$

** $p < .01$

5. CONCLUSION

This study of teachers' use of the program's first completed module of math•ed•ology™ suggests that an important amount of learning can occur in just under four hours of module use. Teachers made gains in knowledge of the teaching standards, and ability to implement the standards.

Differences between primary and secondary teachers' gains in knowledge and ability following use of the module were also investigated. Differences between the groups were dramatic. Primary subjects began module use with significantly higher levels of understanding of the standards, but secondary subjects began with significantly lower levels than those of primary subjects. In their ability to implement the standards, primary subjects began not significantly lower than secondary subjects, but ended higher, achieving more gain.

When the two groups' ratings of the module's 23 components were compared, primary teachers' ratings were higher than secondary teachers' in every case, although differences were significant on only 6 of the 23 components: Background on NCTM standards, and five components within The Lesson section. It seems likely that secondary teachers' ratings were lower because they perceived the third grade lesson as irrelevant to their practice. The lack of major differences between the groups, however suggests that the structure and tools in the program designed for primary teachers will prove a useful base for development of a program for secondary teachers. The findings of this study concerning the module's

efficacy have been echoed recently by other studies of interactive video in teacher education (e.g. Al-Mekhlafi 2000, Markel 1999).

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BIOGRAPHIES

Gary G. Bitter is Professor of Educational Technology, and Executive Director, Technology Based Learning and Research, both at Arizona State University. He has published widely in the areas of educational technology, mathematics education, and the professional development of teachers. He has developed several interactive multimedia programs for the professional development of teachers, including *Understanding Teaching* and math•ed•ology™

Brandt W. Pryor is Associate Professor of Educational Leadership, Lamar University. He was the Co-principal Investigator on the Math Discourse Project which developed the math•ed•ology™ program at Arizona State University. His primary research interest is the application of attitude theory to understanding educational decision-making. He is currently studying teachers' decisions about integrating technology into their instruction.