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ABSTRACT

This study examined changes in prospective teachers' concepts of what constituted effective teaching during a special sequence of senior-level mathematics methods courses that required them to utilize technology in novel ways. Senior-level secondary mathematics education majors used the World Wide Web for research, completing reading assignments, submitting observation forms, and communicating with each other and inservice teachers. Data collection involved interviews, concept maps, written assignments, and questionnaires (conducted three times during the school year). Data analysis examined the impact of Web use on preservice teacher beliefs and actions. Results indicated that appropriate use of the Web had a positive impact on preservice teachers' concepts of effective teaching and the role of technology in instruction. Initially, students were convinced of the importance of technology in mathematics education, though they differed in their familiarity and previous use of specific technologies. Over the course of the year, students gained knowledge about NCTM (National Council of Teachers of Mathematics) standards and the role of technology in secondary mathematics education. They gained confidence in being technology leaders in their schools and became more aware of Web resources available to communicate with other teachers. They came to define effective teachers as having leadership, communication, and interpersonal relationship skills. (SM)

Web-based Teacher Education: Improving Communication and Professional Knowledge in Preservice and Inservice Teacher Training

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Abstract

Changes in prospective teachers' concepts related to what constitutes effective teaching were examined during a special sequence of senior-level mathematics methods courses that required them to utilize technology in novel ways. Students used the World Wide Web for research, completing reading assignments, submitting observation forms, and communicating with each other and inservice teachers. Through a combination of one-on-one interviews, concept mapping, writing assignments and questionnaires, data was gathered and analyzed in an attempt to determine the impact use of the World Wide Web had on preservice teacher beliefs and actions. Results of the study indicated that appropriate use of the Web could have a positive impact on preservice teachers' concepts of effective teaching and the role of technology in instruction.

Web-based Teacher Education: Improving Communication and Professional Knowledge in Preservice and Inservice Teacher Training

A critical issue for teacher education today centers on the relationship, or lack thereof, between preservice and inservice teacher education. With respect to training, there often appears to be little in common shared by the two groups, even though many times the same needs exist for both types of training. Advances in technology offer new opportunities for training preservice and inservice teachers, taking into account similarities and differences between the two groups. Efforts are underway to attempt to provide common experiences essential for the development of these two communities (Cifuentes, et al., 1997; Jensen & Shepston, 1997).

Both teaching and learning can be influenced through the use of the World Wide Web. An abundance of good information related to curriculum and pedagogy is easily accessed for classroom planning. In addition, numerous opportunities exist online for interacting with other educators who share concerns about important issues such as cooperative learning, block scheduling, classroom management, and integration of current technology. Both preservice and inservice teachers can benefit from improved communication with other teachers. Preservice teachers benefit from interaction with other teachers, which supports the development of concepts and skills, while inservice teachers need ongoing support to remain current on new developments and to continue growing professionally. Teacher training has historically been limited in the number of available options for supporting communication between these two groups.

The Web can serve as an agent for change for these two communities of practice. Within each group, the Web provides a flexible means for training that can be adapted to demanding work or student schedules. Use of the Web can also impact the interactions between preservice and inservice teachers by offering opportunities for collaborative exchanges among numerous participants (Henderson, 1996). It also provides long-term support for preservice teachers in an accessible format that can be utilized during the early years of their career.

Implementation

The use of the Web was integrated into various components of the teacher preparation program in secondary mathematics at the University of North Carolina at Wilmington (UNCW). In particular, the Web was used intermittently by secondary mathematics education majors during their senior year. The course Theory and Practice in Teaching Mathematics (EDN 404) is a required senior-level methods course offered during the fall semester. EDN 404 covers fundamental secondary mathematics methods material, including curriculum issues, use of graphing calculators and computers, cooperative learning, problem-solving methods, behavior management, and assessment methods. Students utilized the Web in EDN 404 for research on curriculum ideas as they completed assigned project work, focusing on concepts related to the development of effective instructional materials for use in secondary mathematics classrooms.

Following completion of EDN 404, senior students enroll in a month-long course titled Instructional Seminar (EDN 408) during the spring. The focus of EDN 408 is on the effective preparation and presentation of mathematics lessons appropriate for the high school classroom. Requirements for EDN 408 include preparing and presenting lesson

plans, observing classes in assigned high schools, and studying the *Professional Standards for Teaching Mathematics* (National Council of Teachers of Mathematics (NCTM), 1991). In prior years, there has been a need for more time dedicated to discussion of the *Professional Standards.* Opportunities for interns to interact and share their experiences with each other were limited to those occurring during regularly scheduled class times. Therefore, a more innovative and location-independent approach to the course using the World Wide Web was implemented during spring. The new approach supported the goals of the Seminar while introducing the interns to additional resources for lesson planning and instruction. Interns continued to use the Web resources as they completed their practicum that follows EDN 408 during the spring semester.

EDN 408 was recently adopted as a UNCW Technology College course. The Technology College was established to support use of electronic technology in university-level instruction. A major component of the program is the use of the Web, with an emphasis on communication and collaboration with colleagues at a distance. Students completed approximately fifty percent of assignments and activities for EDN 408 using the Web. The course Web site is located at http://instruct.cms.uncwil.edu/edn408.

At the beginning of the fall semester of their senior year, seven methods students (four white males, three white females) supplied baseline data from which changes in student perceptions during the academic year could be determined. Students provided responses to a survey measuring familiarity with different applications of instructional technology, knowledge about the National Council of Teachers of Mathematics Standards documents (NCTM 1989, 1991), and opinions on various curricular issues.

Table 1 shows the survey questions concerning technology and its role in mathematics education. The survey was administered three times during the students' senior year: prior to taking EDN 404 (fall semester), after completing EDN 404 and before taking EDN 408 (between fall and spring semesters), and after completing EDN 408 (spring semester).

INSERT TABLE 1 HERE

During EDN 408, students had two methods of interaction available to them: asynchronous and synchronous. Asynchronously, students were required to post their lesson plans and critique others' lesson plans using a hypermedia discussion board, thus affording them more time for extended reflection and response. Synchronously, interns were involved in real-time chats with practicing teachers in which interns raised concerns about beginning their practicum experience. Both of these forms of interaction were accomplished through the use of WebBoard™, which had been integrated into the Web site. Students were encouraged to continue to use WebBoard™ and the other online resources of the Web site throughout their practicum experience. Even though EDN 408 was scheduled for four weeks, there were only eight face-to-face classes planned, with students heavily dependent on the Web for interactions with other students, in-service teachers, and the instructors.

Student Responses to Check-for-Understanding Forms

The EDN 408 course Web site contains the components of a typical educational Web page: course syllabus, class calendar, a listing of assignments and a means of getting in contact with the instructors via e-mail. Additional features included specially designed pages reflecting current thinking on Web-based instruction (Khan, 1997). These features

included linking related pages such as the calendar and the assignments, the ability to fill out and submit observation forms online, and the capability for communication that was completely Web-based and not dependent on e-mail. All course content relevant to the NCTM *Professional Standards* was placed online, including multimedia vignettes using graphics and video snapshots taken from actual classroom experiences. Upon completing their study of each standard, students were required to electronically submit assessment forms to the instructors.

The six major standards that were emphasized during EDN 408 are listed below. Following each standard is a list of issues that a majority of students identified as the critical components of the given standard. This information was gathered by examining data from student check-for-understanding forms that were submitted online.

- Teacher's Role in Discourse

  Teacher's role as a facilitator

  Multiple methods of problem solving

  Group work

  Methods for requiring ALL students to participate

  A variety of outlets for student expression (questioning, journals, tests)

  Questioning techniques which lead to student discovery

- Worthwhile Mathematical Tasks

  Using student-generated examples

  Integrating activities which involve individual student interests

Connecting new concepts to other ideas and areas

Considering individual backgrounds and learning styles

Making data relevant by using actual data

- Student's Role in Discourse

Encouraging student-to-student discourse (critiquing each other's work)

Requiring students to explain problem-solving approaches to other students

Providing time for students to freely express opinions

Peer-tutoring, small group work

Providing opportunities for students to reflect, journal

- Tools for Enhancing Discourse

Technology

Well-designed activities

Visual representations, models

Manipulatives

Analogies

- Analysis of Teaching and Learning

Using various methods of analysis including portfolios and journals

Constantly monitoring the classroom environment

Questioning students often

Using inquiry projects

Analyzing student learning through observing, listening, and testing

- Learning Environment

Respecting and valuing student ideas

Considering interrelationships between time, tasks, and physical space and materials

Encouraging multiple methods of problem solving and student explanations of their approaches

Providing students with a sense of ownership

Bringing the Two Communities Together

During the spring semester, inservice teachers had the unique opportunity to meet on-line with preservice teachers (interns) enrolled in EDN 408. Interns were encouraged to ask questions of the practicing teachers about the use of various instructional methods advocated in the *Professional Standards*, as well as to express their concerns and anxieties about becoming teachers. Here is a brief dialogue excerpt taken from a chat session (inservice teachers are indicated with INS and preservice teachers with PRE):

<PRE1> Is it OK to be a little untraditional if my teacher is a little traditional. (Don't tell her I said that!)

<INS1> Definitely, the kids will like that and probably respond well if they understand the limits

<INS1> I think students now like to have some control over their own learning.

<INS2> Yes!

<INS1> What are some of the fears you guys have?

<PRE1> I'm afraid to change what my students are used to.

<PRE2> im afraid that i will ask a question and the students will give no type of response even after hints etc.

<PRE3> Me too!

<INS1> Don't be [PRE1].

<PRE4> Do state guidelines or test ever hinder your implementing The Standards.

<INS2> [PRE2] that is OK. Just make it a challenge and everyone help find the answers.

<PRE1> maybe I'm more afraid of how they'll respond

<INS1> [PRE2] call on a particular student and lead him or her to the answer. They will feel "smart" and will be more willing to respond next time

<INS2> Relax!

<INS1> [PRE4] they REALLY test the standards, so no

<PRE5> I'm afraid I will bore my students and that I'm not creative enough.

<INS2> Standards and State test---No! It helps me.

<PRE1> I'm scared of not finding something creative for every lesson.

<INS1> [PRE1] you can always adapt. You will teach differently every day!

<PRE6> How do you feel about requesting comments from students about our teaching.

<INS2> Creative everyday?? Gosh, no one can be. Just regularly! Ha!

<PRE1> Do you remember the pressures of student teaching?

<INS1> [PRE5 and PRE1] you all are so fresh. You will be much more creative than a lot of the students are used to. You don't have to have "games" to keep their interest

<INS2> [To PRE6] I do it almost daily. "How am I doing today, guys?"

<INS2> Games are fun and good sometimes, but I found the math gets lost sometimes.

<INS1> [PRE6] you can put it as the last question on a test every week. What did you like about this weeks lessons? What would you have liked to be done differently, etc

Practicing teachers found the interchange professionally stimulating and the preservice interns received timely, practical advice from their more experienced colleagues. This type of communication offers interns the unique opportunity to interact with a group of practicing teachers from different schools. With the traditional setting of interactions occurring during field placements and practicum, interns are much more limited in the population of teachers with whom they interact. This sample discussion also illustrates the fact that interns could ask questions that they might have been hesitant to ask if talking with their own partnership teachers or other faculty with whom they interacted on a daily basis at their practicum site.

Southeastern North Carolina is primarily rural, characterized by sparsely populated counties spread over broad geographic areas with regards to inservice teachers. Schools are widely dispersed and teachers' feelings of being disconnected from other practitioners in their field can be acute. Therefore, in addition to providing novel means for communication between preservice and inservice teachers, the communications features of the Web can play a critical role in fostering feelings among inservice teachers that they are members of a larger community of educators.

Survey data

Interns responded to a survey three times during their senior year: before taking EDN 404 (PRE-404), after taking EDN 404 (POST-404 and PRE-408), and after taking EDN 408 (POST-408). Interns responded to each item on the survey with strongly agree

(5), agree (4), no opinion (3), disagree (2), or strongly disagree (1). Interns responded to statements concerning their knowledge of the *NCTM Standards* about teaching mathematics, their experience using the Web for diverse purposes, and their thoughts concerning the role of technology in mathematics education. Selected items that indicated notable changes in mean responses are described in Table 2. Statements indicating a positive orientation are included first in the table and those indicating a negative orientation are listed second.

Data collected from the surveys indicated that initially students were convinced of the importance of technology in mathematics teaching, but differed in their comfort level associated with using technology in their lesson plans. All students identified some familiarity with both graphing calculators and computers. In addition, students had completed the required educational technology course that required the use of a variety of software packages. A few students had used the Web as a resource for research papers in prior classes or for more general research related to a topic of personal interest not related to coursework. Student responses to items on the survey did change during the year and are discussed further in the summary section below.

INSERT TABLE 2 HERE

Interviews

One-on-one interviews were conducted between the instructors and the interns three different times during the year, following the schedule used for administering the written surveys. The interviews were used to obtain more background data concerning student familiarity with and use of specific technologies, as well as particular beliefs students held concerning integration of the technologies into the mathematics classroom.

The interviews were videotaped and the questions that were included in the interviews are provided in Table 3. Initially, students identified technology as important in its role in mathematics education, but were typically uncomfortable in discussing specific uses of technology for the purposes of secondary mathematics instruction. However, students were not typically aware of recommended changes in curriculum and varied assessment recommendations as depicted in the NCTM *Standards*.

INSERT TABLE 3 HERE

Discussion and Summary

Data collected from both the interviews and surveys indicated that initially students were convinced of the importance of technology in mathematics education, but differed in their familiarity and previous use of specific technologies. All students identified prior experience with graphing calculators and computers. All students had completed the required educational technology course that required the use of a word processor, database, spreadsheet, and the demonstration package PowerPoint™. In a few cases, use of technology was more extensive in that at least two students had used the World Wide Web for conducting research in previous mathematics and education courses. However, none indicated even a moderate awareness of the resources available for the planning and presentation of topics specifically applicable to secondary mathematics. In other words, a few students had used the World Wide Web as a student of college-level mathematics, but not as a teacher of secondary mathematics. Even though few had used the Web for research, most students had used the Web as a participant in chats, but not those related to their undergraduate education. Not surprisingly, the degree to which the Web had been used previously was based primarily

on whether the student had access to the Web from their home. Initial responses to the survey items were similar for most of the items, except that a few students stated that they were comfortable using a browser to navigate the Web and one student indicated some awareness of Web resources available for communicating with other teachers.

Data indicated that student responses to items on the survey and to questions asked during the interviews did change during the year and in some cases, the change was marked. More specifically, students indicated little knowledge concerning the NCTM *Standards* initially in the areas of recommended changes in curriculum, assessment, and the role of technology in the secondary mathematics classroom. However, student knowledge consistently increased in these areas for each of the later assessments. As students completed additional assignments utilizing the Web during the year and additional assessments were administered, another notable change was the level of confidence students expressed about being technology leaders at their schools. There was one item on the survey about use of the Web that did not provide different outcomes during the year. This item assessed student opinion concerning their ability to use a search program on the Web. Students consistently agreed during the year that they were able to complete searches, which agreed with their having had previous experience with searches for research projects in other areas during their undergraduate courses.

Students definitely became more aware of Web resources that allowed them to communicate specifically with other teachers. Initially students were not familiar with such resources, but following assignments and chats with other mathematics teachers, students felt very knowledgeable of how to connect with other teachers using the Web. During the chats conducted between the students and teachers, all participants were very

involved and questions asked by the students covered a wide variety of topics related to the mathematics classroom. More specifically, students asked teachers to discuss their ideas and experience concerning the following areas:

- discipline problems;
- changes in planning required for block scheduling;
- activities for motivating students;
- use of technology;
- use of cooperative learning;
- state guidelines and mandatory testing;
- use of various assessment techniques, including portfolios;
- writing effective classroom tests;
- amount of work required outside of classroom time; and
- administrative support.

The teachers asked the students to identify their fears about starting their teaching careers. Students discussed their fears openly and the teachers were supportive in their responses to the students. Students were primarily concerned with their ability to keep the class involved, not being able to answer questions asked by the class, and trying to make effective change in the classroom environment.

Another source of data that provided insight into changes occurring for the students during the year was the analysis of concept maps each student was required to construct at different times during the year. In each case, students provided a concept map describing their ideas about what characteristics were critical in defining an effective teacher. Major characteristics were connected to the component identified as

"EFFECTIVE TEACHER" on the map and the map was extended to include connections between each of the critical characteristics and important aspects related to the effective utilization of these characteristics in the classroom. The following figure details the data from these maps:

INSERT FIGURE 1 HERE

Common characteristics and their associated dimensions identified by students in their original concept maps are indicated by the blue-shaded ovals with lighter-colored connectors. Major characteristics of effective teachers that were common among students are written in all capital letters and connected to the "EFFECTIVE TEACHER" object. The concept maps that students constructed after their Web assignments and chats with practicing teachers included the same characteristics as well as additional ones. Thus, their concepts of an effective teacher had been expanded and these new characteristics can be seen in Figure 1 in the yellow-colored ovals which have the dark connectors, seen as the heavy black arrows. Again, the major characteristics are written with all-capital letters and their associated areas with small-lettering only. The major characteristics, which were identified later in the year, but not initially, were LEADERSHIP, COMMUNICATION, and RELATIONSHIPS. Additional dimensions of an effective teacher that were frequently depicted later in the year were organization, discipline, content, questioning strategies, and relevant examples. One cannot argue that these are all essential features of an effective teacher, but traditionally some of these ideas might not occur to new teachers until they have spent quite a bit of time in front of the classroom.

It seems that having experience with a broader range of interactive materials through the Web and participating in online chats with teachers already in the schools may have helped these new teachers create a more realistic and expansive idea of attributes that play a role in effective teaching. In addition, these new teachers have become aware of an enormous amount of resources available to them as they begin their first efforts at creating an effective classroom environment. Not only will these resources provide them with curriculum ideas, but will also provide them with additional support from colleagues during their first years and beyond.

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Table 1.

Survey Administered Three Times during the Senior Year

Response Scale:

1=Strongly Disagree 2=Disagree 3=No Opinion 4=Agree 5=Strongly Agree

1. I am not familiar with the content of the National Council of Teachers of Mathematics (NCTM) Standards documents.
2. I am aware of the changes during the last decade with regard to what is relevant mathematics content for high school classes.
3. I could explain the high school goals of the NCTM Standards to another mathematics teacher.
4. I am aware of the methods for enhancing discourse in the mathematics classroom.
5. I understand the distinction between "worthwhile mathematical tasks" and other tasks.
6. I am not familiar with methods for collecting information about student learning that go beyond paper-and-pencil testing.
7. I am familiar with methods I could use to assess and improve my own classroom teaching.
8. I am familiar with ideas for changing the classroom environment to support learning.
9. I am prepared to implement the NCTM Standards in my own classes.
10. I understand the role of technology in implementing the Standards.
11. I feel that I can carry out an effective "Net Search" for information on the World Wide Web.

12. I am familiar with specific resources of the World Wide Web for mathematics and education.
13. I feel that the World Wide Web could be useful for finding information that would improve my teaching.
14. I am aware of World Wide Web resources that will allow me to communicate with other teachers.
15. I am at ease with the idea of participating in online chats and discussions on the World Wide Web.
16. It is important for schools to provide computers, software, graphing calculators, and other technologies for student use.
17. I would like to use technology for classroom presentations.
18. I would not feel comfortable teaching a class in which students use technology for hypothesis testing.
19. I am not comfortable with navigating the World Wide Web using a browser such as Netscape Navigator.
20. I feel that I can be a technology leader at my school.

Table 2.

Selected Survey Questions and Mean Responses (n = 7)

Statement	**Pre-404**	**Post-404 Pre-408**	**Post-408**
Q2: I am aware of the changes during the last decade with regard to what is relevant mathematics content for high school classes.	3.1	3.8	4.1
Q3: I could explain the high school goals of the NCTM Standards to another mathematics teacher.	2	3.3	3.7
Q10: I understand the role of technology in implementing the Standards	2.9	4.1	4.6
Q11: I feel that I can carry out an effective "Net Search" for information on the World Wide Web.	4.7	4.6	4.4
Q14: I am aware of World Wide Web resources that will allow me to communicate with other teachers.	2	3.9	4.6
Q15: I am at ease with the idea of participating in online chats and discussions on the World Wide Web.	4.3	4.1	4.4
Q16: It is important for schools to provide computers, software, graphing calculators, and other technologies for student use.	3.9	3.9	4.4.
Q17: I would like to use technology for classroom presentations.	4.3	3.9	4.4
Q20: I feel that I can be a technology leader at my high school.	3.4	4.1	4.4
Q1: I am not familiar with the content of the National Council of Teachers of Mathematics (NCTM) Standards documents.	3.7	2.4	1.7
Q6: I am not familiar with methods for collecting information about student learning that go beyond paper-and-pencil methods.	2.3	1.7	2.0
Q19: I am not comfortable with navigating the World Wide Web using a browser such as Netscape Navigator.	1.9	1.6	1.4

Table 3.

Interview Questions

- How much of a role do you think technology plays in effective math instruction in the public schools?
- Do you have a graphing calculator?

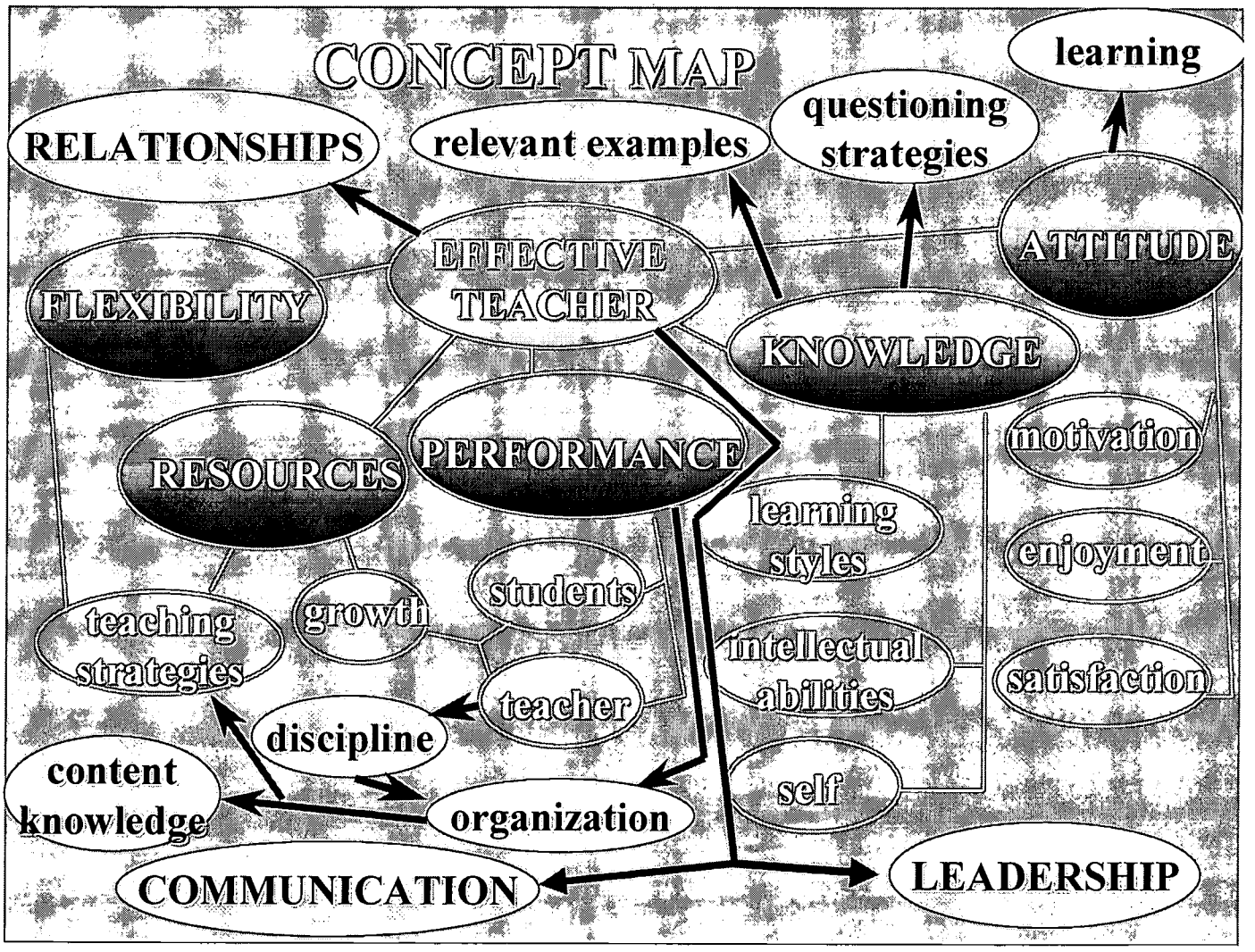
  If so, what model?
- How much experience do you have with graphing calculators?
- Do you think graphing calculators are generally available for student use in the public schools?
- Do you have a home computer?

  Do you have Internet access at home?
- Have you used the World Wide Web before?

  If so, how long have you been using it? What were the purposes for your using the Web?
- How available do you think computers and Internet access are in the public schools?
- Do you think that math teachers use computers on a frequent basis in their classes?
- Other than technology, what influences affect teaching in math classes?

Figure 1.

Concept Map Depicting Student Ideas before and after completion of Web assignments



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