The Mathematics Educator
2000, Vol. 5, No.1/2, 91-107

Developing, Implementing, and Evaluating a Tutor Intervention for a Mathematics Problem Solving Class

Andrea M. Schollaert
Cheryl A. Lubinski

Abstract

A learning assistance center at a four–year public university offers academic assistance to all enrolled students through interactive study groups, individual tutoring, and small group tutoring. The assistance is designed primarily for freshmen in the general education courses. As is the case in most universities, some courses are more challenging for students than others are. One course, in a newly implemented general education curriculum, is a mathematic problem–solving course and it is emerging as one that is difficult for most students. The course syllabus defines it as a multi–dimensional approach to the study of mathematics with a focus on mathematical problem solving. This study includes a review of tutorial assistance and an analysis of the performance or students who received assistance in comparison to those who did not. Both qualitative and quantitative research methods were used.

Introduction

Background

"It is no secret that many students who enroll (or who want to enroll) in college are underprepared for the academic demands of college work " (Ikenbury, 1999). The notion of underprepared encompasses a wide range and level of possible difficulties within the student population. Some students enter college with minor weaknesses in specific areas that are common to many students and are easily remedied. Such weaknesses may include study habits like poor time management or inefficient reading strategies. Others have deficiencies that are more profound and some may fall in between. In any case, universities frequently attempt to provide support to help underprepared students who are not equipped for the rigors of post secondary education.

Colleges and universities across the United States are continually faced with the challenge of retaining students and for providing appropriate support to those requiring assistance outside the classroom. Over the years, many models of developmental interventions for college freshmen were constructed to help students reach the required level of mastery for courses that are needed for success. For the most part, these interventions were developed in accordance with the traditional lecture/multiple–choice examination format, based on passive learning, prevalent on campuses nationwide. However, the tide may be shifting away from this more traditional pedagogical approach to one that is based on providing students with more active involvement in their learning.

One example of such reform is in the general education program implemented at Illinois State University in 1998. This curriculum contains courses that are radically different from the lecture format noted above in as much as course structure is based on constructivist theory that incorporates active and collaborative learning. In addition, offerings now include both a problem solving and critical thinking course. These changes reflect suggestions made by faculty and administrators in post–secondary education. For example, a survey conducted by the American Association of Colleges in 1982 found that seventy–nine percent of the respondents believed that critical thinking and problem solving deserve a place in general education programs (Gaff, 1983). It is also reported that educational institutions, elementary through post–secondary, are devoting increased amounts of time to the formal teaching of problem solving (American Educators' Encyclopedia, 1991 p. 449). While such information suggests that there may be national support for such courses, Illinois State University discovered that most students were not adequately prepared for the course in mathematical problem solving.

Student performance data collected after the first year of implementation of the mathematical problem– solving course showed that the D, F, and withdrawal rates were high. It was also discovered that a new set of challenges arose for providing the appropriate support. It was difficult to apply traditional developmental education principles to courses that stress iterative problem solving, collaboration, and critical thinking.

Situating the Problem

The Course

As is the case in most universities, some courses are more challenging than others are. A newly implemented general education program in mathematical problem –solving course emerged as one that was difficult for many students. As stated on the syllabus:

> *The course is a multi–dimensional approach to the study of mathematics with a focus on mathematical problem solving and reasoning with understanding in discrete mathematics, algebra, number theory, and geometry. Much of the course work involves collaboration with other students both within and outside the classroom. The problem solving is based upon conceptual understanding of mathematics, rather than on algorithmically derived answers, and demonstrated ability to provide written and oral explanations of the reasoning associated with each solution.*

One factor making the new course particularly difficult is its departure from most students' past experiences with mathematics. This statement implies that students, new to the university, expect this mathematics course to be comparable to those they had in high school. After twelve or more years of schooling, most undergraduates have set expectations for college mathematics classes based on their many experiences of attending lectures, taking notes, and learning standard procedures and formulas to solve problems (Arcavi, Kessel, Meria, & Smith, 1998; Otto, Lubinski, & Bensen, 1999). Instructors report that some students who struggled in this course had heretofore been successful in mathematics courses. Interestingly, past success in high school does not necessarily result in acceptable performance in this course that emphasizes understanding and well–written descriptions of the reasoning used to form solutions to problems.

The Intervention

Other courses over the past several years have been especially difficult for students. When these high–risk courses were identified, the learning assistance center at Illinois State University worked with the faculty to develop and provide academic support. One effective intervention was peer–assisted academic support through tutoring. Several studies have investigated the effects of tutoring on college students and positive results have been noted (House & Wohlt, 1990).

While it is the case that peer assisted tutoring was found to be a successful approach for providing academic support, the studies were conducted on the interventions that were designed for the more traditional types of pedagogy described above.

Relying on the traditional tutorial model assumes the peer tutor is able to direct students with discovering the way to find "correct" answers to assignments and problems and that success is measurable when a student reaches this end. This is often accomplished by using examples from class lectures or examples in an accompanying textbook. However, the course for this study focuses on learning the process of problem solving and supporting individual solutions through written expression, where class notes may consist of examples of the thinking and problem–solving strategies of other students and where there is no textbook or concrete examples of 'correct' solutions. Hence, the model of assisting a student with discovering ways to supply only the correct answer is no longer appropriate. This suggests that the more traditional tutoring model be adapted to the format and pedagogy of the course.

The Problem

The problem may be divided into two components as situated in the introduction. First is the nature of the course for which the intervention is designed because it is radically different from other mathematical courses with which most students and learning assistance personnel have experience. The problem associated with this is the scarcity of research on types of interventions for problem solving courses in higher education. Secondly, is the absence of data that show any correlation between participation in tutoring and final course grades. At Illinois State University, tutor effectiveness is currently measured only through student satisfaction surveys. While students report they are pleased with the quality of the service they receive, no empirical evidence of the effectiveness, via a review of performance as measured by the final grade, is available. The related problem is developing a model that is an evaluation of the academic support as related to class performance. The over– arching problem is the absence of a well –developed academic intervention that is designed specifically for students in problem solving courses in mathematics at the post– secondary level accompanied by a systematic evaluation of its effectiveness.

Review of the Literature

The Course

The course that provided the setting for this evaluation of an alternative model of developmental intervention is titled Dimensions of Mathematical Problem Solving. It is one of four options available to undergraduates to fulfill a mathematics requirement. The pedagogy of this course, teaching via problem solving, is one that reflects three recommendations of the *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics, 1989). The first is the recommendation that mathematics concepts and skills should be learned in the context of solving problems. Secondly, the development of higher–level thinking processes should be fostered through problem–solving experiences. And third, mathematics instruction should take place in an inquiry–oriented, problem–solving atmosphere. These recommendations stemmed from research on the teaching and learning of mathematics. Nickerson (1988) claimed that recent research and theory illustrated that students learned more when tasks required them to think about what they learned. A problem solving experience necessitates thinking and reflection is an explicit goal of the course.

Mathematics classrooms of the 1990s and beyond, adhering to the NCTM standards, are ones in which there is a community of inquiry, problem posing, and problem solving. Instructors establish an environment in which developing an approach to thinking about mathematics is valued over memorization of algorithms and getting one correct answer (Schifter, 1996) and this course adheres to these standards.

The change in mathematics education, from mimicking solutions from examples to understanding, affected students and instructors alike. Most math classes consist of the teacher presenting a mathematical problem along with the algorithm for solving the specific problem. In this environment, mathematics means doing the problem by following the rules set by the instructor (Stein, Grover, & Henningsen, 1996). When mathematics is taught as described, knowing mathematics means remembering and applying the correct answer when the teacher asks a question. The truth in math is then determined when the teacher (Lampert, 1990, p.31)) ratifies the answer. It should be no surprise that students carry this assumption of how to learn mathematics to the college environment.

For changes to occur within a mathematics classroom, at any educational level, both the instructors and students need to change. While this study is about

changes in perceptions of what it means to understand mathematics, a description of how teachers engaged in the thinking about teaching mathematics may help to reveal the struggles of freshmen students in this problem solving class. In a chapter found in Constructivism Theory, Perspectives, and Practice, Shifter (1996) presented the descriptions of the development of two primary grade teachers as they were re–educated and attempted to redesign their curricula to be consistent with the NCTM standards for the teaching and learning of mathematics. The new standards of creating a classroom environment that incorporated problem solving and a community of learners challenged them.

The written account of the personal reflections of these two teachers, found within the article, provided a personal look at the difficulty associated with change of pedagogy and beliefs about how students learn mathematics and the uncertainties that accompanied them as they initiated the recommended changes in practice. This article provided support for an assumption with which I approach this study. That is, students will experience comparable difficulty with the transition to the way mathematics is taught and how they are expected to study, learn, and be successful in a course designed in compliance with the NCTM recommendations for the teaching and learning of mathematics.

The view of teaching and learning for this course is based on research from cognitive science that indicated that basic skill acquisition and higher–order thinking go hand in hand and that basing instructional (tutorial) practices on cognitive theories can better prepare students to become strategic learners. As mentioned above and as specified on the course syllabus, this course is grounded in a constructivist theory of learning that emphasizes understanding of mathematics with an emphasis on problem solving (investigating, conjecturing, and justifying), connections among concepts, and on written and verbal communication of strategies and reasoning. There is growing recognition that a key to meaningful learning involved helping students relate new information to what they already knew (Duffy & Roehler, 1988; Fennema, Carpenter, & Peterson, 1989).

The Intervention

The tutoring strategies designed for this course are also founded in the cognitive approach to learning i.e., constructivist learning theory. This theory assumes that learning is a series of mental processes organized by the learner and that there are a series of developmental stages or points of readiness to move on. It also assumes that learning is an active process, one in which individuals constantly receive and organize new information, and then think about problems until they gain insight that leads to a solution. In addition, it assumes that individuals must

have access to pertinent pieces of information that helps to define the problem and that from this they will gain the necessary insight if they have the opportunity to arrange and rearrange the pieces of information (Casazza & Silverman, 1999).

Tutors apply this theory by determining what a student already knows and then trying to connect this new knowledge with existing knowledge. Using the cognitive approach to tutoring suggests that tutors engage in open–ended questioning and use responses as a basis for organizing the tutor session. This organizational plan must include ways to present information so that a student can link it to preexisting schemata (Casazza & Silverman, 1999). The cognitive view of how learning occurs as described by Casazza and Silverman (1999) is characterized by theories of developmental stages as found in the work of Perry, Vygothsky, and Piaget. Both Vigotsky and Piaget may also be characterized as constructivists. All of these theorists assume that learners are able to construct their own meaning.

Purpose

The purpose of this project was to develop and implement a tutor intervention for a mathematical problem –solving course. As mentioned, this course, since its' inception, has been challenging to students and was determined to be high risk for many as evidenced by the high D, F and withdrawal rate of students. In fall 1998, only sixty–four percent of the students earned a C or better, thus the remaining thirty–six percent earned a D, F, or withdrew from the class.

The mission of the learning assistance center is to provide support to students, particularly freshmen, in high– risk courses. Providing tutoring support is not new, but providing support for a course that is so radically different than those for which the students have experience is new. The tutoring intervention was carefully designed to be in compliance with the requirements and pedagogical approach of this course. Tutoring was also based on an active/constructivist approach to learning that emphasizes student growth through practice. Practice in the sessions was provided through discussions of solutions and review and critique of written communication of strategies and steps of reasoning.

Goals and Objectives

The major goal of the project was to develop a tutor intervention for students in a mathematical problem–solving course including a tutor training and evaluation of the program. Data for the evaluation of the intervention were gathered through several venues. One method was through feedback from instructors, tutees, and observations of the tutors. Effectiveness was also measured

via a grade comparison between the groups of students who participated in tutoring against those who did not. To do this, tutoring was offered on a limited basis, i.e., only to sections that were taught by an instructor who had two courses so one section, per instructor, was part of the control group.

Population

The students in the study were primarily freshmen at Illinois State University, a four– year public institution with approximately 17,000 undergraduate students. Illinois State University has always focused on the undergraduate experience with an emphasis in teacher education. The students in the study were all enrolled in the Dimensions of Mathematical Problem Solving, a course that is open to all students but required of elementary and middle school education majors. The majority of the students are female.

Importance of the Study

The study contributed to the field of tutorial assistance by providing the framework for a tutor intervention program for a course in mathematical problem solving complimented by an evaluation of the tutorial intervention. This research has the potential to further understanding of the link between academic support and the development of problem solving abilities. It has both practical and theoretical implications. The practical implication lies in the development of a training module and the implementation of the tutor program. At the theoretical level, the course and the intervention are based on the constructivist theory of learning, the assumption that learning is an active process that is enhanced by student exploration and discovery. It also assumed that students' learning experience was supported through the guidance of a tutor who facilitated groups as they developed problem–solving skills. This model assumed that the tutor served as a member of the learning team involved in building on knowledge and in self–discovery.

Procedure of the Study

This study evaluated several components of the tutorial program designed specifically to meet the perceived needs of the students in the Dimensions of Mathematical Problem Solving course. From the outset, it was assumed that to be successful, students must have the opportunity to practice crafting solutions and refining writing skills required to demonstrate an understanding that is evaluated by the clarity of the articulation of the steps of reasoning that went into the solution for a problem.

The goal of the specialized tutoring program for students in a mathematical problem solving class was to provide assistance, via peer tutoring, to students for whom the course is particularly challenging. Factors making the course difficult have been reviewed and from that information a tutorial intervention was developed. As measures of effectiveness, it was determined that the model be evaluated through the eyes of the administrator of the tutor program, the eyes of the faculty teaching the course, and the eyes of the students for whom the tutor services were designed. Providing tutorial assistance started small in the spring of 1999 by offering assistance to one class and it expanded to six classes in the fall of 1999. These six sections were the focus of this study.

Pilot Study Spring 1999

During the spring 1999 semester, tutorial assistance was provided to a single section of the Dimensions of Mathematical Problem Solving course. In this pilot study, participants, selected at random, were interviewed to assess their beliefs about whether or not there were personal benefits from the tutoring. Transcripts of the interviews were taped verbatim and data were coded and analyzed by one author. In the analysis, patterns of responses were noted such as, helpfulness of the questions asked by the tutor and an appreciation for the opportunity to share problem solving strategies. The information gathered from this study proved useful for the development and implementation of the larger scale effort.

The tutor chosen for this pilot study was a mathematics secondary education major with several semesters of experience with tutoring. He had never had the course but was a student in the university's Presidential Scholar Program and had consistently had high evaluations on tutoring from both the tutees and his supervisors. The tutor was also interviewed for additional data.

The tutor met with groups of students to provide assistance as they completed their first two guided group homework assignments. The guided homework typically consisted of one problem for which there were multiple solutions. In addition to providing multiple solutions, the groups had to write the steps of reasoning associated with the steps in the solution. Participation in tutoring was voluntary and attendance to the sessions was high. During the third and ninth weeks of the semester, four members of the class were interviewed to ascertain their perceptions of the benefits of tutoring.

A review and analysis of the data indicated that students benefited from work with a tutor. The self–reported benefits included a reduction in math anxiety, bolstered self–confidence, and increased knowledge of problem–solving skills.

This small sample uniformly reported that tutoring was effective because the tutor never gave the answer but rather asked questions they were able to use as a guide as they studied on their own.

Study Fall 1999

During the fall 1999 semester, tutors provided assistance to a target population i.e., to six sections of the course in which the instructor also taught a section for which no assistance was available. Tutors were selected prior to the beginning of classes and completed a training program designed specifically for tutoring this one course.

Data were gathered through several venues that included interviews with both the faculty and student participants and through a tabulation of students' final grades for the course.

Participants

All participants were enrolled in the problem –solving course for one academic semester. The study provided a comparison of students in twelve sections taught by six instructors for the course. The six instructors in the study taught two sections of the course and this was the primary factor for course selection. For each instructor, one section was assigned a tutor to work with students while the other section received no support from tutors at the learning assistance center. The tutor schedule was used a determining factor for selecting which sections would receive tutoring since it seemed desirable for tutors to be free at the time the class was offered to introduce him or her self to the class. One hundred and seventy seven students participated in tutoring during the first eight weeks of the semester (the entire duration of the intervention). As per the request of the coordinator of the mathematics course, the tutoring ceased after eight weeks.

Tutor Selection and Training

Tutors in the project met the rigorous selection standards of all tutors in the learning assistance center. In order to become a tutor, a student must demonstrate academic prowess and be selected through a competitive screening process. In addition, all employees must complete the first two levels of the tutor certification criteria. Tutors for the Dimensions of Mathematical Problem Solving must also complete four hours of specialized training prior to actual contact with the tutees.

The problem–solving training focused on the orientation to the content of the course, the difficulties of previous students, types of questions to ask to assess existing knowledge, and strategies for guiding the development of the appropriate skills. Tutors were given opportunities to practice modeling strategies and guiding students with using existing materials to determine what they already knew, what they needed to know, and strategies to be used to solve problems independently. Training activities included discussion, simulations, descriptions of strategies, and personal reflection.

The Intervention

Tutors met with the sections of the course to which tutoring was assigned to introduce themselves and to distribute sign–up sheets. If, during the sign–up period, it was discovered that the pre–selected times were not convenient for most students, the tutor often adjusted his/ her schedule to maximize availability for the greatest numbers of students. In a few instances, a student could not meet with any tutor because of schedule conflicts. This student was encouraged to make an appointment with the course instructor and was not included in the final analysis.

Tutoring began in earnest during the second week of classes. Tutees met with the tutor in small groups, often those established in the classroom by the instructor. Tutors had copies of the problems in advance of the sessions but were encouraged to serve only as facilitators to group problem solving activities and not to teach or demonstrate the solutions they may have reached.

Data Collection and Analysis

Participation in Tutoring

Tutors kept attendance sheets for each tutor session. Copies of the sheets were retained and the data were entered into an Excel spreadsheet that also included the numbers of sessions attended, date of attendance, and tutor name.

Student Performance

Grades for participants and non–participants were accessed through the Student Enrollment Warehouse (SEW) database on campus. This database had all information needed for the final analysis.

Faculty Interviews

The program administrator interviewed all but one faculty member and recorded all but one interview. The questions asked instructors to provide their perceptions of whether or not tutoring was beneficial to their students, if and how they might change the role of the tutor, whether or not tutoring should be required, and what they would suggest remain the same or what might be changed. All instructors reported they were pleased to offer tutoring as an option, that they believed tutors should be encouraged to have weekly meeting with the faculty, that tutors encourage students to also see their instructors for assistance, and that tutors incorporate study strategies into their tutoring sessions. The major concern of a few instructors was that students might become too dependent on the tutor.

Student Evaluations

Students completed tutor evaluations after tutor sessions as part of the administrative procedure in the learning assistance center and in some cases instructors requested feedback and forwarded the information. Student perceptions of tutorial support were that the sessions:

- helped them get on track with the way they should be thinking which they believed helped a lot;
- helped them think of different ways to solve the problems; and
- helped because they provided an opportunity to talk as a group and to answer questions among themselves.

Study Objectives and Results

The first objective of this project was to develop a training module for a course in mathematical problem solving. The module was developed through the assistance of the tutors, course instructors, and feedback from the tutees. At the conclusion of the tutor intervention, tutors made suggestions to be implemented in future training.

The second objective was to develop and to use a tutor observation form that looked at the specific goals for tutoring the course in mathematical problem solving. The intent was to have a form that would give appropriate feedback to the tutor. During the first few weeks of the project, the tutors developed the observation guide used for this project. The form was used and after each observation the tutor and the supervisor met for a one–on–one debriefing. The observation tool proved useful for both the tutor and the administrator.

The final objective was the to evaluate student performance. This was used as the primary evaluation of the effectiveness of the tutor intervention. This was accomplished through the comparison of the grades of students who participated in the tutoring with those who did not. When the results of grade comparisons among students in the same section were made, the results showed that in all but one section, students who took advantage of tutoring out performed those who did not. Table 1, presents the results of student performance within the same section of the class and controlled for attendance to tutoring.

Table 1. Comparisons Of Grade Point Averages
Same Section
Tutored / Not Tutored

Course Section	Class Average	Average GPA Tutored	Average GPA Not Tutored
03 N=28	1.92	2.09 (N=22)	.66 (N=6)
06 N=30	2.60	2.46 (N=15)	2.73 (N=15)
10 N=24	1.70	1.84 (N=19)	1.40 (N=5)
08 N=30	2.00	2.09 (N=22)	1.75 (N=8)
09 N=29	2.20	2.14 (N=28)	1.0 (N=1)
15 N=27	2.03	2.08 (N=25)	1.0 (N=1)

The data shows that those attending tutoring sessions earned higher grades, in all but section 06, than the non–tutored students earned.

Constraints

There are constraints to this study which are considered below:

- There is variability in pedagogy among instructors even when they are teaching the same course from a common syllabus. The major impact of such differences was minimized by study design because each instructor had one section in the treatment group and on in the control group. Nevertheless, interaction between the instructor and the specific class characteristics conceivably could lead to different pedagogical approaches by the same instructor.

- Assignment to the treatment group is another limitation. While it was possible to minimize instructor effect through assignment there are other factors such as time of day of the class, location of the classroom, the composition of the class,

and each students prior experience with problem solving that influence student performance.

- There are differences with approaches to tutoring even though all are required to complete training before facilitating sessions. Tutors are also influenced by the attitudes of the participants, time of day of the session, skill and experience with working with groups, and content expertise.

- And finally, there is the possibility of contamination from the spread of information about the support being offered to the treatment group. Students have been seeking assistance for this course since its' inception but have been denied tutoring. Support, albeit on a limited basis, was available for the first time the semester of this study. As Cook and Campbell (1079) note, such situations can create problems such as rivalry, demoralization, or compensation for those in the treatment group.

Conclusion and Recommendations

Findings

The findings from this study suggest that tutoring can be an effective type of assistance in a mathematical problem solving class as evidenced by final grades for the course, feedback from students, and comments made by instructors. While it is not possible to generalize beyond this single study, it was informative to see that academic support was beneficial to several of the students and was well received by faculty and participants.

These findings also appear to nullify the concern of faculty that students who participate in tutoring will become so dependent on the tutor that they will be unable to engage in effective problem solving without the assistance of the tutor. Since exams are completed individually the final grades are determined through the efforts of the individual taking the exams.

And finally, the findings suggest that it is possible to help students attain success, even in a challenging course, while maintaining the high standards set by the course instructors. Instructors were aware of the sections for which assistance was available. However, since, instructors might be prone to looking positively upon a student who wanted the extra help to do well or others may form negative opinions of someone who needs assistance; instructors were never provided the

names of the students who took advantage of the tutorial intervention thus minimizing the chances that grades were influenced by the instructor's 'feelings' about who would seek assistance.

The results of the study for this project support the assumption that tutoring is beneficial to many students. However, a one–semester study does not provide sufficient evidence to support or reject the notion that tutoring, as it was structured for this study, is ideal. The problem is now to ascertain whether the results are replicable when tutoring is made available to all students enrolled in the course.

The recommendations for future study are to:

- provide tutor assistance to all students enrolled in the mathematical problem–solving course and continue to compare the grades of those who participate with those who do not;
- include ACT composite and math sub scores in the analysis to establish if some groups receive greater benefit from tutoring than others;
- continue to gather feedback from students, faculty, and the tutors; and
- provide an ongoing evaluation of this program in order to modify the existing model as data suggest.

References

Ainsworth, L., Garnett D., Phelps, D., Shannon, S., & Ripperger–Suhler, K. (19994). *Mathematics: Needs and approaches using supplemental instruction* {on–line} wwwumkc.edu/centers/cad/si/sidocs/lamath94.htm

Arcavi, A., Kessell, C., Meira, L., Smith III, J. (1998). Teaching mathematics problem solving: An analysis of an emergent classroom community. *CBMS Issues in Mathematics Education*, 7.

Casazza, M., & Silverman S. (1996). *Learning Assistance and Developmental Education: A Guide for Effective Practice*. San Francisco: Jossey–Bass

Commission on Standards for School Mathematics of the National Council of Teachers of Mathematics. Curriculum and Evolution of Standards for School Mathematics (1989). Reston, VA. *National Council of Teachers of Mathematics*.

Dejmozla, Edward. L. (1991). Problem–Solving. In Kapel, D., Gifford, C., Kapel, M. (Eds) *American Educators Encyclopedia.*

Duffy, G., & Roehler, L., (1989). Tension between information giving and mediation: Perspectives on instructional explanations. In J. Brophy (Ed.), *Advances in research on teaching* (Vol. 1, pp. 1-33). Greenwich, CT: JAI Press.

Fennema, P., Carpenter, T., Peterson, P., (1989). Grouping for instruction in mathematics: A call for programmatic research on small–group processes. In Grows, D. (Ed.) *Handbook of research on teaching and learning*. (pp 165–196). New York: Macmillian.

Fosnot, Catherine. (Ed) (1996). *Constructivism: theory, perspectives, and practice.* New York: Teachers College Press.

Gaff, Jerry, J., (1983). *General education today: a critical analysis of controversies, practices, and reforms*. In The Jossey–Bass series in higher education. San Francisco.

Good, Mulryan, & McCaslin (1992). Grouping for instruction in mathematics: a call for programmatic research on small–group processes. In Grows, D., (Ed) *Handbook of research on mathematical thinking and learning*. (pp. 165-196). New York: Macmillan.

House & Wohlt (1990). The effective of tutoring program participation on the performance of academically underprepared students. *Journal of College Student Development*. 31.

Ikenberry, S. (1999). The truth about remedial education. *Community College Journal. Vol* 8.

Lampert, M., (1990). When the problem is not the question and the solution is not the answer: Mathematical knowing and teaching. *American Educational Research Journal. 27*, 29-63.

Nickerson, R. (1988). On improving thinking through instruction. In E. Rathkopf (Ed.), *Review of research in education* (vol. 15, pp. 3-57). Washington D.C. American Education Research Association.

Otto, A., Lubinski, C., & Bensen, C. (1999). Creating a general education course: a cognitive approach. In Bold, B., Keith, S., Marion, W. (Eds.). MAA Notes # 49. *Mathematics Association of America*, Washington, D.C. 191-194.

Shifter. (1996). In Fosnot, Catherine (Ed) *Constructivism, theory, perspectives, and practice.* New York: Teachers College Press.

Stein, Grover, & Hennigspen (1996). Building student capacity for mathematical thinking and reasoning: An analysis of mathematical tasks used in reform classrooms. *American Educational Research Journal*. Summer 33(2), pages 455-488.