PREPARING TECHERS-A DIAGNOSTIC MATHEMATICS COURSE

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ABSTRACT

A Diagnostic Mathematics Clinic serves students who are having difficulty with mathematics. In the clinical setting, University preservice mathematics education students work on a one-to-one basis with a student. The university students administer and evaluate diagnostic tests; conduct parent, student, and teacher interviews; and analyze measurement and screening data provided by the school. Based on these data, the clinician and university director develop an achievement plan for each student. This article describes the effects of the clinical experience on undergraduate students who are pursuing certification to teach mathematics.

Preparing teachers-a diagnostic mathematics course

The University of Houston-Clear Lake (UHCL) Diagnostic Mathematics Clinic serves second through eighth grade students who are having difficulty with mathematics. University preservice mathematics education students (clinicians) work on a one-to-one basis with a student. They administer and evaluate diagnostic tests; conduct parent, student, and teacher interviews; and analyze measurement and screening data provided by the school. Based on these data, the clinician and university director develop an achievement plan for each student. This article describes the impact of the clinical experience on university preservice students. In order to better understand this impact, it is necessary to describe the operations of the clinic.

Background Information

The National Council of Teachers of Mathematics (2000) states: "Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well." The National Commission on Teaching and America's Future (1996) also believes that effective teachers need to understand and be committed to their students as learners of mathematics. Working with students in a one-to-one format in a math clinic provides a unique opportunity for preservice teachers to focus instruction based on the needs of individual students.

According to Engelhardt (1985) mathematics clinics have different purposes: teacher education, public service, or research. One focus of a clinic is to educate teachers to cope with students who have difficulty learning mathematics. In this setting clinicians typically attend a seminar sequence and practica. In the seminar, theoretical and practical topics are explored; while in the practica these ideas are implemented with students. Dockweiler (1993) believes that the *Curriculum and Evaluation Standards* published by the National Council of Teachers of Mathematics should guide the establishment of any mathematics clinic. According to Dockweiler, a clinic should serve three roles: providing service to the community, training teachers in diagnosing and remediating the difficulties of students, and research. The Diagnostic Mathematics Clinic was established using the teacher education model described by Engelhardt and encompasses the three roles described by Dockweiler. It is staffed by undergraduate students working toward elementary or secondary mathematics certification.

Sheila Tobias (1999) suggests finding ways to integrate the needs of future teachers into standard undergraduate mathematics courses is difficult. UHCL has addressed this concern by creating math courses specifically designed for preservice teachers. One such course, the Diagnostic Mathematics Course, is offered each fall, and enrollment varies from 15 to 24 undergraduate mathematics education students. This course has been offered for more than 16 years at UHCL. Children are typically referred to the clinic by teachers or their parents. Information about the clinic appears in local newspapers, and flyers describing the clinic are sent to area mathematics supervisors, elementary schools, and middle schools. There is a registration fee for the clinic, and the children meet at the university one and a half hours each week for ten

weeks. Questionnaires about the child and mathematics are completed by the parents and the child's mathematics teacher.

Palmer (1994) stresses the importance of obtaining a solid, reliable picture of the student's current understanding of mathematics before beginning instruction. Eaves (1992) believes the key to successful instruction is beginning with the known and working towards the unknown. Since the level and accuracy of prior knowledge varies with each child, he describes diagnostic testing as a positive action to determine each student's knowledge level. The Diagnostic Mathematics Clinic utilizes the KeyMath Revised Diagnostic Test (KMR; Connolly, 1988). The KMR has three major areas with the following subtests: Basic Concepts - numeration, rational numbers, and geometry; Operations - addition, subtraction, multiplication, division, and mental computation; Applications - measurement, time and money, estimation, interpreting data, and problem solving. In establishing these content areas, Dr. Connolly reviewed mathematical curricula, mathematics programs, basal mathematics text books, research articles and other publications, especially those of the National Council of Teachers of Mathematics. According to Nicholson (1988) KMR is well constructed with excellent directions for interpretation and comparison of scores, both within the KMR and other instruments. If the area of mathematics is the only problem area delineated for a student, Davis (1989) recommends the KMR as the best measure for assessing the student. The KMR was also favorably reviewed by Bachor (1989-1990), Huebner (1989), and Finley (1992). According to Beck (1992):

> In the galaxy of educational test, KeyMath-R can only be described as a brightly shining star. From all aspects-content development, technical and normative underpinnings, and presentation of materials-the test is an outstanding example of the test-maker's craft.

Once the KMR has been administered and scored, the clinician develops an achievement plan for the student. This plan is based on previous test data; information from parents, teachers, the student; and the KMR data. The objectives described in the achievement plan form the basis for the remaining eight weeks of the clinic.

The clinic sessions are scheduled in viewing rooms and are under the supervision of the clinic director. Clinicians submit lesson plans prior to the clinic session, along with reflections of previous lessons. The clinic director observes sessions and provides clinicians with feedback.

Data Collection

Preservice students were surveyed at the end of the fall semester, 2000, and asked to respond to the following question: Will your experience working with one child in a diagnostic setting impact your classroom teaching? If so, in what way?"

Focus on the Child

Almost all clinicians noted the importance of fostering the child's self-esteem and positive attitude toward mathematics. They found that by focusing on the child's strengths during the session, the child became more confident in his mathematics skills. The clinicians found that a lack

of self-confidence could be a hindrance to succeeding in mathematics. They indicated that knowing this will encourage them to keep a positive, "You can-do-it" attitude as they teach.

Clinicians learned the value of establishing a supportive environment for students. One clinician noted she thought her student understood everything because he did not ask questions. In reality, the student was very shy and was afraid to ask questions. The clinician realized the importance of establishing an atmosphere of trust to encourage questions from students. This clinician plans to use a journal in her classroom and have students write down what they did not understand in class. These problems can be addressed the following day, without the student feeling uncomfortable.

According to Kennedy (1998) how a subject is taught tells students whether the subject is interesting or boring, clear or fuzzy, applied or theoretical, relevant or irrelevant, and challenging or routine. Clinicians found the importance of making instruction relevant to their students. Using the individual child's interests as a learning tool was found to be effective in providing meaningful instruction. For example, one child enjoyed hunting, fishing and working with animals. Whenever possible, these interests were included in instruction. Another student's interest in cats was used in a shopping game in which everything sold had to do with cats. In her classroom, this clinician is going to survey her students about hobbies and interests and use this information in creating mathematics problems.

Clinicians found it was important to consider a student's attention span. A clinician noted that lecturing to her student resulted in his becoming distracted immediately. In order not to "lose" him, she had to completely involve him in her teaching. For example, if she were teaching a lesson on fractions, she would give him fraction pieces to use as she taught the lesson. In her classroom teaching, she plans to actively involve students.

The ability to learn and process knowledge at an average rate of speed were attributes one preservice teacher had always taken for granted. After working with a special needs student, he no longer takes this ability for granted. He never knew with certainty what his student would retain and be able to do in subsequent tutoring sessions. This clinician decided to begin each tutoring session and each class session with a review of the material covered the previous day. He learned that when working with students similar to this student, it will be important to vary instructional activities and to provide as much structure as possible when working mathematics problems.

In working with one child who was experiencing difficulties in mathematics, clinicians felt they would be more aware of special needs students in their classrooms and have a better idea of how to fulfill their needs. "I have the tools to be able to determine the ways in which a student with a learning problem might learn best."

Instruction

All clinicians administered the KeyMath diagnostic test and developed and administered their own diagnostic test. They noted the importance of the diagnostic test in identifying each child's individual needs. In their own classroom, many clinicians indicated they would administer a diagnostic test prior to teaching a new unit or chapter to identify students' weaknesses as well as prior knowledge. They felt, in a classroom, diagnosing problems quickly can prevent wasted time

and "grasping at straws." According to clinicians, "Whether it be discussing the results of a diagnostic test administered by a diagnostician or developing, administering, and evaluating my own diagnostic test, I feel prepared to discover the weaknesses of a particular student or of the class as a whole. I now realize the importance of diagnosis in my class, and I am going to use techniques for a quick diagnosis during the monitoring and adjusting phase of my teaching."

University students also noted the importance of minimizing or managing frustration. One clinician noted his student seemed to have forgotten some important concepts that had been discussed in the previous tutoring session. Throughout the previous session, the student seemed to understand the concept. Yet, when she tried applying the concept during the following session, she could not. The clinician was frustrated for a number of reasons. The clinician began to wonder if he had done a good job; had he spent enough time with his student on the subject matter; had she already forgotten what she had learned last week; or was something else preventing the student from working with the concept. The clinician's comment, "If there is a frustration level in working with one child, there must be a twenty-fold frustration level in working with twenty children." This clinician believes that by realizing that some children may have low retention, he can "turn it around" and use it as a challenge or opportunity. "When I teach I will be constantly asking myself, 'What can I do to maximize retention?' This is where opportunity knocks on my door, and I have to be ready to answer it."

Success of students, according to the clinicians, is very dependent on mastery of concepts at lower levels. If, for example, a child has trouble with rational numbers, it would be easy to assume the problem lies with rational numbers. Yet, with proper diagnosis, the problem may be with earlier concepts such as numeration, addition or multiplication. Clinicians believe working in the diagnostic setting has given them tools and knowledge to work with students to determine where the actual "breakdown" of knowledge occurs.

Organization and being prepared are critical attributes noted by clinicians. Each tutoring session required a lesson plan, which incorporated manipulatives and a variety of activities. Obtaining the manipulatives, organizing each lesson, and adapting the lesson to students' abilities are required by classroom teachers every day. Clinicians found the tutoring sessions were more successful when they were better prepared and more organized.

Clinicians also reported the importance of flexibility. One ADHD student would come to the tutoring sessions in various moods. One day he would come to the clinic eager to work, while the next week he would complain about being tired and choose not to do any work. The clinician found letting the student rest or simply talk about his problems helpful. After the student was able to rest or vent his frustrations, an assignment or activity could be performed successfully. In his regular classroom, this teacher said he would develop a "time out" format where students will be given short breaks away from the regular activity. Upon completion of the break, students would return to the activity and complete the assigned task without penalty. Clinicians learned that even with the best preparations and the best intentions, sometimes a lesson does not work the way you thought it would. They learned to take a deep breath, back up, and try again.

Perseverance was also recognized as a valuable asset. If something does not work, do not give up; try something different. A clinician noted you "must be patient enough to take the time to find the method that will work with each child." Another clinician noted she had the time to look at a variety of different manipulatives, to try them out, and discover which ones were the most

effective for her student. When working with an entire classroom of students, this clinician feels that if a certain method or tool does not help a particular student, she will be able to use another one that might better meet the student's needs.

Clinicians have learned to never underestimate a student, to always have more material and activities planned than they think they will be able to do. This was a surprise for preservice teachers. According to one clinician, she had planned her first lesson plan, establishing reasonable time goals to accomplish each objective. However, at the end of the lesson she had extra time and no additional activities planned. The clinician had not considered what she would do if this happened and stated "After this experience I will forever have more materials and activities than necessary."

One preservice teacher discovered the use of manipulatives and games to enhance children's learning. Based on the success of using manipulatives and games with one child, she plans to incorporate manipulatives and games in her own classroom. Another clinician found his student learned mathematical concepts by first using manipulatives and then applying the concept. He realized everybody learns in different ways and he will have to be prepared to teach twenty or so students in several different ways. "I will be prepared with two or more manipulatives for each mathematical concept I plan to teach."

A preservice teacher found that students can effectively learn mathematics without a lot of worksheets. Her student enjoyed the games and manipulatives and based on test scores, the student's mathematics skills improved. This clinician is going to incorporate games and manipulatives in her classroom, and she is also going to recommend that her parents use games and manipulatives with their children at home.

Additional Insights

Clinicians realized there were factors outside of school that as a teacher they will have no control over, and they must stay focused on what they can do to help their students, including asking for help from other teachers and administrators. Scheer and Henniger (1982) describe the clinic as an ideal setting for parental involvement in the educational process. One of the requirements of this program was that the clinician interview the parents and teacher of his or her student. A clinician indicated she has learned how to discuss a student's mathematical weaknesses with parents and teachers. She also learned questions to ask that lead to a greater insight into the student's problems. Clinicians learned the importance of input from the student's parents. They were able to provide background information that helped the clinician determine the best strategies in working with the student. Clinicians indicated that communication with the parents of the students in a teacher's classroom will be equally important.

Assessment of Clinical Experiences

A preservice teacher noted:

> A teacher's teaching abilities are always work-in-progress. She can always improve, if not a new technique for teaching, perhaps a new understanding of learning - a diagnostic setting provides that opportunity.

According to another preservice teacher:

> The diagnostic clinic has given me time to work, talk, and enjoy a student in a way that would be difficult to do when there are twenty-five students in a classroom. This experience will be a valuable memory to remind me to take time to enjoy and get to know my students so that I can provide for them, in a personal way, learning that is exciting and fun.

Another clinician noted:

> I can use the knowledge I gained from teaching in the diagnostic clinic to become a better teacher. I will remember my work in the clinic and consider often if different activities or a different approach might help the learning process. I will also remember to praise students often when they are successful and try to be flexible with my teaching methods when I see frustration from my students. Most of all, I will try to be available to the students for the one-on-one contact that is often lost in the large classroom.

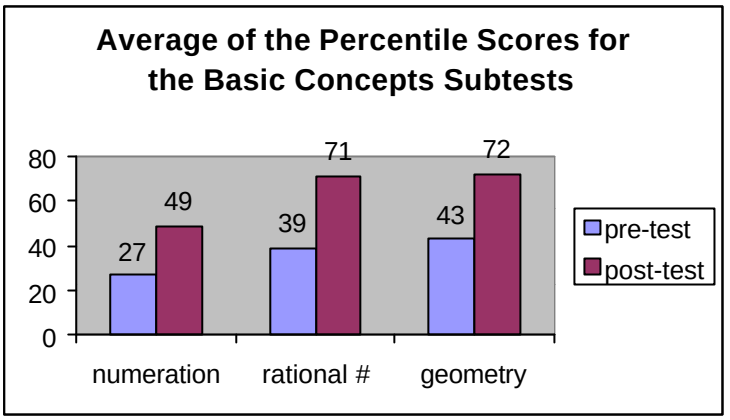
A preservice teacher reported:

> The most important lesson I learned from working with Kristen in the mathematics clinic is accomplishments, accomplishments by Kristen and accomplishments by me. When Kristen felt good about correctly answering the problems assigned to her, a little grin would appear on her face; she would have this little smile that I interpreted as "I'm good." This had to be one of the most warming experiences I have ever felt. I knew I had done well. Not only had Kristen accomplished the task of learning, but I had accomplished the task of teaching. Diagnostic teaching is an attitude that cares very much about each student's learning. I will carry this attitude with me into the classroom.

Impact on Public School Students

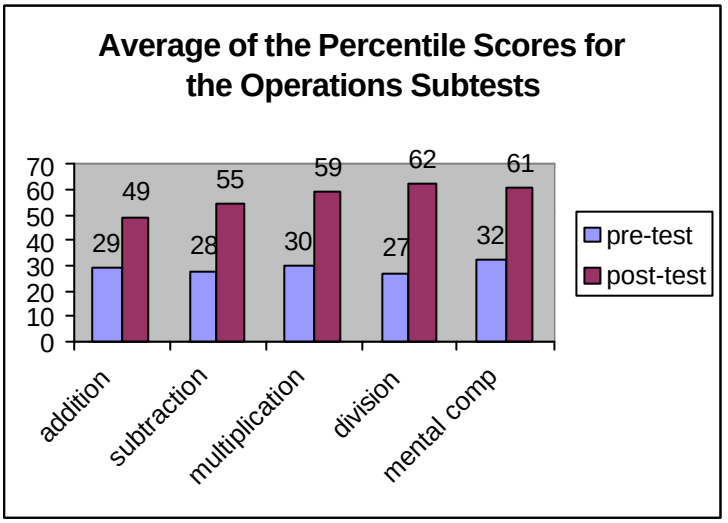
Public school students who participated in the Diagnostic Mathematics Clinic from Fall 1991 to Fall 1995 were surveyed. Fifty-five students who completed the program with both pre and post scores were included in this study. On the first day of the clinic, the university student administered the KMR to his/her student. On the tenth and final day of the clinic, the alternate form of the KMR was administered. A total of 45 students received tutoring in the Basic Concepts area of the KMR. Table I presents the mean scores for the Basic Concepts subtests.

Table 1



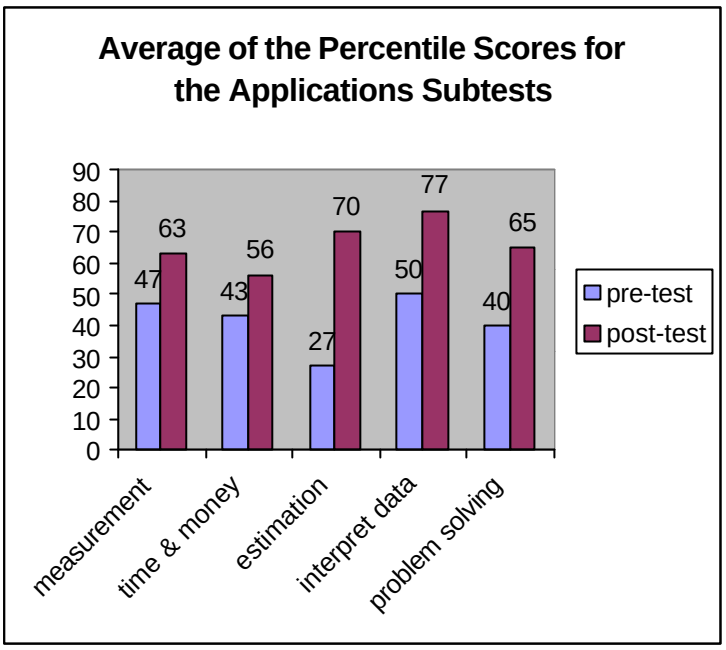
The second area of the KeyMath-R test is the area of Operations. Table 2 shows the mean scores for the Operations subtests. Forty-eight students received tutoring in the Operations subtests with more students receiving tutoring in subtraction than in any of the other subtests.

Table 2



The final area of the KeyMath-R diagnostic test is Applications. Fifty-four students received tutoring in this area. Table 3 presents the mean scores for the Applications subtests.

Table 3



Conclusion

The results of this study indicate the positive impact of clinical mathematical experiences on preservice mathematics teachers. Novice teachers have detailed how the clinical experiences have assisted them in focusing on both the student and instruction as they teach and plan to teach mathematics. The clinic gives university students the opportunity to practice mathematics instructional techniques with a student on a one-to-one basis and the confidence to try various manipulatives with students. In addition, the clinic provides teachers with practice in writing lesson plans, diagnosing students' problems, and reflecting on lessons taught. The impact of the clinical experiences of public school students is also significant. These students improved in their understanding of mathematics and informal assessment indicated a change in students' attitudes about themselves and mathematics.

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