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Infusing Evidence-Based Practices into the Special Education Preparation Curriculum

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Abstract: *This article describes how a math intervention was developed based on five standards needed to be an effective math teacher of students with disabilities and four validated practices shown to be effective with students with disabilities. Emphasis was placed on the importance of explicitly teaching these strategies in teacher education methods courses. Preliminary data indicated that when these standards and validated practices were used to teach first grade students at risk for math failure, achievement gains were seen and preservice teachers felt they gained knowledge about teaching students mathematics.*

Teacher preparation programs have always had the responsibility of training and graduating highly qualified teachers. No Child Left Behind (NCLB) defines a highly qualified teacher as someone who has: (a) a bachelor's degree, (b) full state certification, and (c) knowledge in each subject they teach. To ensure our students are highly qualified, many special education teacher preparation programs develop their curricula based on the Knowledge and Skill Competencies adopted by the Council for Exceptional Children (CEC, 2000). When preservice teachers graduate, we assume these competencies have been met. We also assume they were given explicit instruction about how to implement validated practices for their students. However, there is much discussion about the research-to-practice gap in special education. In order to close this gap and ensure our students have a repertoire of strategies to take to the classroom when teachers, teacher educators must provide preservice candidates with explicit instruction and practice in these strategies and practices. In this article, I first present an overview of a study conducted with first graders at risk for failure in math. I then describe how the intervention for this study was developed based on those standards and validated practices needed by effective math teachers. Although this study focused on first graders, the concepts for developing and implementing lessons can be adapted to any subject area at all grade levels.

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Overview of Study

Approximately 5–8% of the school-age population is identified as having mathematics disabilities (MD; Geary, 2004). Despite its prevalence, MD has been the focus of less systematic study than has reading disability (Ginsburg, 1997; Miller & Mercer, 1997). This relative neglect is unfortunate. In school, skill in mathematics is important for success; after school, mathematics competence contributes to gainful employment, income, and work productivity—even after intelligence and reading have been explained (Rivera-Batiz, 1992).

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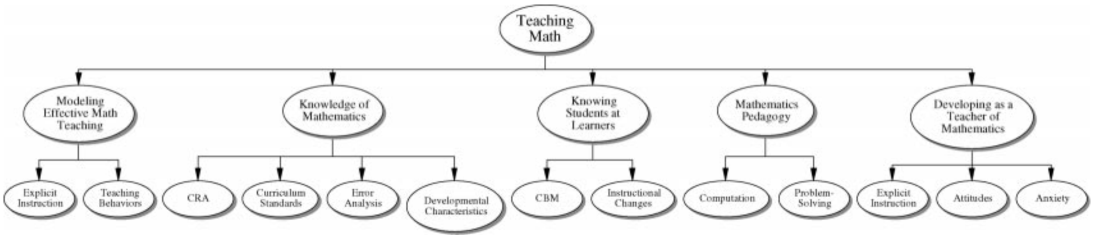

Figure 1. Framework

To increase understanding of MD as it develops in the early grades, Vanderbilt University's National Center on Research on Learning Disabilities is conducting a large-scale study of first graders. All students (n = 840) in 41 classrooms, representing a demographically diverse population, were assessed at the beginning of first grade on a broad array of math tests. Based on this initial assessment, as well as 6 weeks of curriculum-based measurement (CBM) in computation and in concepts/applications, 444 children were designated as "potentially at risk." These 444 students were assessed in a 2-hour battery of math, reading, and cognitive assessments to identify a subset of 130 students as "at risk." These children then were assigned randomly to two groups. One group received math tutoring in small groups 3 times weekly for 20 weeks; the other continued in their general education programs without modifications. The entire sample of 840 students was monitored weekly on CBM in computations and concepts/applications; they were also mid- and posttested using the group-administered math measures. The 444 at risk students were mid- and posttested on group and individual batteries of math and reading tests. These 444 at risk children will be followed through fourth grade.

Nine master's level students and two project staff served as the tutors in our intervention. Many tutors had little, if any, teaching experience, so it was important to ensure they received effective training prior to working with the students. Prior to working with their at-risk students, the tutors were trained first during a 3-hour session. The training consisted of overviews of all tutoring topics, the structured format for delivering the tutoring, and the behavior management system to be used during the sessions. After the initial training, weekly meetings were held so tutors could practice the next topic with each other. By practicing before interacting with their students, tutors were able to ask questions and use the concrete objects to confirm understanding. Time was also devoted to discussing problems and solutions as well as sharing stories of success. Preservice teachers need explicit instruction and practice to be able to implement strategies effectively with their students. To guarantee our students complete their training and have a good understanding of what and how they should be teaching, we encourage teacher educators to incorporate similar training into preservice classes.

Standards for Teaching Mathematics to Students with Disabilities

Using the CEC-Division of Learning Disabilities Knowledge and Skills Competencies in Math, Parmar and Cawly (1997) identified six standards that preservice math teachers must develop: (a) Modeling Good Mathematics Teaching; (b) Knowledge of Mathematics; (c) Knowing Students as Learners of Mathematics; (d) Knowing Mathematics Pedagogy; (e) Developing as a Teacher of Mathematics; and (f) Teacher's Role in Professional Development. The first five standards, coupled with four validated teaching practices: (a) explicit instruction, (b) effective teaching behaviors, (c) curriculum-based measurements, and (d) concrete-representational-abstract method were used to develop the intervention used in this study. Figure 1 provides the framework we used to develop our intervention.

- *Standard 1: Modeling Good Mathematics Teaching*

Preservice candidates must have the skills to deliver effective math instruction. As

Figure 2. Sample Script
Topic 10
Place Value
Day 1

Objectives
Students will:
Identify tens and ones place value

Materials
Review sheet 9
Topic 10 Day 1 Tutoring Sheets 1–4
Base 10 Blocks
Paper
Pencil
Point Sheet

Note to Tutors: Topic 10 continues to work on place value. A different skill is taught every day, so all 3 days must be covered.

Mastery Criteria: *Topic 10 Day 1 Tutoring Sheet 2: 8/10.*

Tutor: *The first thing we need to do today is complete this review sheet. I'll read the questions and you write the answers.*

Read directions and allow time for students to answer.

Advanced Organizer

Today we'll continue working on place value. Last time we drew tens and ones. Today, I'm going to show you rods and cubes and you're going to *write* the number without drawing them. First, let's quickly review what we know about Base 10 Blocks.

Review

Put a rod and a cube in front of the students.

What does a rod mean?

If student gives incorrect response, tutor says **A rod means 10. What does a rod mean?**

Students: 10

Tutor: Right, a rod means 10. What does a cube mean?

If student gives incorrect response, tutor says **A cube means one. What does a cube mean?**

Students: One

Tutor: Yes, a cube means one.

Does every number have a number in the ones place?

If student gives incorrect response, tutor says **Remember, every number as a number in the ones place. Does every number have a number in the ones place?**

Student: Yes.

Tutor: Right, every number has a number in the ones place.

Now let's write some numbers.

Modeling

Give students Topic 10 Day 1 Tutoring Sheet 1.

Look, this says 2 tens 7 ones. We have to write the number.

I'm going to show 2 tens and 7 ones with my Base 10 Blocks.

Show 2 rods and 7 cubes.

Now I need to see what number I have here. First I'll count my rods by 10s. 10,20 (point to each rod as you count). **Next, I'll count my cubes starting with how many tens I have, like this 21,22,23,24. . .27.**

So, 2 tens and 7 ones equals 27. Now I need to write 27. Write 27. **I want each of you to write 27 on your sheet.** Allow time for students to write 27 providing individual assistance if needed.

Guided Practice

Let's try a few together. Point to the next problem. **This problem says 6 tens and 0 ones. How many rods do we need?**

If student gives incorrect response, tutor says **We have 6 tens, so we need 6 rods. How many rods do we need?**

Students: Six.

Tutor: Right, we need 6 rods. How many ones do we need?

If student gives incorrect response, tutor says **We have 0 ones, so don't need any cubes. How many cubes do we need?**

Students: Zero.

Tutor: That's right, we need zero cubes.

Now let's see what number we have here. When we count rods we count by what?

If student gives incorrect response, tutor says **When we count rods we count by tens. What do we count by when we count rods?**

Students: Tens.

Independent Practice:

Tutor: Now you're going to complete this sheet on your own. First you have to read the number of tens and ones and then show the number with your rods and cubes. After you show the number, you'll write the number on your paper. I'll be watching and asking you questions as you work. Do you have any questions?

Answer any questions students may have.

Monitor students as they work, providing individual assistance as needed.

You've all worked hard today (or other feedback that may be needed)**, it's now time to fill in your point sheets.**

3 Points: 8–9 correct answers
2 Points: 6–7 correct answers
1 Point: 4–5 correct answers

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teacher educators, we must provide our students with the skills necessary to teach mathematics concepts. Such mastery occurs by explicitly teaching them multiple strategies. Moreover, we must provide our students with ample opportunities to use these strategies by having them either practice the skills either in our university classes or with "real" students in field-based experiences. To ensure we were providing our tutors with good teaching strategies, we incorporated components of the explicit instructional model as well as several methods to teach mathematics into the tutors' scripts. (See Figure 2 for a sample script).

Explicit Instruction

Explicit instruction, designed to provide ample opportunities for student responses and increased student time on-task, includes five major components: (a) presenting an advance organizer, (b) modeling concepts being taught, (c) providing guided practice activities, (d) providing independent practice activities, and (e) reviewing concepts taught.

Advance organizers were used to gain student attention and link previous knowledge to current knowledge. These quick statements were helpful as they set the tone for the lesson and provided students with explicit instruction about what they would be doing that day. As seen in the script (see Figure 2), the advance organizers were simple, yet they cued students that it was time to focus on their instruction.

The next component, modeling, was very important to the success of our intervention. Modeling is the act of talking aloud while demonstrating a new concept to students. It allowed students to see how the tutor used the manipulatives, followed an algorithm, and used metacognitive strategies. Manipulatives can be overwhelming for students when they begin to use them, so it was important for tutors to demonstrate how to use these concrete objects to solve problems. Tutors completed as many problems as needed until they were confident their students understood.

During guided practice, tutors interacted with students by presenting problems and asking the students to respond to questions, typically by choral-responding. However, tutors often questioned individual students to ensure their understanding. This stage was important for two reasons. First, initial success is imperative when learning a new concept. Guided practice allows tutors to give students feedback on strategies they were using as well as monitor student progress to determine if students were ready to move on to independent work or if they needed further review. Second, scaffolding provided during guided practice starts with a great deal of verbal assistance and moves to more directed learning as students become more proficient. By providing students with this initial success, feedback, and scaffolding they became more confident in their ability to complete the work.

Finally, after students developed proficiency, they completed independent work. This independent work consisted of worksheets developed to closely mirror the activities completed during modeling and guided practice. Although students were expected to complete the independent practice sheets individually, we closely monitored them and provided assistance as needed.

In regards to maintaining skills taught, cumulative and distributive review was used (Carnine, 1997). Distributive review ensures skills are reviewed over an extended time period, with heavy review of a concept for the first few weeks and the review lessoning over time. Review sheets were developed and given to students on Day 1 of each topic. These 10-problem review sheets took approximately 3 minutes to complete and provided tutors with a quick, efficient method of monitoring student's retention. If needed, tutors spent 1–2 minutes per day practicing skills where students needed additional practice. Quick, verbal reviews were also conducted at the beginning of each day's lesson to get students started.

Effective Teaching Behaviors

In addition to using the explicit teaching format, several effective teaching behaviors were incorporated into the scripts. These teaching behaviors have proven effective at increasing student achievement and should be used in all lessons (Benner, 1987; Brophy,

& Good, 1986; Englert, Tarrant, & Mariage, 1992). First, the lessons provided tutors and students with specific objectives and needed materials. When clear objectives are presented and materials are gathered, teachers can promptly begin their lessons. Second, the lessons are focused and paced quickly to keep students engaged in the process and provide sufficient opportunities to respond. In addition, tutors were able maintain the momentum of the lesson because they were provided with a consistent format across all tutoring sessions, so there were no elements of surprise. Third, effective questioning and wait-time were provided even for questions of varying levels. Finally, both positive and corrective feedback was given to students, both verbally and by earning points. Immediate corrective feedback was given as needed so students would not continue to practice errors.

- *Standard 2: Knowledge of Mathematics*

Having a knowledge of mathematics requires preservice teachers not only to be competent in the principles and processes of mathematics but also in conducting error analyses. They need to know the developmental characteristics of their students and have knowledge of the state and local K-12 curriculum standards.

K-12 Curriculum Standards

As tutors used the scripts to teach specific topics, they became familiar with state and local curriculum standards. We selected topics by analyzing both mathematics textbooks and local school district benchmarks. We also solicited feedback from other teachers. See Table 1 for a list of the topics used in the tutoring.

Concrete-Representational-Abstract Method

The Concrete-Representational Abstract (CRA) method of teaching math was used to design the tutoring sessions. This method of teaching math allows students to work with concrete manipulatives to assist them in understanding the concept being taught. Students then move to the representational stage, which allows them to make drawings to answer their questions. Students then proceed to the abstract level. Although many skills at the first grade level are at the concrete and representational level, this method can be applied to higher-level math skills as well. (For more information about the CRA method, see: Butler, Miller, Crehan, Babbitt & Pierce, 2003; Mercer, Jordan, & Miller, 1996; Witzel, Smith, & Brownell, 2001.)

Table 1. Topics Covered

1. Identifying and writing numbers to 99
2. Identifying more or less with objects
3. Sequencing numbers
4. Using <, >, and = signs
5. Skip counting by 10s, 5s, 2s
6. Introduction to Place Value
7. Place Value
8. Identifying operations
9. Writing number sentences
10. Place Value
11. Addition facts to sums of 18
12. Subtraction facts to 18
13. Review of Addition and Subtraction Facts
14. Missing addends
15. Place value
16. Two-digit addition with no regrouping
17. Two-digit subtraction with no regrouping

Error Analysis

Error analysis is the process of identifying systematic errors in computation (Ashlock, 2002). Student errors should be detected as soon as possible, so students do not practice incorrect procedures. Preservice teachers need to be taught how to identify common errors and plan for them to occur. As we developed our lessons, we anticipated typical errors and incorporated explanations as well as provided additional strategies, for tutors to use. (see Figure 1 for examples).

Student Characteristics

Parmar and Cawly (1997) believe that teachers must: know when to present concepts to students, understand the sequence of concepts to be presented, estimate how long a student needs to stay with a topic to ensure mastery and be able to determine if mastery has been achieved. In our intervention a mastery level criterion was set for each daily lesson. Most concepts covered 3 days,

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but if all students in a group of 2–3 students met the criteria on Day 1 they could move on. If not, they continued to receive instruction.

- *Standard 3: Knowing Students as Learners of Mathematics*

Preservice teachers must understand assessment procedures used in math and use results to make instructional decisions for their students. Such assessments can be as simple as directly observing students, conducting error analyses, or performing weekly curriculum-based measurements (CBMs) or standardized testing when needed. It is imperative that preservice teachers are explicitly trained about the importance of using assessment data to make informed instructional decisions. In our work, direct observations and the daily reviews assisted tutors in making instructional decisions. However, the weekly CBMs provided the most useful assessment data.

Curriculum-Based Measurements

CBM is a system for monitoring student progress that uses quick, repeated probes (Deno, 1985). Weekly CBMs were administered to monitor students' progress and responsed to the intervention in the areas of computation and application. The information obtained from the weekly CBMs was used to alter tutors' interventions (Fuchs, Deno, & Mirkin, 1984; Fuchs, Fuchs, & Bishop, 1992; Allinder, 1996; Fuchs, Hamlett, & Fuchs 1990). Changes in intervention typically consisted of slowing down the pace, reviewing a concept, or using alternative strategies targeted at particular error patterns. The CBM information was also given to teachers and parents to show progress students were making. Students enjoyed these weekly reports, as they could see their progress and their motivation increased. Although students were not required to set new goals for the next week, many students indicated that they wanted to improve their scores across the following week.

- *Standard 4: Knowing Mathematics Pedagogy*

Knowing Mathematics Pedagogy requires preservice teachers to understand the sequence in both computation and problem solving. Young students must begin to develop problem-solving skills. These skills are often given a backseat to the drill and practice of building computation skills. In our intervention, both problem solving and computational skills were included. Moreover, this standard emphasizes the need to present the sequence for grades K-12, as most preservice teachers will be certified to teach across all grade levels.

- *Standard 5: Developing as a Teacher of Mathematics*

Preservice teachers must understand three theories about teaching math, (a) behaviorism, (b) guided meaning, and (c) constructivism. They also need to know how they can compliment each other. Standards also emphasize the need to increase preservice teachers' attitudes about teaching math and lessen their anxiety. Preservice methods courses should provide students with explicit instruction and practice.

Reinforcement System

In addition to considering standards and related validated practices, we implemented a reinforcement system that allowed students to monitor their progress in two ways: being on-task and answering problems correctly. Students monitored their on-task behavior. When timers, set in variable intervals of 2–5 minutes, went off students determined if they were on task. If all students were on task and working, they received points. If any student was off task, no member of the group received points. This policy was explained to students on the first day the groups met and again at the beginning of each session. Students were encouraged not to be the one who caused others in the group to lose point-earning opportunities. Both examples and non-examples of on-task behavior was demonstrated. The second way students could earn points was by correctly answering problems. At the end of each session, tutors quickly scanned students' work and gave 1–3 points for the number of correct answers. Once students obtained 30 points, which could be done within a week's time, they received a prize (e.g., sticker, pencil). Overall, tutors found the reinforcement program effective with most students. However, some students had significant behavior issues and needed an individualized program. For these students a system was implemented so tutors could target specific behaviors (e.g., keeping hands to self, not interrupting, work hard, follow directions). This program, called "Rocket Behavior," awarded students points for achieving their own goals (see Figure 3). Each time tutors observed the behavior, a star was filled in. At the beginning, students were given a prize after all stars were filled in for one rocket ship. As positive behavior was shaped, prizes were given for three rocket ships.

Preliminary Results

The goals of our intervention were to increase the acquisition, proficiency, and maintenance of topics presented to students and to provide tutors with scripts and activities that allowed them to assist their students in gaining math skills. Data taken from *The Test of First-Grade Math Skill and Knowledge* (Fuchs, Hamlett, & Fuchs, 1990) indicated that at-risk students who received tutoring grew significantly better statistically on the computation and concepts/applications subtests than those who did not receive tutoring. Effects on both subtests were moderately large, exceeding one-half a standard deviation. In addition, the growth of at-risk tutored students was larger than that of students who were deemed not at-risk at the beginning of the year (and received only classroom math instruction), with effect sizes a small but impressive one-third of a standard deviation. Mean improvement scores on the computation subtest for each group were: (a) Tutored At-Risk Students, 13.20; (b) Non-Tutored At-Risk Students, 9.30; and (c) Students Not At-Risk, 11.28. Mean improvement scores on the concepts/applications subtest include: (a) Tutored At-Risk Students, 11.64; (b) Non-Tutored At-Risk Students, 9.14; and (c) Students Not At-Risk, 10.4.

Tutors were asked to give us feedback on the lessons at the end of the 20-week intervention. Overall, they were pleased with the scripts and activities. In regards to the lessons and activities they indicated: (1) the activities provided enough variety so that students could learn through different modes, (2) the students enjoyed the activities, (3) the activities made the concepts understandable and generalizable, (4) the scripts were great guides for teaching and good models to use in the future, and (5) the lessons were easy for the students to understand and they liked being actively involved in the lessons by using manipulatives or orally answering questions. The tutors were also positive about the practice opportunities they had in using manipulatives with real students. When asked about progress their students gained, tutors offered the following: (a) students were helped both academically and socially; (b) all students made progress, but the lowest students made the most significant gains, (c) the students lowest at the beginning of the tutoring brcame the most motivated and made the most progress. Although these data are preliminary, they are positive about the methods used to improve student achievement and prepare preservice teachers for their future role as classroom teachers.

Final Thoughts

Regardless of the subject matter, becoming an effective, highly qualified teacher is complicated and usually not intuitive. The skills of teaching most often must be taught. We used explicit instruction and found it effective for both students and teachers. If preservice teachers are taught explicitly, required to use this model of teaching in their own lessons, and implement effective strategies; they will have the tools needed to become successful teachers when they have their own classrooms. However, like elementary and secondary students, university students will not master important knowledge and skills unless teacher educators explicitly teach them and provide the feedback they need to become effective and highly qualified.

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