(DIS)EMPOWERMENT: THE IMPLEMENTATION OF CORRECTIVE MATHEMATICS IN PHILADELPHIA EMPOWERMENT SCHOOLS

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"I'll read some division problems. You write them. Problem A. 5 goes into 35. Say the problem".

The teacher taps a bell and the students respond "5 goes into 35".

"Write it. Don't work it yet. Problem B. 5 goes into 30. Say the problem."

The bell dings.

"5 goes into 30" They respond uniformly.

"Write it. Problem C. 5 goes into 45…"

After copying down several problems, the thirteen seventh and eighth grade students are given one minute to solve each problem in their identical workbooks. Once the minute is up, the class reads their answers out loud. Next, they move on to the another exercise, one in which they practice reading together the individual digits in three digit numbers. This is a typical exercise in the division Corrective Mathematics (CM) class.

All students[i] in Philadelphia Empowerment Schools are required to spend 45 minutes each day in Corrective Mathematics, an intervention program used to teach them the basic skills and rules of math. Corrective Mathematics groups students into different modules based on a placement test, progressively moving students as a class through the modules: addition, subtraction, multiplication, division, basic fractions, fractions/decimals/percents, ratios/equations, until they reach the enrichment stage. Each class is taught through Direct Instruction (DI), a method where the teacher reads from a script and the class is focused on repeating skills until students learn them. The exercise above was just one part of the many lessons in the division workbook, which combined will take the class several months to complete.

INTRODUCTION

The need to improve math education around the country has been well documented, especially in urban school systems like Philadelphia (Boaler, 2008, Przychodzin, Marchand-Martella, Martella, and Azim, 2004, Moses, 2001). In Spring 2010, only 56.6 percent of students in Philadelphia Public schools scored proficient or advanced[ii] on the Pennsylvania State Standardized Assessment (PSSA). In Philadelphia Empowerment Schools, the 107 lowest performing schools in the Philadelphia School District, only 45.8 percent of students scored proficient or advanced (PSSA preliminary results). Yet, across these schools, there is wide variation. While over 80 percent of students in some Empowerment schools scored proficient or advanced in math, in other schools less than 20 percent of the student population reached math proficiency (Murphy, 2010; PSSA math results).

In October 2009, former Philadelphia Public School Superintendent Arlene Ackerman implemented the Science Research Associates (SRA)[iii] Corrective Mathematics and Corrective Reading curriculum in all Empowerment Schools, as well as schools in Corrective Action II[iv] under No Child Left Behind and other low performing schools as deemed by the District. Within these schools, all middle school students are enrolled in 45 minutes of Corrective Mathematics and 45 minutes of core[v] math each day. Prior to the implementation of Corrective Math, students spent all 90 minutes on the core math curriculum[vi].

As one might expect with such a drastic change, there are ongoing debates between administrators, teachers and parents about the merits and weaknesses of the Corrective Mathematics program. Despite these questions and concerns, there has been minimal research on the impacts of CM in Philadelphia, or abroad. This article presents an initial foray into the field. Through extensive observations and interviews , I document the implementation of Corrective Mathematics in one Philadelphia Empowerment School, looking specifically at how this implementation relates to the needs of the school's students. This research answers two important questions: 1) What does the CM curriculum look like in the classroom, and 2) how does it support or inhibit learning in the core math class. Overall, I found that the Corrective Math curriculum in this Philadelphia

Empowerment School is not being implemented as its designers intended and, as it is used, the program conflicts with the learning needs of Philadelphia students. While this study cannot be used to generalize about CM in all Philadelphia schools, I offer an in depth look at what the curriculum actually looks like in practice. Moreover, because the Philadelphia School District mandates the uniform way in which CM is implemented (Caulk, 2009), findings from one school may hold up in other schools throughout the District.

THE COGNITIVE REVOLUTION AND CONSTRUCTIVIST PEDAGOGY

The CM and core math curricula, both simultaneously taught to Philadelphia Empowerment School students, are based on distinct approaches to math pedagogy. While the CM curriculum is based on Direct Instruction, a behaviorist teaching strategy, the core math curriculum taught in Philadelphia Empowerment Schools is founded on a constructivist approach to learning. An understanding of these two approaches and the assumptions behind them will help to clarify how these curricula interact with each other and address student needs.

Direct Instruction and the Corrective Math Curriculum

The *Corrective Mathematics* curriculum currently used in Philadelphia is a form of Direct Instruction (DI), a traditional approach to teaching created by Siegfried Engelmann in the 1960s. DI is based on a behaviorist approach to learning in which the teacher has full control to mold a student's behavior. This theory supports the idea that students learn best through repetitive, structured practice (Wortham, 2003).

According to Engelmann's definition of Direct Instruction, these programs should create a controlled environment to ensure that students are instructed in a specific way. To guarantee that concepts are taught with clear objectives, the teacher follows a script. In the script, students are instructed to practice each skill individually until it is memorized. If a student produces a wrong answer, he is to be corrected immediately. Skills are taught in a specific order, progressively increasing with difficulty, and students are organized in homogenous groups and taught to the level of the lowest performer, with the hope that all students prove mastery of a concept before moving forward (Adams, and Engelmann, 1996; Engelmann, 1966; Kinder, and Carnine, 1991; Przychodzin et al., 2004).

Corrective Mathematics is a Direct Instruction intervention program developed for struggling students by the company SRA/McGraw-Hill. The program uses seven modules to target the understanding of addition; subtraction; multiplication; division; basic fractions; fractions, decimals and percents; and ratios and equations. It is lauded in Philadelphia (Ackerman, 2009) as a research-based program, yet only one of the 15 studies in the SRA's *Research Base for Direct Instruction Mathematics Programs* (Przychodzin, 2004) focuses on Corrective Mathematics. This single research study evaluates the implementation of Corrective Math in a suburban setting, where each of the 10 students in the class was given an individual tutor, unlike Philadelphia's urban setting with 33 students in a classroom (Parsons et al., 2004).

Since the creation of Direct Instruction in the 1960s, the Cognitive Revolution, based on the constructivist learning theory, has challenged the traditional way of understanding knowledge, thinking and learning. This new field of research has shown that ideas cannot be imposed upon students, but students must interpret thoughts and incorporate them with their own prior understanding(Wortham, 2003). A math classroom guided by the constructivist approach does not instruct students to memorize procedures, but instead challenges students to problem solve, grapple with difficult concepts, and question their answers (Schoenfeld, 2002; Schoenfeld, 2004). This setting allows students to learn through a variety of styles, such as asking good questions, working in groups, and valuing the responses of their peers (Boaler, 2006). Furthermore, there is ample evidence that this process helps students remember the ideas for longer than other forms of math instruction (Boaler, 1999).

RESEARCH METHODS

Through the observation of classrooms and interviews with teachers and other administrators, I collected data describing the implementation of Corrective Math in Philadelphia Empowerment Schools. Understanding how CM is being implemented in the classroom is an important first step in judging whether the program is effective for these students.

For a month and a half during October and November 2010 I observed seventh grade core math classes and seventh and eighth grade Corrective Math classes at a Philadelphia Empowerment School. In order to understand the effectiveness of the implementation of Corrective Math, I observed four different Corrective Math classrooms, subtraction, division, basic fractions and enrichment, on a total of nine occasions. A different teacher taught each of the four classes. During these observations I completed a qualitative study of the classroom culture and the actions taken by students and teachers. I noted students'

accuracy in answering questions and completing problem sets and the level of student engagement by observing whether students were on task participating in response to the teacher's cues and answering the problem sets. Teachers' deviations from the script and their reactions to student work and questions were also noted. I also completed five 45-minute observations of the core math class, which allowed me to make comparisons with the Corrective Math classes. Additionally, my observations provided information about the school culture, students' disposition towards math, and District math standards.

Interviews with teachers and other administrators provided information about overall implementation of the CM and core math curriculums, as well as opportunities and discontinuities that CM provides for students. These teachers provided details about how the program was conducted, including information about the placement process, and they informed me about lessons that occurred between my visits. Additionally, they provided expert knowledge about the needs and levels of certain students, including student performance in other classes, specific difficulties they might have and, in the teacher's experience, how the students learn best. I used a respondent-driven sampling method to recruit teachers for interviews starting with my original contact at the school. The majority of teachers I interviewed have taught for at least four years. Many of the teachers play active roles assisting with curriculum development and overall teaching strategies at their schools. Additionally, the majority of teachers in the sample had attended a workshop given by a representative of SRA/McGraw-Hill explaining the goals and purposes of the CM program. Going beyond the teachers at the school I observed, I interviewed three teachers who work with the CM curriculum at other Empowerment Schools in Philadelphia in order to get perspective on how typical my observations might be. These teachers explained the implementation of CM at their schools. They also provided me with further examples of how the CM curriculum supports or impedes their students' learning.

FINDINGS

Implementation of CM Does Not Align With the Program Design.Direct Instruction programs like CM can be an important teaching tool for certain students; however, the program was created according to strict implementation guidelines. In my observations of Philadelphia Empowerment Schools, I found several ways in which implementation of CM falls short. First, instead of enrolling students who have shown a need for remediation in the CM program, as the guidelines instruct, all students in Philadelphia Empowerment Schools are enrolled in the program. Secondly, due to the rigid nature of the placement exam used to place students within the levels of CM, many students were improperly placed within the program. Despite this improper placement, higher performing students were not retested after a few weeks of instruction, as the program guidelines require. Finally, the CM classes I observed contained more students than recommended by the program. All of these factors led to classrooms with diverse levels of students—a stark contrast to CM guidelines which specifically mandate homogenous classes. In my observations, these implementation failures led to classrooms where the lowest performing students could not follow the lesson and little individual attention could be given to students.

School-wide Implementation/Innacurate Placement

The problems with CM implementation in Philadelphia Empowerment Schools begin at the district level. The CM curriculum was created specifically as an intervention for special education[vii] or struggling students (Series Guide, 2005; November 11, 2010). The one research study documenting CM, (provided by SRA/McGraw-Hill) demonstrates this model: in the school observed in the study, "school counselors identified a pool of learners [to participate in the CM program] based on their previous failure" (Parsons et al., 2004, p. 97). Successful implementation of the program involves identifying weaker students and grouping them based on their individual areas of difficulty (Series Guide, 2005).

In the school I observed, all students were enrolled in CM, despite the teachers' knowledge of individual students' specific needs. By administering the program to students who are not in need of intervention, the program misuses students' time. Students who are not struggling are taken away from their core math classes, and instead must sit through instruction that is not designed for their skill level.

Moreover, the implementation of CM to the entire school population exacerbates the incorrect placement of students, because students who do not need remediation are included in CM classes. In the school I observed, all students in the school took the CM placement exam and were placed in one of the seven levels of CM based on the results of that exam. A small percentage of students passed all seven levels of CM on the exam and were placed in an enrichment section, but due to the rigid grading of the exam and the testing of content that students had not studied for many years, few students earned this distinction. Since all students took the placement exam, not just students who had shown prior need for remediation, many students with strong content knowledge-- but who might have needed to sharpen their computational skills-- did not pass the exam and were placed in CM classes.

Long division is an example of a skill tested on the exam that students had not studied for many years. Students learned long division in third or fourth grade, but most students forgot the procedure since they use calculators in their core math classes.

The school does not spend time reviewing long division after it is initially taught (November 18, 2010). Additionally, since students are allowed to use calculators for the majority of the PSSA exam, they are not required to know long division for that exam either. Many students who have a strong knowledge of math are placed in the division section of CM because they do not know how to perform long division on the placement test. As one eighth grade teacher explained:

> I had girls who went on to the best high schools in the city…they were testing advanced on the PSSA. They just forgot how to do long division. The District wasn't providing them [the students] the necessary skills to pass a test like that [the placement test] (November 18, 2010).

At this teacher's school, 40 percent of eighth graders placed advanced or proficient on the PSSA (Philadelphia School Profile), but only 13 out of 700 students in the school, less than two percent, tested out of CM into the enrichment section. Although this is just one example, several teachers in the study echoed this sentiment.

Beyond initial placement, CM guidelines also mandate students be retested continuously throughout the program. The CM guidelines state, "students who do poorly on the placement test, but have previously done well on the mathematics portion of any standardized achievement test should be reevaluated after a week or two of instruction" (Series Guide, 2005, p. 25). This reevaluation did not take place at the school I observed. The retesting of students is especially important because the placement exam tests students on content, not on the speed at which they learn. Without supplementary placement tests, students who master a concept quickly do not have a chance to move forward. At the school I observed, 25% of eighth grade students scored proficient or advanced on the PSSA; only 2% placed out of CM. None of the students who placed into CM were retested after instruction began.

Heterogeneous Classes

Because an entire CM class moves together through each lesson, the CM guidelines require classes to be grouped homogenously. Furthermore, the CM Series Guide says that each class should not have more than 10 students; if a classroom has more than 10 students, students should be broken into smaller groups based on ability level (Series Guide, 2005). In my observation, classrooms repeatedly contained more students than permitted by the CM guidelines, and no classroom had grouping by ability level. The CM classes that I observed had 12, 13 and 15 students per class. Other teachers I interviewed had 20-30 students per class, with largest having 31.

These large class sizes, coupled with the inaccurate placement of students, causes disparities in the level of student knowledge. These disparities in levels of learning make it difficult for all students to learn. In heterogeneous classes, the lowest performing students are often not helped and the fastest students are bored. Every one of the observed CM classes contained students with large variations of knowledge and speed. The following observation is from the CM fractions class on November 19th:

> *Sixteen students are present in the classroom. When the class checks the answers to lesson 31, eight students get almost all of the questions correct, six write completely wrong answers, and two do not have most questions answered.*

In the other CM classes, as well, students showed extremely varied knowledge of the content. While checking answers on a lesson in the CM subtraction class, a handful of students answered all the questions correctly, while the majority of the class wrote incorrect answers. In the CM division classroom, one of the students correctly completed the mastery test five or ten minutes before the other students, but was held back by the slower speed of other students.

Most of the teachers interviewed believe that the range of student skill levels makes teaching and learning more difficult. One teacher explained, "for basic fractions we could have started a little higher [on a more advanced lesson], but since there was such a large class, there was a big range. There were some [students] that knew nothing about fractions and some that [only] needed little refreshers on how to convert from mixed numbers to improper fractions" (November 19, 2010). Since the class moves at the same pace as a group, larger classes make it more difficult for the lesson to attend to the learning needs of each student. Moreover, many teachers and students agree that the CM curriculum wastes time by moving at a slower speed than the needs of the students. As one teacher stated, "the division book had 70 some lessons. They weren't getting through it in a full year. Sometimes all they need is a refresher, not 70 days of a refresher" (November 19, 2010). For many proficient students, the additional time in CM merely took away from more targeted core classroom instruction.

Inadequate Individual Attention

The large class size and diverse levels of students also mean that there is little individual attention given to students and no remediation given to the lowest performers. This goes directly against the direct instruction principle that students should be corrected immediately when they produce an erroneous answer (Series Guide, 2005). In the observed CM classrooms, students continuously repeated mistakes, usually without knowing their errors. For instance, in the observed CM classrooms (and in

accordance with the CM guidelines) after students completed an exercise the class would check answers. Students checked answers by, first, switching books with a peer, and subsequently, by the teacher or the students reading correct answers out loud. Each student marked whether the answer was correct or incorrect and wrote a total score for the exercise, but no explanation was given as to why the answers were correct or wrong. There was no opportunity built in to the lesson for students to look over their own work, and since students didn't correct their own workbooks, many students were unaware of which questions they answered incorrectly. Teachers, also, rarely looked over each student's work. The observed teachers were often unaware if multiple students made the same mistake or if one student repeated the same error. For example, in the CM division class:

> *On November 15th, the class begins with a mastery test, which occurs periodically throughout the book. They are given five long division problems to complete: each with a four-digit number divided by the single digit number eight or nine. As they are completing the test, most students are working diligently but one girl is vocally complaining that she does not know how to do the problems. One boy finishes the problems in one or two minutes. Most of the class takes at least five to ten minutes to complete the work. Ten out of 13 students in the class get all of the answers correct. The teacher considers the class to have passed the 80 percent threshold and the class moves on to the next lesson.*

Although CM is designed for the lowest achieving students, ironically these students are the most disadvantaged due to faulty implementation of the program.

This problem manifested itself in all of the classrooms that I observed. In the basic fractions class, I observed a group of five boys near the back of the classroom who were working diligently. One of them was answering all of the questions correctly, except questions involving adding fractions with unlike denominators. For these problems, he followed the rules of multiplying fractions and multiplied the numerators and then the denominators, subsequently producing the wrong answer. This is the same error I noticed him making in class two weeks earlier. In those two weeks his mistake had not once been corrected.

There are many students in the CM classes, who, like this boy, consistently and unknowingly made the same errors. Because of the large class sizes and diverse levels of students, students in CM classes often struggle to learn the material. In fact, one year after entering the program many students did not show any improvement. Due to school restructuring, all students at one Philadelphia Empowerment School retook the CM placement test *after* completing a full year of the CM curriculum. Many of these students tested into the same CM class as the year prior.

CONCLUSION

In my time spent observing classrooms and interviewing faculty and administrators, I found that the Corrective Math curriculum in Philadelphia Empowerment Schools is not being implemented as designed and conflicts with the learning needs of Philadelphia students. Empowerment Schools, intervention programs, and the Corrective Math curriculum are key elements in the Philadelphia School District's plan, originated by then superintendent Ackerman, to improve schools in Philadelphia. Despite this, there has been a significant lack of attention on and research about the implementation of the Corrective Math program. Further, there has been little to no public explanation for why the District chose the CM curriculum.

The School District of Philadelphia must consider which students need remediation and what type of remediation best serves the students. Instead of implementing universal programs, school districts should focus on the specific learning needs of individual students. Additionally, they should consider the use of intervention programs that are supported by current research showing that students learn best when they can problem solve and engage with their learning (Bransford et al., 1999; Kilpatrick et al., 2001). Teachers, who have a strong knowledge of the strengths and weaknesses of their students, should play an active role in choosing these programs.

There were obvious limitations to my research in terms of scale and scope. I observed CM classrooms of students at one Empowerment School. Through interviews I did learn about the implementation of CM at other schools, but I was not able to view classes at any of those schools. Further, these interviews enlightened me to the fact that the challenges and successes of CM vary greatly between schools. This is especially true since each school serves a different population of students with specific needs. Future research on CM should include observations at a diverse set of schools in the District.

The observations took place in math classrooms of seventh and eighth grade students. Although I did not observe classrooms at the elementary and high school level, I was able to interview elementary and high school teachers who provided information about CM in their classrooms. Although many of these observations are similar to the implementation of CM at the elementary and high school level, there are grade specific issues with CM that I was not able to document. In further research on CM, elementary and high school classrooms should be observed.

The voices of students are also missing from this research. Although I observed students in the classroom, I was not able to document their opinions and beliefs about the program. This research would further be bolstered with access to student data, such as test scores, which would provide evidence of the success of the CM curriculum.

One major focus of future research should be on the variety of ways that CM is being implemented in Philadelphia. As I concluded from my data, the current use of CM does not align with the guidelines of the program. If the program stays in place, changes should be made to implement it correctly. This includes not prescribing CM to all Philadelphia school students, correctly executing the placement tests, creating homogeneous classes, and limiting class size appropriately.

Observing the effectiveness of the CM program in the classroom and analyzing how the program impacts the learning needs of students is an important first step in evaluating the use of the CM program in one Philadelphia Empowerment School. Given the findings in this study, more attention should be given to understanding how CM impacts students with the goal of determining whether the CM program is the best intervention to meet the needs of Philadelphia students. Intervention should consider and address the skill levels of individual students and should be integrated with the school's teaching and testing on the core curriculum and the PSSA. There are many intervention programs based on research about how students learn which address basic skills *and* use strategies to prepare students for success in mathematics (Ebby, 2010). The lowest performing schools should be supported in advancing their students by the use, where needed, of a sensitive and well implemented intervention that complements student learning in the core curriculum.

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END NOTES

[i] Students in Kindergarten do not participate in CM. Additionally, a small number of students who test out of CM are placed in a SRA designed enrichment course.

[ii] The PSSA scores students as advanced, proficient, basic or below basic.

[iii] SRA is a division of the text book company McGraw Hill.

[iv] The Pennsylvania Department of Education defines Corrective Action II as a school that has not met Annual Yearly Progress (AYP) for five years in a row.

[v] Seventh and eighth grade students in Empowerment Schools use the Prentice Hall Middle Grades Math textbook.

[vi] Additionally, prior to this switch, core math classes used the Math in Context book instead of Prentice Hall.

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