MIXED-ABILITY SECONDARY SCIENCE IN ONE URBAN SCHOOL DISTRICT:

A MULTIPLE CASE STUDY

by

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I dedicate this dissertation to my students,

past, present, and future.

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CONTENTS

LIST OF TABLES

MIXED-ABILITY SECONDARY SCIENCE IN ONE URBAN SCHOOL DISTRICT:

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The standards and accountability movements demand that all students be given the opportunity to learn more science than ever before. However, there is much uncertainty about how educators should proceed with this task. Issues of concern include achievement gaps, tracking, and graduation requirements. The purpose of this multiple case study was to explore the challenges identified by four secondary science teachers in one urban public school district as they taught classes that included students representing a wide range of abilities and prior academic success. These mixed-ability science classes were generally defined as science classes which are required for high school graduation but which have no academic prerequisites.

The central research questions in this qualitative study were: 1) How do secondary science teachers describe the challenges they face while teaching a mixed-ability science course required for graduation when the course has no prerequisites; and 2) What strategies do they use to deal with these challenges? Data collection was confined to four cases within one Midwest urban school district during the 2004-2005

school year. Each case involved one class taught by an individual teacher. One case was an 8th grade science class at a middle school. The other three cases represented three district-required courses in three different high schools: 9th grade biology, 10th grade chemistry, and 11th grade physics.

Data sources included interviews with the teachers, observations in their classrooms, district achievement and demographic data, and school documents. Three themes emerged from the cross-case analysis: 1) a sense of belonging; 2) the teacher's focus; and 3) successful learning. The final chapter discusses the implications of these themes and makes recommendations for further study.

MIXED-ABILITY SECONDARY SCIENCE IN ONE URBAN SCHOOL DISTRICT: A MULTIPLE CASE STUDY

Chapter One: Introduction

> *For a long time we believed in the "some kids" agenda. Some kids will go to college, some kids will go to the work force, some kids can go to the military. That's garbage. We believe that every kid can learn at a high level and that college is for every child.*
>
> —John Deasy (Rimer, 2008)

Background

"Science for All" has been a powerful recommendation during the past two decades of science education reform (American Association for the Advancement of Science, 1993; National Research Council, 1996; Texley & Wild, 2004; Yager, 2005). The standards and accountability movements demand that all students be given the opportunity to learn more science than ever before. However, there is much uncertainty about how educators should proceed in this task. (Hurd, 2000) described the problem:

> *There has been a lot of action in the reform movement, such as making existing courses more rigorous; lengthening the school day and year; reducing class size; demanding more homework; increasing high school graduation requirements; and focusing science teaching on inquiry skills and discipline standards. These actions do not reflect a coherent point of view, nor are they consistent with our changing culture and its demands on students. (p. 282)*

Even the concept of "science for all" is not clearly understood:

> *Despite the best intentions to promote equity and to close achievement gaps, the science education reform movement has failed to respond adequately to the diversity of the student population. It has become increasingly obvious that "science for all" does not necessarily mean that "one size fits all"—curriculum, instruction, or assessment. (Lynch, 2001, p. 622)*

As educators struggle with the issues involved in promoting equity, there is abundant evidence that at one time access to science education was restricted. Lederman (2003) points out that science practitioners have traditionally been white, male Westerners: "It is they who define the rules, methods, instrumentation, descriptions of results, and criteria for knowledge production" (p. 604). In this way, she contends, traditional scientists have been the definers of science careers and gatekeepers for access to science. As science reform efforts attempted to provide access to students who traditionally would have been denied, achievement gaps have become persistent (Haycock, 2001; Norman *et al.*, 2001).

One of the practices associated with lost opportunity and achievement gaps in science is "tracking", a practice of "separating students into different courses or course sequences based on their level of achievement or proficiency as measured by some set of tests or course grades" (Haury & Milbourne, 1999, p. 1). Oakes (1985) and Wheelock (1992) were among the leaders of the effort to expose the unfairness of this practice. Darling-Hammond (1997) wrote: "Deep-seated inequalities in access to knowledge are institutionalized by curriculum disparities across schools and by tracking within schools—that is, the differentiation of curriculum and course-taking options based on presumptions about what students can or should learn" (p. 266). In our multicultural

society, it is essential that such presumptions not be allowed to place minority students into less-demanding courses (Banks *et al.*, 2001).

Not everyone agrees, however, that tracking should be eliminated. Polansky (1995) stated "the research clearly illustrates that tracking does not work" (p. 33) while at the same time calling tracking a "divisive and volatile issue" (p. 33). Loveless (1999), on the other hand, claimed that the tracking research is "ambiguous" (p. 28) and he warned that detracking is risky. Detracking is complex and these reforms involve more than just revising the scheduling of classes to achieve equity: "Detracking is also a highly normative and political endeavor that confronts deeply held cultural beliefs, ideologies, and fiercely protected arrangements of material and political advantage in local communities" [Oakes et al., 1997, p. 507]. Teachers who have experienced teaching in heterogeneous detracked classrooms report diverse reactions to the tracking debate (Atkins & Ellsesser, 2003).

While the tracking debate continued, the school district in this study took steps to provide rigorous science education to all students. First, non-core courses were eliminated. Second, a new set of science standards was adopted as requirements for high school graduation for all students. The graduating class of 2006 was the first in which all members were required to earn credit in biology, chemistry and physics. The course sequence was designed so that all 9th graders take Biology 1-2, all 10th graders take Chemistry 1-2, and all 11th graders take Physics 1-2. Recognizing that not all students would master the same standards to the same depth, three options were provided for each of these required science courses. For example, the standards for Physics 1-2 were required for all students, but they were offered in three different ways. Physics 1-2

Fundamentals is a course available only to special education students for whom an Individualized Education Plan (IEP) recommends special support (the Fundamentals courses are taught by pairs of teachers using the co-teaching model). Physics 1-2 Honors is a course available only to students who meet an algebra prerequisite and who have been successful in previous science courses. The vast majority of students take the regular Physics 1-2 course, which has no prerequisites. As such, this option of Physics 1-2 includes students with various reading abilities, mathematical abilities, and degrees of success in past science courses, as well as diversity along many other modes of comparison. While theorists and policy makers debate whether or not such heterogeneous classes are the right way to go, these classes are a reality and it remains to be seen what problems may arise within these classes.

Creating heterogeneous classrooms does not ensure equity. Since different students learn in different ways, strategies are recommended for differentiating instruction within the mixed-ability classroom (Billmeyer, 2003; Chiappetta & Adams, 2004; Gallagher, 2000; Krueger & Sutton, 2001; Marzano, 2003; Marzano *et al.*, 2000; National Research Council, 1998; Nieto, 2002; Silver *et al.*, 2000; Tomlinson, 2001; Winebrenner, 1996, 2001). But how do the teachers actually implement differentiated instruction in mixed-ability secondary science classrooms? Rubin (2003) stated: “Despite heated debate over detracking, little research exists on how the reform plays out in the classroom” (p. 539).

Among studies conducted in heterogeneous classrooms, confounding variables often compromise comparison to this unique secondary science situation. Taylor (1997) conducted research on models of teaching used in middle school classes organized for

gifted students as compared to classes for non-gifted students. Cooper (1996) studied heterogeneous classes of 9th grade English and history, but not science. Cone (2003) researched a detracked 12th grade English class. Oakes and Wells (1998) examined a variety of heterogeneous classes in ten schools. Koba (1996) studied heterogeneous 9th and 10th grade science, but the unique course also involved integrating the science disciplines. Robertson (1998) and her associates studied 9th grade classes that were detracked, but the science curriculum was uniquely integrated with math. Claus (1999) investigated detracked secondary science classes, but this particular study only looked at a combination of two previously different levels (Regents and honors) of college preparatory science classes—it did not include the "basic" students who were not in the college preparatory track. Clarke and her colleagues (2003) examined tracking data in science and mathematics, with a stronger focus on mathematics. All of the aforementioned studies offer insights that are useful while examining the issues in mixed-ability secondary science courses, but for the sake of administrative decision-makers and classroom teachers more research is needed to learn about issues that teachers identify when heterogeneous secondary science classes are established.

Purpose

The objective of this multiple case study was to explore the issues identified by four secondary science teachers in one urban public school district as they were teaching classes which included students representing a wide range of abilities and prior academic success. These mixed-ability science classes were generally defined as science classes which are required for high school graduation but which have no academic prerequisites.

Research Questions

The central questions in this study were:

- How do secondary science teachers describe the challenges they face while teaching a mixed-ability science course required for graduation when the course has no prerequisites?
- What strategies do they use to deal with these challenges?

The subquestions included:

- What are the ranges of student differences in these mixed-ability classes?
- What are the teachers' perceptions about the scheduling of these classes?
- What are the teachers' perceptions about the students in these classes?
- What issues are identified as important in teaching this heterogeneous mix of students?
- What adaptations do teachers make in these mixed-ability classes?
- What kinds of support do these teachers identify as needed?

Delimitations and Limitations

The scope of this study was confined to four cases within one Midwest urban school district during the 2004-2005 school year. Within that district, each case involved one teacher and only one of that teacher's classes. All four cases represented the same central phenomenon of mixed-ability science classes having no prerequisites, but each case provided a different view of the phenomenon. One case was an 8th grade science class at a middle school. The other three cases represented three district-required courses in three different high schools: 9th grade biology, 10th grade chemistry, and 11th grade physics.

Generalizability of this study's results will be limited to some degree. The uniqueness of each of the four cases, as well as the district's specialized approach to the reduction of tracking, restricts the potential for applying the findings directly to other science classrooms or other school districts. Nonetheless, while generalizability was not a major objective of this qualitative study, careful attention was given to verification strategies so that the interpretations might provide useful insights for teachers in other heterogeneous science settings.

Expected Outcomes

This study was intended to explore some of the issues that develop when school districts attempt to bring rigorous science to all of their students, particularly when the students in the same classroom have various degrees of science skills and background experiences. Practicing classroom teachers should be able to find meaning in these cases to assist them with strategies in their own mixed-ability science classrooms. Administrators and professional developers within the school district under study should be able to use the results to plan professional development and other support systems for teachers, as well as consider the findings when making decisions for the science program. Finally, it was intended that the results of this research should create new questions and expose new areas for future research. This was not a study to evaluate the program as "right" or "wrong", but rather to use these cases to learn more about what is actually happening. Spurred by the new insights, further research should seek additional understanding of issues facing secondary science teachers in mixed-ability classrooms.

Chapter Two: Methods

> *Where thoughts come from, whence meaning, remains a mystery. The page does not write itself, but by finding, for analysis, the right ambiance, the right moment, by reading and rereading the accounts, by deep thinking, then understanding creeps forward and your page is printed.*
>
> —Robert Stake (1995, p. 73)

Characteristics of Qualitative Research

Creswell (2003) examined the work of other writers describing the characteristics of qualitative research, and he provided (p. 181-183) a list of characteristics including: research in the natural setting; multiple methods of data collection; emergent procedures; personal interpretation; holistic view of the phenomenon; sensitivity to the researcher's personal biography; complex reasoning that includes inductive and deductive processes; and the use of one or more inquiry strategies. These characteristics are involved in a shift of the research focus away from numbers (quantitative), and instead aim for a product that relies more on words and pictures to describe the situation (Merriam, 1998, p. 8). The strengths of this kind of research are particularly well suited for uncovering the meaning (Maxwell, 1996, p. 17) of what is taking place in the mixed-ability science classrooms. "In a qualitative study, you are interested not only in the physical events and behavior that is taking place, but also in how the participants in your study make sense of this and how their understandings influence their behavior" (Maxwell, 1996, p. 17). Maxwell (1996) also explained that qualitative research is focused on small numbers and is able to "preserve the individuality of each" (p. 19) during analysis, thereby helping to develop understanding of the particular context of each situation. Another advantage of

qualitative research, according to Maxwell (1996), is that it can identify unanticipated phenomena and influences (p. 19). This study used these strengths of qualitative research to explore deeply the issues in mixed-ability science classrooms.

Strategy of Inquiry: Multiple Case Study

Because each teacher's experience with a mixed-ability science classroom, in one particular school district, during the particular year of the data collection would be a uniquely "bounded system" (Stake, 2000, p. 436), I chose case study as the strategy of inquiry for this research. Creswell (2002) defined case study as "an in-depth exploration of a bounded system (e.g., an activity, event, process, or individual) based on extensive data collection" (p. 485). Merriam (1998) stated that "a case study design is employed to gain an in-depth understanding of the situation and meaning for those involved" (p. 19). While this study sought to provide a rich description of the issues facing the teacher in each case, the inquiry was designed as a multiple case study, which can also be called "collective case study" (Stake, 2000, p. 437). Four different cases were examined in order to uncover a deeper understanding, since "the more cases included in a study, and the greater the variation across the cases, the more compelling an interpretation is likely to be" (Merriam, 1998, p. 40). The common case involved the issues facing a teacher in one mixed-ability secondary science class, but each of the four cases happened at a different school within the district, at a different grade level, and with different science content. The selection of these cases was intentionally conducted to maximize the potential for deep understanding, as Stake (2000) pointed out regarding sampling decisions in collective case studies, "balance and variety are important; opportunity to learn is of primary importance." (p. 447)

One of the features of case study research is that it is particularistic. Merriam (1998, p. 30) explained that this specificity of focus can examine specific instances but also illuminate a general problem. Stake (2000, p. 439) warned that the search for particularity will be competing with the search for generalizability. It was important in this multiple case study to balance the focus on unique features in each of the four cases during the cross-case analysis which then examined the particular features of the common case. The particularistic illumination that results from this study should be able to "suggest to the reader what to do or what not to do in a similar situation" (Merriam, 1998, p. 30).

Another feature of case study research that shapes the design of the questions and the usefulness of the findings is "rich, thick description" (Merriam, 1998, p. 29). Although some case studies are intended to be evaluative (Merriam, 1998, p. 39), the actual intent of this multiple case study was to provide description. The data collection was not directed toward causal explanations, but rather toward an insightful description of what issues the teachers were facing in their classes. In order to develop the deepest description possible, data were collected from a variety of sources. Merriam (1998) pointed out that the three main sources of information in qualitative case studies are interviews, observations and documents. This multiple case study sought understanding of the issues through interviews with the four teachers, observations in each teacher's classroom, and student records defining the nature of the mix of students involved with each case.

Role of the Researcher

In a qualitative case study, the researcher is the primary instrument for gathering and analyzing data, and therefore must recognize the potential for allowing personal biases to interfere throughout the process (Merriam, 1998). For this reason, it is essential that researchers "explicitly identify their biases, values, and personal interests about their research topic and process" (Creswell, 2003, p.184). Since I have a long history with the school district of this study, it is imperative that I describe the situation and explain my own personal history with the development of the science program that is the focus of this case.

The Research Site. During the year of this research project, this metropolitan school district served over 45,000 students. On the secondary level, there were twelve middle schools (with 55 science teachers) and eight high schools (with 96 science teachers). During the last two decades of the twentieth century, site-based decisions at the schools led to school differences regarding the rigor and variety of science courses offered at each school. At the middle level, some schools offered "honors" sections for science, while other schools scheduled all students in heterogeneous science sections. At the high school level, schools offered a wide range of courses, from one-semester introductory science courses to upper-level Advanced Placement courses. During that time, the science graduation requirement was two years of science, and there were no prescribed courses or course sequence required to fulfill that science requirement. The majority of students took a two-semester biology course in 9th grade, followed by two more semesters of science, fulfilled by physical science, chemistry, earth science, physics, or other laboratory science courses. During the 1999-2000 school year, the district-wide adoption of new science standards and assessments, combined with new

science graduation requirements for the class of 2005 (later postponed one year to 2006), led to all schools in the district offering the same courses. At the middle level, “honors” sections were phased out in order to raise the level of expectations and rigor for all students, not just the high achievers. At the high school level, science courses that were not considered college preparatory were eliminated. The State earth science standards were integrated into the outcomes prescribed for three other courses: biology, chemistry, and physics. These three courses were designated as the required science curriculum sequence to be completed by all students for graduation. As I described earlier in the introduction, each of these three courses was offered according to three different options: Fundamentals (for students whose special education IEP recommends special support), Honors (with achievement prerequisites), and the regular level (to prepare all students for college). This last level, having no prerequisites, included the high school mixed-ability classes that were studied during this research project.

<u>Researcher Bias</u>. For twenty-five years (from 1973-1998), I was a middle school science teacher in this school district. My experiences raised my awareness and concerns about the achievement gap that was associated with a high science failure rate for African-American, Hispanic, and Native American students. It also became clear to me that when the schools were racially desegregated by court-ordered busing, segregation still existed in many classrooms. High quality courses were available, but all students did not seem to have equal access to those courses. Looking for answers, in 1989 I began to attend a variety of multicultural science workshops and I became involved in several science projects funded by the National Science Foundation. I attempted a variety of changes in my own classroom, and engaged in on-going dialogue with colleagues

regarding changes in their classrooms. These experiences moved me to the view that heterogeneous science classrooms were the best way to prevent the tracking that seemed to be feeding the achievement gap. Throughout this research project, then, I needed to be always aware of my tendencies to support heterogeneous classrooms for science education.

From 1998-2001, while the school district was adopting the new standards, assessments, and graduation requirements for science, I left the middle-school classroom to become a curriculum specialist at a high school. During this time, I served as a member of the committee recommending the changes to the district science curriculum, and I was intimately involved in the controversial debates over the details of the new graduation requirements.

Bringing this kind of personal history into this research project is significant. First of all, I recognized my own awareness of all of the arguments for and against the district science plan. Secondly, I realized that I held strong personal opinions about many issues involved in that plan. While I favored the elimination of the lower-track courses, I remained uncomfortable with the idea that every student must earn credit in biology, chemistry, and physics in order to graduate from high school. Noddings (1992) questioned the arguments against tracking by stressing that fairness in education should dictate that students be given opportunities that enhance their talents and interests, and to require the same college preparatory curriculum for all students threatens failure for those whose talents do not match the requirements. I agreed with her, realizing that wide variations in interests and intelligence exist within any student population. I worried that the new science requirements could possibly carry two specific threats: either a large

percentage of students might be denied graduation, or else the quality of the newly-required science courses might deteriorate in order to accommodate all students. And so, as researcher, I understood that my personal experiences had already filled me with concerns about the difficulties in heterogeneous classrooms. At the same time, one of the hopes of this research was to discover that these worries can be alleviated by identifying teaching strategies that bring successful understanding of science concepts to all students.

In 2001, I became the science supervisor for the district, taking on direct responsibilities regarding the implementation of the new science standards and graduation requirements in all schools of the district. For three years, we faced various forms of resistance from teaching staff, principals, parents and students as the mixed-ability courses were established. At the beginning of the 2004-2005 school year, I left the supervisor position in order to take a sabbatical leave of absence from the school district to conduct the research for this study. I weighed the advantages and disadvantages of doing research in my own "backyard" (Creswell, 2003, p. 184)), noting especially the need to protect validity, as well as to avoid power issues that might affect the roles of the participants. The fact that I had formerly been a supervisor for the participants in this project meant that I needed to carefully communicate my intentions and describe my new relationship with them. I assured them that I would not return to the supervisor position after the leave of absence. During the participant selection process, I took care to avoid any sense of coercion, reminding the teachers that I no longer had any supervisory authority over them, nor would I in the future. My work with them was not to pose a threat concerning anything they might say or do, nor would I be in a position to grant them any favors as a result of their participation in the study. At the