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

by

Francis A. Tworek

A DISSERTATION

Presented to the Faculty of

The Graduate College at the University of Nebraska

In Partial Fulfillment of Requirements

For the Degree of Doctor of Philosophy

Major: Educational Studies

Under the Supervision of Professor L. James Walter

Lincoln, Nebraska

May, 2008

APPROVALS

I dedicate this dissertation to my students,

past, present, and future.

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The time and energy that I have invested in this research project must naturally have diminished my time and energy available for other people. My own family carried additional burdens to compensate for my preoccupation with my studies over the years. Without love and support from my wife, Pat, I could not have completed this work. And not only did our children, Becky, Molly and Andy, put up with me throughout the entire process, they also inspired me with their own educational achievements.

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

Francis A. Tworek, Ph.D.

University of Nebraska, 2008

Adviser: L. James Walter

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.

Researcher Bias. 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

same time, my prior supervisory experiences with these teachers offered advantages in gaining access to their time and voice, as well as adding a level of understanding about their classroom issues, since I had already shared in their experiences to some degree.

Institutional Review Board. A potential risk in this study involved the need to protect the identities of the four participants. Because the district's new plan for secondary science education had been recently implemented and was indeed controversial, it was possible that one or more of the participants might express criticisms toward the district's decisions, or else criticisms of those who opposed the district plan. Either way, there was a risk that a participant might be subject to embarrassment, harassment, or damage to reputation if her/his identity in the study would be revealed. My application for IRB approval described the risk, and the Informed Consent Form (Appendix A) notified all prospective participants of the concern, and of their rights throughout the study.

Access to Site. First I obtained permission from the school district's Research Review Committee (Appendix B). The request for district approval included a request for access to student records and district documents as well as assistance from district personnel in the Research Office. I assured the Research Office that I would share the results of the study with them, with the intention of providing new insights and understandings about the issues facing teachers in the mixed-ability secondary science classrooms. Next I sought permission from building principals (Appendix C) to contact individual teachers in order to discuss this research project and request their participation.

Data Collection Procedures

Participant selection. The four participants in this study were secondary science

teachers in this school district. The selection was purposeful, designed to maximize the richness of the data. The first criterion was that the teacher was teaching a science class included in the definition of this case (students were placed in this class by grade level only, with no prerequisites for ability or past achievement). To maximize variation among the four cases, the next criterion was to select one teacher from each of the grades 8th though 11th (Appendix D). There were 26 potential participants for 8th grade science, 32 for 9th grade biology, 27 for 10th grade chemistry, and 26 for 11th grade physics. Once the first teacher had volunteered, no more were selected from that school. Selection preference was given to schools in the inner-city, as opposed to those closer to the suburban areas, with the intention of studying cases with as much student diversity as possible.

The invitation to each teacher began through direct contact, first by telephone and then during a face-to-face meeting. Since I had a personal history with the potential participants during my years with the district, I gave priority to those teachers who had indicated in the past a willingness to speak out on the issue of mixed-ability science classes. Among the four participants, I attempted to maintain a balance among those who tended to favor the program and those who tended to oppose it. During the selection process I reminded potential participants that the purpose of this study was to explore and describe issues and strategies that were surfacing in those mixed-ability classes.

Interviews. Once the participants were identified, each teacher selected one class in her/his schedule to be the focus of the case study regarding issues facing the teacher. The primary sources of data were four private, face-to-face interviews with each of those teachers during the second semester of the school year. Marshall and Rossman (1999)

stressed that the interview should be as unstructured as possible so that "the participant's perspective on the phenomenon of interest should unfold as the participant views it, not as the researcher views it" (p. 108). However, they did say that a "degree of systematization in questioning" may be necessary in multiple case studies (Marshall & Rossman, 1999, p. 108). I began the first interview with the intention of asking certain open-ended questions of each teacher, knowing that I might adjust the questions and allow the teacher's own issues to dictate the flow of the conversation (Appendix E). The second interview prompted each teacher to talk about the range of diversity in the specific classroom of the case study (Appendix F). The third interview focused on specific strategies each teacher used in order to deal with the diversity within the classroom (Appendix G). The final interview was tailored to each teacher's unique class (Appendix H), referring often to a spreadsheet of data that I had provided to them, as well as discussing particular circumstances from the classroom observation that I had made before the final interview.

Each of the 16 total interviews lasted approximately 45 minutes with several going over 60 minutes. I negotiated with each participant to determine the site and time for each interview. Most of the interviews were conducted at the teacher's school, either during a planning period or after student dismissal, but one teacher preferred that we meet off-site on weekends. Merriam (1998) recommended audio-taping to preserve all information for analysis. I recorded each interview on tape, transcribed the tapes myself, and asked the participants to verify the accuracy of the written transcriptions.

Observations. The second source of data in this study came from classroom observations. This was a concern to me because I felt that my presence in the classroom

would make it all the more difficult to conceal the identities of the participants in the study. The Informed Consent Form (Appendix A) cautioned the participants about such risks and specified that I would only do a classroom observation if they allowed me to do so. All four participants responded positively to my request. I assured them that I would not interview the students, nor would I record the events on audio or video tape. For each observation, I asked the teacher to select a place for me to sit during class, and I recorded written notes as I observed the classroom setting and the events taking place during the class period. After each observation, I went home and processed a detailed description from my hand-written notes (see Appendix I for an example page from my word-processed observation notes). I then asked the teachers to verify the accuracy of my observation notes, and to validate my perceptions of what I had observed.

Student Records. For the study's third main data source, I worked with the district's Research Office to gain access to existing student data (Appendix J) about each class, but no individual students were identified by name. I used the student data to describe the nature of diversity in these mixed-ability classes, beginning with basic demographic data and then giving particular attention to the range and distribution of scores on past standardized tests, as well as the range and distribution of course marks in previous science courses and in the first semester with this instructor. After compiling these student records into descriptive spreadsheets, I shared them with the teachers during the interview process.

Documents. In addition to the interviews, observations and student records, I collected data through examination of school and district documents (such as course catalogs, student handbooks, school improvement plans, documents offered by the

participants, etc.). Information from these documents assisted in the depth of the case descriptions, and study of these documents also helped shape the direction of the final interviews.

Data Analysis Procedures

I followed the six generic steps of qualitative data analysis described by Creswell (2003, p. 191-195).

Organize and prepare data. I typed verbatim transcripts of the tape-recorded interviews and descriptive observation notes, leaving space on the side for reflective comments. I worked with school district personnel to develop queries from the student record database and used spreadsheets to sort and organize those retrieved data. I also visited with teachers, counselors and principals at each of the four schools to collect documents for examination. As each set of data became available, I organized and stored them by teacher so I could develop each case separately.

Read through the data. During the second semester of the 2004-2005 school year, I read through all of the transcripts, documents and records as soon as available, keeping notes directly on the transcripts, as well as maintaining notes in a notebook regarding general impressions and potential usefulness of the information. As time passed after the semester of data collection, I read through the data many times.

Coding. This process began with my looking for patterns and emerging issues that could be developed into categories (Bogdan & Biklen, 1992; Creswell, 2003; Creswell & Maietta, 2002; Marshall & Rossman, 1999; Merriam, 1998; Miles & Huberman, 1994; Stake, 1995; Yin, 2003). After investigating the options for using qualitative data analysis software (Creswell & Maietta, 2002) and consulting with the

university staff in the Office of Qualitative and Mixed-Methods Research (OQMMR), I elected to use the Atlas.ti software program (Muhr, 2004) to code, sort, and manage the data. At first I developed 63 codes which I was able to sort into seven categories: setting, teacher perceptions, teacher expectations, teacher development, perceived barriers, strategies that work, and support for teachers. While engaged in this step of data analysis, however, external circumstances influenced me to set my research aside for several months at a time. When I resumed the active process of writing, I worked closely with two professors (each at a different university than my own) who acted as sounding boards for the development and revision of the codes while I attempted to identify the themes for the cases. I wanted to hear the voices of the teachers in the data in order to identify themes that truly represented their lived experiences. My early efforts at coding were done interview-by-interview, so that I actually cycled through the first interview with each of the teachers, and then cycled through the next interview with each, and so on. When I returned to study the data after two years away, I concentrated only on the first teacher's complete set of data. This allowed me to focus exclusively on the experiences of each teacher, one at a time. During this phase of analysis, I re-coded all of the data using 22 codes listed in Appendix K. I then examined the coded data by teacher in order to see the major themes that emerged in each teacher's case.

Case descriptions. Chapters 3-6 of this paper present the four individual cases that describe the experiences of each teacher with a class of mixed-ability science students. Each of these chapters is based on the codes that surfaced in the analysis of the data and identifies the major themes for that case. Chapter 7 is a cross-case analysis that compares and connects the themes from each of the individual cases. In this chapter, I

made a distinction between the themes that were directly related to what I wanted to know (the *etic* themes) and the themes that emerged from the voices of the teachers themselves (the *emic* themes). Comparing these themes across the four cases, I identified three over-arching themes (Appendix K). I re-coded the data for these three themes in order to complete the cross-case analysis.

Plan for the narrative. Each of the individual cases was written with generous use of quotations from the participant, as I intended to help the reader visualize the setting and comprehend the teacher's perspectives. The cross-case chapter discussion includes tables to give the reader additional descriptive information in order to further stimulate an understanding of the issues. I also incorporate in this chapter my own personal reflections of my related experiences in returning to teach 8th grade science while completing this dissertation.

Interpret the data. The final chapter includes my own interpretations of the results of this research, including comparisons to the findings of other researchers. My interpretations culminate in recommendations for future research.

Validation Strategies

As in all research that depends so heavily on the interpretations of the investigator, strategies must be identified to check the accuracy of the findings. I used the following strategies throughout the research process to enhance the credibility of my work.

Triangulation. Case study research depends on multiple sources of information in order to develop rich descriptions of each case. I used participant interviews, classroom observations, student records, and various kinds of documents (some provided by

participants, others from the school sites, and others from the school district). These sources of data provided different perspectives on the issues facing the teachers in these cases. An additional source of triangulation then came from the multiple cases, as patterns and themes were examined from the perspective of the different participants.

Audiotapes of interviews. I used the tape recordings to verify the accuracy of the interview transcripts.

Member checks. Throughout the project, beginning with the interview transcripts, observation notes, and later with coding, case descriptions, and cross-case analysis, I asked the participants for feedback to check the accuracy of the data and the plausibility of the emerging interpretations. Even though my analysis and writing extended more than two years after the data collection, all four participants were gracious enough to respond to every request for feedback.

Rich, thick description. I attempted to describe the findings with enough detail in each case to help the readers form a mental image of the teacher's reality and to encourage the readers to discover connections to their own experiences.

Clarify researcher bias. I have already described the personal history and professional viewpoints that I brought to this research project. I maintained awareness of those potential biases throughout the data collection, analysis and interpretation phases of this study in order to maintain the credibility of the findings.

Present negative or discrepant information. As themes emerged that were related to controversial school district decisions, I needed to discuss the ideas that seemed to contradict the district's intentions. Rather than hide those problems from the reader, I included them in the report.

Peer examination. Throughout all stages of this research project, I met regularly with two university professors who were former colleagues of mine within the school district. We shared perspectives on the coding, case descriptions and findings in order to see if my interpretations of the data resonated with them (Appendix L).

Audit trail. A more formal auditor from outside the district also provided feedback (Appendix M) from the perspective of a person not familiar with the science program in this school district. I shared with her the written records of the evolution of the project to document my thinking throughout all phases of the study. This documentation included notes and comments about the chronology and descriptions of procedures used, as well as my reflections during each step of the process.

Narrative Structure

Merriam (1998) suggested that the first step in planning the structure of the final report is to determine which readers will be interested in the results. This case study was designed with several groups in mind as a potential audience: practicing classroom science teachers; administrators and professional developers within the school district under study; and the general science and education communities. The focus of the report was a detailed description of each of the four cases, followed by a cross-case description of the general set of issues facing teachers in mixed-ability science classrooms. The case descriptions included direct quotations from the participants to add their voices to the story that emerged. Relevant literature was included and discussed in order to add deeper meaning to the case descriptions. Tables were included to summarize and highlight the themes of the cases.

Ethical Issues

Wolcott (2002) proposed that the very nature of qualitative social research can be obstructed by misguided attempts to remain ethical. He quoted Miles and Huberman (1994, p. 265) in declaring that field research can be considered "an act of betrayal." Throughout the process of gaining access and winning trust, the researcher sustains the intention of publicly sharing what will be collected in private. Even with the best intentions on the part of the researcher, it is possible that the resulting report will embarrass or harm the participants. In order to reduce such risks, I anticipated ethical issues that might arise during the following stages of this project (Creswell, 2003, p. 63-67).

Problem statement. The problem of detracked science classes itself involves controversy. This study was conducted with the teachers in mind, aiming to provide insights for facing the issues in the classroom, rather than marginalizing anyone holding one viewpoint or another.

Purpose and research questions. This study did not attempt to deceive the participants about the intent of the study. Everyone was aware that the research was being conducted as a part of my graduate work at the University of Nebraska-Lincoln, and there was no funding sponsor for the project. Participants were informed that the school district in which the study was conducted was not a sponsor of the research.

Data collection. This case study included information gathered from student records, but none of the students were identified by name. All of the student data was used to describe the classes under study, not to expose individual students. The classroom observations were conducted with the direct permission of the principals and the participating teachers. Even so, certain risks shadowed the four teachers. During the

data collection stage, the greatest concern was whether or not the benefits the teachers might receive through participation would be able to balance the loss of personal time that they volunteered to this project. Since there was no financial incentive offered, nor was there any promise of special reward, the main benefit offered to the participants in this study was the opportunity for the teacher to add her/his voice to the exploration of mixed-ability science classes. While scholars, administrators and teachers are actively engaged across the nation and the world in the debate about whether or not students of different abilities should be scheduled in the same classes, the science teachers in this district are living the reality of mixed-ability classes. The four teachers in this study were given the opportunity to have their stories told anonymously. However, the risk of unwanted recognition continues to follow each of them into the future as soon as this project is completed. Anticipating such risks, the informed consent form (Appendix A) described the time commitment, the right to withdraw from the study, and the risk of loss of anonymity. Even if this research project could not guarantee absolute protection from risk or harm, at least I was able to honestly forewarn the participants before they voluntarily agreed to involvement.

Data analysis and interpretation. The greatest potential risk to the participants in this study involved the possibility that they might be described in the report in an unfavorable way, that the school district might react to perceived criticisms, or that colleagues or supervisors might retaliate for the views expressed. In order to minimize the risk of embarrassment, harassment, or damage to reputation, all names of schools and individuals in the school district were replaced by pseudonyms. Each participant was also given opportunities throughout the study to review how she/he was portrayed.

Interviews with the participants were conducted in locations and at times that reduced the likelihood that the teacher might be identified as a participant in this research. The audiotapes of the interviews were destroyed after the content of the transcriptions was verified. Detailed descriptions in this case study focused on classroom issues and did not include physical descriptions of the participants. All data and records in this study were protected in locked cabinets and/or password-protected computers in my home office. After three years, the data and records will be destroyed.

Dissemination of findings. Information obtained in this study may be published in scientific journals or presented at scientific meetings, but identities will continue to be kept strictly confidential. During the writing of the final report, I was conscious of avoiding words or language that might indicate a bias against persons because of gender, sexual orientation, race, ethnicity, disability, or age. I also made a commitment to not engage in any practices that might involve the suppressing, falsifying, or creating of findings to meet my own needs or the needs of any audience.

Chapter Three: Angela's Class

I'm trying to take anyone out that I can save, which is unfortunate, because I can't take everyone out.

—Angela

How Angela Got Here

As she was growing up in a small Midwestern town in another state, Angela did not realize that someday she would find herself teaching science to a diverse group of 8th graders in a large urban school district. In fact, she had not been aware that she was heading toward teaching, nor was she even looking for a career involving science. Angela was excited about art. In high school, she had a "fantastic" art teacher who recognized her art talent and helped her to enjoy the awareness of that talent. All the way into college, she thought that studying art was fun.

The transition to science was slow. Back in high school, science classes were lecture-based and required a lot of memorization. Angela recalls high school as "I'm gonna walk down the hallway, studying my notes." But rarely did she think any of the science instruction would be useful. At some point in college, however, as she became more serious about planning for future employment, she began to question the job market for her art talents. "I didn't think I believed in myself enough to pursue graphic design, which is what I went into college thinking I was going to do." She found herself attracted to the variety of courses offered in science, and "I felt I could make or do more with my life in the field of science than I could in the field of art." She found herself taking more

and more biology courses, and she finished college with a degree in kinesiology, hoping to go on to chiropractic school.

At this time, she began looking at her life and the choices she had been making. She recognized that she was spending the majority of her time working with young people in one way or another. She had spent summer time as a camp counselor with thirteen-year-old young ladies. During the school year, she had worked after school in a daycare. "When I really look deep, where I was choosing to spend my time, where I felt the most valued, was in a classroom—not even in the classroom, but with kids, in some realm." And so she went back to school to become a teacher.

In the meantime, Angela was also experiencing a different kind of transition. When she graduated from high school, she had "a hundred people in my graduating class, [pause for thought] 99% of which were Caucasian." Now she was attending a university in a large city, where the sheer numbers of people, and differences among them, created a school atmosphere of diversity that would have been incomprehensible earlier in her life. Here she did her student teaching, most of which was at the elementary level. She also completed a two-week middle school observation in one of the most diverse schools in that city. This was not a positive experience. "I pretty much vowed to myself that I would *never*, *ever* teach in an urban middle school, after that experience." She did not blame the "unruly" and "off-task" students as much as she was disappointed with the type of instruction that she observed. The students themselves did not frighten her, but she was troubled by their lack of engagement in the lessons. She was observing a teacher for whom "every minute of the day" was "a fight." Whether the teacher was fighting for the students' attention, or fighting to develop some kind of interest, or fighting "to keep them

from fighting themselves," Angela was most uncomfortable watching what happened in that classroom.

> *I just thought that it was so exhausting for that teacher. And I didn't think that I could ever handle having to relate to kids on that sort of level. And as an observer, merely an observer in that room, I was exhausted when I left. And I wasn't doing anything.*

She pretty much ruled out the option of ever teaching in a middle school. "I thought that I would really walk out with my elementary school license, middle school endorsement, and teach elementary school."

Nor did she anticipate moving to the city where she now teaches. She would have preferred to stay in her home state, but the teaching positions were "pretty rough to get" at the time. Attending a job fair, "merely there to get experience at interviewing," she happened to speak with someone from her current school district and it was such a pleasant interview that she decided to come to this city "to try something that I didn't think I could do." She laughed quietly as she told me that, but in reality she was not intimidated by the challenge. She felt she had learned greatly from the way her university structured her pre-teaching experience.

> *They really make a point to get you in as many different classrooms, with as many different teachers, as they can. My biggest influence was my cooperating teacher. I think they do an excellent job of choosing cooperating teachers who are very capable in the classroom, and come up with really good ideas, and who are willing to work with their student teachers. So my*

> *biggest influence was my student-teaching experience. I gained a lot of confidence from what I was doing.*

By this time, Angela had gotten over her aversion to teaching middle school, and she accepted a position teaching 8th grade science. "I thought that I had learned enough, and I could relate to kids enough that it wouldn't really matter what the kids' background was or what my background was."

A Visitor's View of Angela's Class

The hallway outside the classroom door has five posters on display. These posters are student-made explanations of varied information about the solar system. Even before entering the room, I have a strong clue about what these students are studying right now. The classroom door itself greets me with seven yellow smiley faces, each face showing one letter, arranged to spell the word "WELCOME."

Inside the classroom, rectangular tables are arranged in three rows of five. As observer, I take my seat at the far left table in the back of the room. The front of the room is at the north wall. This front wall holds a bulletin board in the northwest corner, and a whiteboard covers most of the remaining space of the front wall. An overhead projection screen hangs in front of the center of the whiteboard. The teacher's desk is in the front (northwest corner) of the room, and there is a demonstration lab table in the center of the area in front of the whiteboard.

The east wall has wall cabinets two-thirds of the way toward the back, with counter space and below-counter cabinets the rest of the way to the back wall, as well as across the entire back wall. These countertops include four sinks, one safety goggles cabinet, and one computer station. The west wall has no cabinets or counters; however

this wall does include two windows, plus a radiator running the length of the wall. A second computer station is on a cart by the west wall.

Student work is displayed prominently throughout the room. Solar system posters hang from the ceiling. Solar system models stand on the counters. And on the west wall near the teacher's desk there is a large jigsaw puzzle, each piece representing one student in this teacher's classes. The puzzle pieces are decorated with photos, words describing interests, and other personal information.

In addition to all of the student work, many other posters decorate the room. There are posters on the front wall explaining district initiatives. There are posters on the east wall displaying the bell schedule, anti-smoking messages, safety rules, and measurement techniques. In the back southeast corner are life science posters. On the back wall are astronomy posters. The west wall shows more astronomy posters and assorted inspirational posters. Near the front jigsaw display are six steps of scientific investigation. Overall, the room is filled with images and messages.

Students begin filing into the classroom. This school touts a flexible schedule for maximizing opportunities for teaming and interdisciplinary teaching, so there are no audible signals to begin or end class periods. After about four minutes of student arrivals, Angela announces: "Okay, ladies and gentlemen, thank you for being on time." This 8th grade science class period has 23 students enrolled. On this day of my visit, there are only 14 students in the room, ten males and four females. A fifth female will enter later in the period. Of the 23 students enrolled in this class, 61% are male/39% female, whereas the other 8th grade science classes in this school are 47% male/53% female. Of the 23 students, 16 receive free or reduced lunches, seven are currently served

by special education, two are in the ESL program, one is identified as "gifted." These 23 students live in nine different zip code areas of the city. Fifty-seven percent of the students are African-American, 30% are Caucasian, 9% are Hispanic, and 4% Asian-American. The student population of this school is 41% African-American and 46% Caucasian. In terms of age, the oldest and youngest students in this class are separated by two years and three months.

The abilities and academic backgrounds of the students in this class are mixed. All students in this district are required to take 8th grade science. There are no prerequisites. There are no honors groups. This particular section of the course, however, stands out since it includes seven (30%) special education students who are mainstreamed in all of their classes, but pretty much travel together throughout the day with a special education co-teacher for each class. So this class is co-taught by Angela and a special education teacher. The students' grade point averages (GPA) range from 0.19 to 3.56. Their daily attendance ranges from 51% to 98%. On their 6th grade California Achievement Tests (CAT), the national percentile scores in this class range from a low of 2 to a high of 81 in reading, and a low of 5 to a high of 91 in math. On the 6th grade Test of Cognitive Skills (TCS), the scores range from 61 to 129, with 141 points possible. During the first semester of this two-semester course, only 10 of the 23 students successfully completed the course with a grade of C or higher.

On the day of my visit to the classroom, these students are preparing for tomorrow's exam—a district Criterion-Referenced Test (CRT) on the concepts of astronomy. Both Angela and her co-teacher speak to the entire class about the need to score well on this exam. Angela reminds the group that the review game has been moved

from another day to take place today, and she offers students the option of playing this "TV Jeopardy" review about the solar system, or the alternative option of working alone on their timeline projects. Six students decide to work in the back of the room. The co-teacher goes back to assist them individually as needed. Angela organizes the game group at the front of the room and explains the rules. She divides the players into three teams and provides a remote clicker to each group. The game continues for the rest of the period with obvious enthusiasm from all participants. Even the students who are on the team that is losing the game are leaning as close as possible to the TV monitor and spiritedly shouting answers. The co-teacher in the back of the room calls out to remind all students in the room to reduce their voice volumes, since the students working in the back of the room need to be able to concentrate.

Even though this school has no bells to signal the end of a period, the students are aware of the schedule. As the competition for correct answers about the solar system reaches an intense climax, a student somewhere in the room shouts: "One more minute!" Students throughout the room all stand up, and start moving toward the classroom door. The participants in the Jeopardy game are also standing, but their attention is still focused on the TV monitor. As the final question is answered, and the winning team is determined, the co-teacher announces the end of the period. Students have already been standing near the door, and they immediately begin to file out of the room. Angela asks a few of them to stay for a while to help clean up.

Angela's Description of her Class

Angela is in her second full year of teaching. She previously described her pre-service exposure to diversity as "kind of shifting from absolute zero to fairly diverse," but

she describes this year as "by far the most diverse situation I've worked with." She describes this class period as "racially, primarily an African-American group." She views the gender ratio as "pretty even." She speaks of this class as having "a very distinct group of special education students mixed in with a very distinct group of higher-achieving students." She is aware of differing learning styles as she says "there are students in this classroom who are very independent learners, and there are some who learn best when they're working with others." She has one student who "might be assigned to a BD classroom" if this school had a self-contained BD classroom, but "we accommodate them in the regular ed classroom." And she points out the differences in reading ability as she declares that "it's a reality for some of these kids that they really can't read." All of the differences in the classroom have presented a challenge: "Well, when I came, I guess I really didn't have an idea in my mind [pause for thought], I didn't think that [pause again], or I didn't realize that having honors kids and special ed kids would play that much of a difference in my classroom."

Even so, Angela says she likes the idea of heterogeneous groups.

> *I think that you have to strive to achieve, especially at this age, when everyone around you is striving to achieve. So if you take those lower-achieving students out, and put them in a class of lower-achieving students, their standards might become a little less than they would be in a heterogeneous classroom.*

And she believes the advantage not only favors the low-achieving students, but "I think it's such a positive thing for the high-achieving students, when they can realize that not only do they *know* the information, they can *teach* the information, or help someone else

to understand it." However, the mixed grouping seems to be taking a toll on some of the students. Angela feels that her "attention is drawn from those who are truly here to learn," as she spends extra time and effort attending to the needs of "my struggling learners or my behaviorally challenged learners." She feels that her advanced students either end up with "additional work" or else they become bored while Angela tries to "hang in there for everyone to get it," rather than leave half of the class behind in their level of understanding.

> *I think of the thing I struggle with the most, is watching some of my high-achieving students wait. And by waiting, I mean academically to a point, but more so behaviorally. Because I think one of the things that plays out when a student might not understand something, is that they sometimes come off-task, and sometimes give up, and are less motivated. And so, students that are waiting, are waiting for them to regain that composure so we can move on so we can get further.*

In the end, the high-achievers do not get as far in the curriculum as Angela would have liked "because often-times there are other things I wish we could have gotten to, but the basics took us too long." She believes her own inexperience and lack of time "holds me back from helping them go further."

In addition to concerns over the heterogeneous mix of academic abilities and backgrounds, another kind of diversity has made this situation uncomfortable for Angela. It started last year, when she first came to this school: "I didn't know if *I* felt out of place, but I felt that *other people* felt that I was out of place." She says that some of her students didn't know how to relate to her.

> *They really challenged: "You're white; I'm not white, you don't know how I am." Does that make sense? And that was a tough thing for me to deal with, the fact that they would think that because I wasn't the same race, or that because they perceived that I came from a more affluent home, that I wouldn't know, or be able to understand, where they were coming from. That was very difficult.*

She found it very difficult to get some of her students to understand that she wanted to get to know them personally and to build relationships that would enable her to help them. But at the beginning of this school year, her school principal engaged the teaching staff in a special "scavenger hunt" activity in which the teachers toured the attendance areas for their school.

> *We were taken out of the comfort of our school building, where we face the kids day-to-day, and put into their neighborhoods—where they come from. What does it look like when they wake up and look out the window—if they have a window to look out of. She took us out of this building and brought us to the ghetto—brought us to places that I wouldn't have thought my kids were coming from.*

Angela now sees new dimensions to her efforts to get to know her students.

> *And I think that really puts into perspective, you know, how can I balance such differences. So I think you're pretty naïve in thinking that you know where they are coming from, or you know about them, without on some level experiencing it.*

Strategies for Success

Faced with the challenges of this class, Angela knows what she wants to accomplish. Rather than relying on lecture-based memorization that she experienced in her own schooling, "what I envision for my students is hands-on, really getting into the how's and why's." She wants to create a positive atmosphere in which the students are engaged, making what they are studying a part of their real lives. But first, she realizes, she must connect with those real lives of her students.

> *My primary focus in the classroom is, first, the student. Really getting to know the student, both academically and, I guess, on a personal level, getting to know what interests them and how can I speak to them as they enter the room, getting them to really feel welcome, so they really feel that I know who they are and where they're coming from.*

She is aware that the school has cumulative files for students, as well as databases with individual academic records, but she prefers to rely on her own interactions with them to learn about their needs: "I don't want to label them before they get here, before they respond to a) my teaching style, and b) the type of activities that I do in class." She would rather teach them and assess their learning without relying on prejudgments. She monitors their level of participation and reflects: "Am I engaging them in the content—are they showing <u>any</u> sort of interest or participation in what I'm doing?" Along the way, she communicates with others who know the student well, particularly "conversing with parents via the email, via phone calls, via correspondence in the agenda, about progress." And when she becomes aware of particular problems, she responds accordingly. If the student is having trouble with reading, she looks for ways to

demonstrate the concept or to provide audio and/or visual assistance to reduce the reliance on the written word. She searches for varieties of methods of presenting concepts, hoping to meet individual needs. She maintains a strong focus on cooperative learning strategies.

> *When you have a student who might not achieve as high as other students, and you put them in a group where they can at least share their ideas and then hear some other ideas, and take it back and process it, instead of kind of falling at the norm of what their usual performances are, they're able to say, "Okay, I'm in a group now, and even if I can't get everything on my own, at least I'm contributing."*

However, Angela feels that her efforts to differentiate and meet the needs of all of her students are falling short at times. "I do the best I can, but it takes a lot of time to pull all of those things together." So she takes advantage of as many sources of support as she can. While much of her search for resources involves solitary time on the Internet, she also recognizes the value of professional support from colleagues. First of all, the building administration is helpful: "Academically and behaviorally, I think our principal at this building stands behind both the students and the teachers 100%." And the middle-level teaming offers many types of support.

> *I think the teaming concept does a lot for the heterogeneous mix, in that it gives us a chance to talk about what works and what doesn't with several students. You might have a student that has attention difficulties, and in one classroom I might find that, "Okay, he has attention difficulties, but I can keep him focused if he's sitting at the overhead, flipping my overheads for me, or if*

> *he is given a task everyday to do." The chance to have a dialogue about what's working with individual students, and what's not working with individual students, is helpful.*

Team planning also allows teachers to design interdisciplinary units to improve student exposure to concepts, to make ties, to increase motivation and interest.

And the greatest assistance at the building level comes from the collaboration with a co-teacher. This special education teacher plans and prepares lessons with Angela, "so that both have an equal part in teaching the lesson." Angela believes this helps the students "in that they have two sources for information in the room, two different perspectives." And the special education teacher helps Angela "because she has different ways of teaching the same material, to help different learners."

Even with all of this assistance to supplement her own strong science background, however, Angela feels that her preparation for teaching this mix of students is still not adequate. She is constantly looking to other teachers outside of her building in order to gain new insights, methods, and activities. She looks for "opportunities to visit with other teachers who have been doing it for a long time." She wants to "find out what's working and what's not." Rather than depending on professional developers who might say, "This is the way it should be done, it could be done," she would like to hear veteran teachers say, "This is the way I did it, this is what worked, and this is what did not work." And so she volunteers for district initiatives, signs up for district committees, and makes profitable use of district in-service days in order to network with veteran teachers and establish professional communication. And when she finds someone with particularly

good ideas, she is willing to sacrifice her own plan time to visit another school and observe that teacher working directly with students.

Unfortunately, even with all of the good intentions and selfless effort that Angela demonstrates for the sake of her students, success is not guaranteed. Some factors, such as a lack of adequate computer and technology access, are out of her control. And then there are the students themselves. "I think for this particular class, for this cohort on the whole, maturity is not there." The teacher cannot do all of the work herself. "Responsibility is not there, and I don't think that we're doing kids any favors by taking the responsibility away from them." So Angela continues to use varied strategies, and she continues to search for new ones, hoping to reach all of the students in this diverse class.

Major Themes in Angela's Case

Student-Centered

From the welcoming door decorations to the display of student work, it is clear that Angela is focused on students. She creates opportunities to talk with them "just to show interest in who they are as a whole person, rather than just who they are in my classroom and what do they know about science." As we saw on the day she offered the Jeopardy review game, she provides options for students and gives them choices about their own participation. She looks for opportunities to give them success: "If they haven't had any successes, how can you put success in front of them, at least once." She teaches them to set their own expectations and develop their own rubrics on classroom projects. "It might have led to a lesser grade; however, when we held them up and

graded them, it was consistently good projects." She wants her students to understand science, and she constantly searches for better methods for meeting their needs.

Differentiating instruction to meet the needs of the students is a goal for Angela, but she finds it difficult to do enough for some of the students in this section. She provides varied options for student choice, she mixes kinesthetic activities with reading instruction, and she balances individual assignments with group projects. In order to understand the needs of each student, she concentrates on developing personal relationships with each one. But at the same time, she seeks out professional assistance from colleagues, such as her middle-level team and the special education teachers.

> *If there is a situation, I'll first go to someone who knows them personally, you know, "What have you gained and what information can we learn from the [*cumulative record*]?"*

Yet Angela is acutely aware that some of her students are not mastering the concepts, despite her best efforts to meet their needs. She speaks in a disappointed tone as she states that she has some students who would benefit from more differentiated instruction: "I do the most I can, but the inexperience and the lack of time, I think, holds me back from helping them go further."

Concept Development

In her efforts to help the students understand the concepts, she plans carefully and prepares lessons adapted to different learning styles. Again, the room's décor emphasizes the concepts being studied, and she creatively finds interesting ways to present difficult ideas. For example, she borrowed live pet rats from another teacher and used them to help students visualize concepts of inheritance of genetic traits.

> *So, we can do Punnett squares until the sun goes down, but if I can bring in the rats, and I can show you what their parents are looking like, we can now see how that would work out. Because we know doing a Punnett square takes it down to a basic level, but let's apply it to an organism, so we can get to <u>really</u> see how this might play out.*

Interdisciplinary units developed in coordination with her team teachers also add such benefits to understanding.

> *But I think we're constantly making ties, working from math to science, with surface gravity and size of planets, he (the math teacher) can do some graphing activities with that, and now we'll get into it in here, and so it'll be, "Oh, I already know that!" Good! I think that helps a lot.*

And yet, despite Angela's best efforts, this class does not seem to make enough progress in the understanding of concepts. She believes that the presence of the low-achievers slows the group down, and as a result, the students do not get to the level of understanding that she had hoped for.

> *So I think achievement might be the same, but the enrichment opportunities, or the extras, that he might get in a—I hate to say "higher functioning" or "lower functioning"—but in a higher functioning class he's going to be stimulated to think about the concepts more, because [*pause for thought*], not because of what <u>I'm</u> doing for him, but more so what his <u>peers</u> are doing for him.*

<u>Assessment</u>

Measuring the achievement and levels of understanding becomes critical in this situation. Angela used informal assessments all of the time.

> *How they're engaging, are they grasping or gleaning the topic, or the intent of the lesson, what am I trying to get across from them? And, can they, in an informal situation, repeat it to me?*

She then uses more formal methods, such as "classroom assessments, quizzes, tests, district-mandated CRTs." She grades on a combination of these scores and includes participation and the prompt completion of homework. She practices flexibility in grading, not in the content achievement, but in the variety of ways a student may demonstrate understanding.

At this point, however, there is an apparent mismatch in her expectations for the students. "On a personal level, my own idea for success has been an A, because that's what I'm accustomed to." With an A as the standard, only two of her students are being successful in this course.

> *But in looking at, even particularly in this class, I will definitely commend a student for a 65% (F), if that 65% is more than what we saw last time, last quarter, you know, "Are you making gains?"*

Frustration

It is that type of mismatch, involving expectations and outcomes, that is instrumental in a growing sense of frustration with this class.

> *And so, success for one student might be, you know, "Did I get the A I wanted?" That's 100%. "Did I do everything I needed to do, and did I do everything perfectly?" And that might be success for one child. Another child*

> *could come out with 50% as their grade, but they are successful in that they successfully engaged in social situations, because so many of my activities are cooperative. Are they able to succeed in something that they probably haven't done before in social situations? Is 50% a huge increase for them?*

Angela wants all of her students to get an A, but she does not believe some of them can. With her student-centered concerns, the final solution for one student was to have him removed from this section and placed in another class where more of the students are "high-achievers."

> *I actually pulled one student out, one of my higher-levels who at parent teacher conferences, you know, we were talking with parents and just noticing [*pause for thought*], kind of withdrawn from second semester on, you know, when he was put into that group, and without as much stimulation. I just felt like I wasn't seeing the same kid.*

In fact, with this particular mix of students, she feels that "I'm really struggling with, you know, I felt overwhelmed in this particular class because it is so overwhelmingly [pause for thought] kind of low in everything that we're doing." As a result she is trying to "take out anyone that I can <u>save</u>, which is unfortunate, because I can't take <u>everyone</u> out."

> *I would love to say that mixed-ability classrooms are, you know, the way it should be. Sometimes it works and sometimes it doesn't. And I don't think [*pause for thought*], this is not one case where it is working.*

Chapter Four: Barbara's Class

The kids are always the bottom line.

—Barbara

How Barbara Got Here

Barbara believes that she was led by a higher power to accept her calling as a teacher. "I'm a disciple of God—disguised as a teacher, really—and I truly believe that that was what I was always meant to be." She grew up in a large family with six sisters and two brothers, and her mother frequently depended on her to help with the younger kids. "I just always kind of had a knack for that." So, "from the very beginning," Barbara was always interested in teaching.

In her own formal schooling, beginning with the Catholic nuns in her parochial elementary school, the teachers reinforced that inclination as they encouraged her—as early as sixth, seventh, and eighth grades—to participate in math competitions that were partly "teaching math" competitions. Her teachers had high expectations for her, and she enjoyed the role of teacher. When she moved on to the public school for ninth grade, she began serving as a teaching assistant for her math teacher, who recognized that she already had most of the math skills that he was trying to develop in her classmates.

Up to this time in her life, math was always easy for her and the teaching of science was not yet in her dreams. New windows opened for her as she moved from the ninth-grade "junior high" to the public high school.

> *It was tenth grade. I had a biology teacher who was wonderful. I loved dissecting, I loved camping, I love the outdoors anyway—my family is very outdoorsy—and so biology just really hit me.*

This biology class was truly challenging. Barbara enjoyed that. And the teacher put a lot of his own personal experiences into the class, telling the students about trips he had taken, and showing them pictures from those trips. There was book work too, of course, "I do remember a thick biology book," but that book was used mostly for homework. "When you were in the classroom, you were actually *doing* science, and *sharing* science, more importantly."

Even so, she still finished high school thinking she would be a math teacher. In college she continued to excel in math courses while she found science to be more difficult, and not as enjoyable as her biology interests had led her to expect. "My problem was that I was taking my hobby and making it into my profession, and sometimes that doesn't mix." Nevertheless, she benefited from the push at that time to get more women and minorities into science classes, and her college professors gave her positive guidance to continue on the path of science. In the end, her love of the outdoors, her success in biology, and her skills in math gave her the momentum to prepare for teaching science.

Her student-teaching experiences reinforced her decision. She teamed with two "wonderful" cooperating teachers in a brand-new suburban middle school. They all worked together to improve their skills, and she "just felt like I was one of their equals," not an undergraduate student teacher. They were receptive to learning from Barbara, while she was learning from them. The experience was fruitful and enjoyable. At the

conclusion of her student teaching, the suburban school district offered her a teaching contract.

But Barbara decided that she wanted to start her career a bit farther from home. Having lived with her parents all through her college years, it was time to be independent. She accepted a position in a city several hundred miles away and spent eight years there enjoying her growth as a teacher of biology and human physiology. During these years, she married and started raising a family. When her husband (also a teacher) decided to advance into an administrative position, they moved to the area near the district where she now teaches.

Barbara became a stay-at-home mom for six years as her three children were growing. Of course, the teacher inside her kept pulling her toward education, and she volunteered at her children's schools whenever she could. As her youngest son reached pre-school, that school even offered her a contract. Her heart was still in secondary education, however, and as soon as all of her children were full-time students, she accepted a part-time (mornings only) one-semester position at an all-girls Catholic high school. She considered that experience to be enjoyable and valuable, leading her to re-adjust her thinking about some of the pre-conceptions she had regarding same-sex schools. And it also confirmed her desire to return to teaching.

In the following semester, then, she interviewed for a substitute position in the district where she now teaches. The Human Resources department immediately wanted to bring her to full-time status. She resisted as long as possible, hoping to be available for her own children whenever the need might arise. Eventually, she accepted a long-

term substitute position at a middle school, with assurances from the administrator that she could leave at a moment's notice if ever her children needed her at home.

Barbara describes this semester-long experience as a real opportunity for personal growth. It was located in the inner-city, with a majority of students being African-American. "This was a wonderful experience for me, because I had never been around African-American children except in college, really." She could not remember having a single African-American student in her student teaching in the suburban school district. And she laughed as she recalled that the city of her first teaching contract probably did not have any African-Americans in the entire city. And so this was a new experience for sure.

> *When I decided to accept the [long-term substitute position in this district], every day I left home it took about a half-hour to get over there, and I felt that I was rocketing off to a different planet—this was foreign to me. And I thought, first of all, that I could teach any grade level, and that I could teach any kind of child, and [*pause for thought*], this was [another* pause*], very, very different for me.*

During the drive to work, she often found herself praying for guidance. She laughs as she relates that she would pray an entire rosary during the morning commute, but she is serious as she describes how she prayed for individual students, asking God to "show me how to get to them, show me what I need to make this valuable in their lives, and that they know I value them."

At the conclusion of the semester, the substitute position ended as the regular classroom teacher returned to the school. The school district was eager to retain Barbara

and they negotiated with her regarding a placement closer to her own neighborhood. During her initial visit to that building, she told the principal that "whenever I go into a building, I do what I think is best for the kids." She did not want to be in a situation where that attitude was not appreciated. The principal did indeed admire her attitude. Barbara has now been an active member of that school's teaching staff for 15 years.

She treasures all of her years of teaching experience. The eight years in the first city, the 6 years of helping at elementary schools, the semester at the girls' high school, the semester at the middle school, and the 15 years at her current school have all given her insights into the needs of young people. She laughs quietly as she declares, "I like to believe I'm getting better and better with age—kind of like a good wine."

A Visitor's View of Barbara's Class

As I enter the classroom before the beginning of the class period, Barbara provides me with a seating chart for 23 students, and she lets me know that I can sit at the back corner table where there are no students assigned. From this vantage point, I can observe the activities in the classroom. My table partner, a Quaker parrot named Huckleberry, is sitting on a ring stand in the middle of the table. (Barbara has previously explained to me that a Quaker parrot—not as large as a regular parrot—is very friendly and not likely to bite students.)

Looking around the room, I see that the black-topped lab tables are arranged in three rows of five, with two chairs at each table. The door to the hallway is at the front, left corner of the room. At the opposite end of that front (north) wall is another door—this one leading to the teacher planning area. The walls of this windowless classroom are decorated with a variety of posters. On the front wall by the American flag (near the

hallway door) is a poster of a weightlifter, with a caption about inner strength. Below that are the school district's weapons policy and the Biology Content Standards. To the right are two posters regarding homework: "Homework should be picture perfect—always do your best" and a picture of Snoopy on his doghouse, "No Homework Allowed" with the "No" crossed out and replaced by a "Yes!" Above the chalkboard are posters showing the Frayer Model for Vocabulary, a sample of the Frayer Model in use, and Combination Notemaking. The screen for overhead projection is in the center of this front wall, behind the teacher's demonstration table. To the right of the screen is a wall-mounted TV, under which are more posters:

"The road to success is always under construction."

"Make it a habit to listen to your teachers."

"Discover yourself."

"Greek of the Week"

"Yes You Can."

Snoopy at the typewriter: "It's exciting when you've written something that you know is good."

"The Writing Process"

The east wall of the classroom has shelving for student projects. The back (south) wall has a large fabric display covered with photographs of students, showing them reading, doing investigations, collecting outdoor field data. To the right of the photo display on this wall are three more posters:

The compound light microscope

The typical animal cell

The American Dream—a photo and brief story of Andre Mills, an African-American vice-president of ConAgra Foods.

There are more shelves on the back portion of the west wall. On the wall to the right of the shelves are several orange rectangles identified as "Topics":

Cells – Genetics – Evolution – Ecology – Energy

At the end of this wall, next to the hallway door, there is a white sign "The Six Kingdom Classification of Organisms." Below that paper are six hot-pink rectangles:

Animalia – Plantae – Fungi – Protista – Eubacteria – Archaebacteria.

Black counter tops, including sinks, surround the room on the east, south and west sides. On these work spaces are aquarium tanks and cages for live animals (fish, python, mealworms, parrot, etc.) There are also five computer stations on the back counter.

While I am sitting in the back corner of the room with Huckleberry, the students have been entering the classroom. This is the second day of the second semester for these 9th grade students of biology. Five new students had been added to the class roster yesterday. Even with the presence of new classmates, everyone seems to know what to do. As the 7:45am tone sounds to begin this first period of a block schedule, everyone is totally silent. And that includes Barbara. This is time for Silent Reading. When a young man enters two minutes tardy, he simply signs a book on the teacher's desk, goes directly to his seat, takes out a book and begins to read. A few minutes later, another tardy student enters and follows the same protocol.

This biology class has 25 students enrolled. On this day of my visit, there are 19 students in the room, eleven males and eight females. Of the 25 students enrolled, 44%

are male and 56% are female. Of the 25 students, 13 qualify for free or reduced lunches, three are currently served by Special Education, four are in the ESL program, and one is identified as Gifted. These 25 students live in nine different zip code areas of the city. Twelve percent identify themselves as African-American, 52% are Caucasian, 32% are Hispanic, 4% are Native American, and there are no Asian-Americans in this group. The student population of this entire school is 11% African-American, 58% Caucasian, and 28% Hispanic. In terms of age, the oldest and youngest students in this class are separated by four years and five months.

The abilities and academic backgrounds of the students in this class are mixed. All students in this school district are required to earn two semesters of biology credit for graduation. There are three different options, however, for students to master the required biology standards. There is an "Honors" offering (which happens to have a similar gender mix as Barbara's class, but has a different racial mix, with 10% African-American, 68% Caucasian, and only 16% Hispanic). There is also a "Fundamentals" offering for students served by Special Education, and these students tend to be male (72%) with 28% African-American, 40% Caucasian, and 28% Hispanic. And the third option, "regular" Biology, is the type of class that Barbara is teaching this period.

There were specific prerequisites for the students who wanted to be in one of the "Honors" sections, and at this school 25% of those enrolled in "Honors" Biology are identified as "Gifted," but there were no prerequisites for the regular level of Biology, and therefore Barbara's students have a wide range of backgrounds. Their grade point averages (GPA) are as low as 0.19 and as high as 4.00. Their daily attendance this year ranges from 55% to 100%. On their 8th grade California Achievement Tests (CAT), the

National Percentile scores range from a low of 2 to a high of 72 in Reading, and a low of 4 to a high of 91 in Math. On the 8th grade Test of Cognitive Skills (TCS), the scores range from 58 to 130, with 141 points possible. Of the 19 members of the class who previously attended this same district for middle school, only eight of them successfully completed the 8th grade science course.

Today's lesson began with 15 minutes of silent reading. Now Barbara addresses the students to remind them that the theme of this week's lessons is Cell Reproduction. She next pauses to introduce me to her students. The lesson resumes as Barbara outlines the tasks that need to be done and sends the students on their way to collect plant growth data, or to study mealworm experiments on the computer, or to turn in their current events homework, or to turn in their Greek assignments. As most of the students disperse quietly, she asks for the five new students and gives them special instructions and updates. Then she proceeds to circulate throughout the room, attending to the needs of individual students.

At one point, Barbara announces to the entire group that one of their classmates needs to borrow some correction fluid. Another student immediately offers to lend some, but Huckleberry the parrot also responds with a loud squawk. Barbara explains to me that the parrot "does that when I speak too loudly—it's my reminder to quiet down." The parrot's call attracts the attention of one of the new students, who comes over to our table to pick up the bird. Barbara intervenes with a warning that the other students in the room have already been given special handling instructions. She proceeds to teach this student how to safely hold Huckleberry.

Now Barbara returns to circulating through the room. In one corner she coaches the new students on the basics of the mealworm investigations; at another location she asks if someone will water the plants that belong to today's absent students. The students are all participating with the exception of one new student, a male wearing black cotton gloves, who is now sitting alone in the back right corner of the room.

At 8:22am, Barbara instructs all students to return to their desks and she addresses them regarding a newspaper article about a new bacterium that was discovered at the local medical center and named after the state. After this "current events" teaching moment, she turns off the classroom lights and turns on the overhead projector to share notes about the "Big Picture" for the topic of Genetics. A female student who had been absent enters the room, hands the teacher a pass, and joins the class without disruption. Every single student actively takes notes as Barbara continues writing and drawing on the overhead. She probes with questions that draw her audience into an interactive discussion about cell parts and DNA.

After ten minutes, she turns off the overhead and turns on the classroom lights. She directs students to work in pairs with envelopes containing pictures representing the stages of mitosis. As students quietly try to sequence the pictures with their partners, Barbara circulates and praises the students who are successful. Once all students have completed the task at least once, she mixes the partnerships and lets them try again with someone else. The conversations throughout the room are enthusiastic. While the students work, one young man asks Barbara if he can hold the python. She lifts it from its tank and gives the snake to him.

At 8:48am, over an hour since this block began, the teacher requests attention by announcing, "It's my turn." All student conversations stop immediately. She writes the word "chromosomes" on the board, and follows with an interactive discussion about the stages of mitosis. She then follows this ten-minute discussion with a worksheet. The final 15 minutes of class time are spent on the worksheet, clean up, putting the snake back in the cage, and the completion of a "meaning paper" that will serve as the ticket out of the room at the end of the period. As the end of the period is imminent, a few students begin to rise from their chairs. "You aren't standing yet—the bell hasn't rung yet," she reminds the class. A few seconds later, the tone sounds to end the 90-minute block. The students remain at their places until they are dismissed, and then they hand Barbara their papers as they leave the room. One student—the one who had been wearing the black cotton gloves earlier in the period—stops and talks with his teacher about arranging a time when they can meet.

After all students have cleared the room, Barbara turns to me and explains that this class did not go as smoothly as normal, since special explanations were needed throughout the period to get the new students accustomed to the classroom routines.

Barbara's Description of her Class

"I think the hardest thing for a teacher to do is mix the ability level, where you have the very slow and the very fast." Barbara recognizes that the diversity of backgrounds among this group of students presents a challenge to a teacher. Yet this is a stimulating challenge for her.

> *Why would you want to teach someplace where everybody's little clones and perfect and behave and know everything? I wouldn't want to. Variety is the spice of life!*

She laughs as she declares, "I am *needed*—this is my adventure!" And yet she is so very, very serious as she discusses the difficulties of meeting the needs of each one of her students. Some of her students seem to know about the biology concepts already, while others insist that they have never been exposed to any of these ideas before. And there are many issues that further complicate the task facing the teacher, the task of helping all of these students master the prescribed biology standards. Attendance patterns, health conditions, trouble with authority, problems at home, social conflicts all interfere with consistent classroom opportunities. And then "some are lazier than others, some are quiet, and some are loud." Barbara adds that "they're all really smart, in different ways." And that's why she expects all of her students to succeed. She recognizes the great diversity, and she appreciates it.

> *This is real life. This is what you're going to hit in the grocery store, on the road, anything. I think it helps the kids be empathetic to other students and their lifestyles, and their abilities. It makes them appreciate what they have. I just think this is real life.*

But that doesn't make the job easy. Barbara accepts the difficult challenge, repeating often that this diversity is best for the kids, and that it is her responsibility "to meet each of those kids' needs, as close as you can."

Listening to this teacher talk about her students, you get the impression that she treats each one as a child of her own. She does not anticipate failure from any one of

them, and she looks for multiple ways to assist each one toward success, which she defines as the understanding of the biology concepts she is teaching in this course. "Tell me what you need" is a frequent exhortation. She is constantly communicating with them to find out what they need in order to be more successful.

Sometimes what she discovers about an individual student makes her believe that the student is out of place in this particular section of students. She tells me about one member of this 9th grade group who turned out to be 18 years old, married, and needing biology credit for graduation. She felt that it was in his best interests to get him moved to a situation in which he could demonstrate competency in the biology standards and test out of the course. She gave him special help before school and after school until he could successfully move on, and now he is no longer in this class. On the other hand, she speaks about a student being served by Special Education who was "a very nice girl, works hard," but who seemed to be struggling with the pace of this course. Barbara met with her parents, and with the Special Education teacher who managed this student's IEP (Individual Education Plan), and they decided to transfer this student to the "Fundamentals Biology" class where the pace would better fit her needs.

Conversely, Barbara told me about another student in the group—a student who has been identified as "gifted"—who might have been placed in the Honors Biology course instead of this class. Barbara believes this student is being served well right where she is, in Barbara's diverse class. She declares that the placement goes beyond labels and categories. Serving a student's needs is more about "personalities and the teacher" than about groupings and tracking. When asked if this gifted student is in the right place, Barbara laughs: "Oh, I definitely believe God put her with me for a reason!"

Strategies for Success

So how does she do it? How does she teach biology to students who present such a variety of backgrounds and needs?

> *I always talk about the "Burger King Syndrome" and I tell the kids this isn't Burger King—it's not "Have it your way." [I tell them:] "This is the way things are done." But then I turn around, and I make it Burger King because I think you need to personalize education for your students.*

Barbara's reference to serving the customer reflects several aspects of her teaching philosophy. On the one hand, she believes strongly in identifying the learning goals for herself and for her students. She wants them to successfully build knowledge, and she organizes her lessons and plans her instruction with those goals in mind. At the same time, she makes certain that her students are also aware of those learning goals, so that they know what they are to accomplish, and she guides them to use organization skills toward achieving those goals. Next she delivers the personal touch. "I negotiate with kids—they know that if they can't get something done, they can always come and talk to me about what they can get done." She gives them choices and positive affirmation as frequently as possible. She tries to get to know them well enough to know what they need in order to feel successful.

She wants to find out who they really are, and she depends primarily on her own interactions with the students to learn as much as she can. "I feel I have to make that environment so comfortable for them that they can honestly and openly tell me" [about their own weaknesses]. "If there is something that you need, I need to know you need it." She encourages communication, enjoying the benefits of email to avoid embarrassing

sharing in front of other classmates. She tries to learn about their culture, seeking assistance whenever possible from expert sources. She collaborates with parents, fellow teachers, counselors, specialists, ESL teachers, Special Education teachers, and other colleagues with expertise. She attends sporting events and gives personal attention outside of the classroom. She models for them the behaviors that she wants them to develop. "So if I'm open with them, I expect them to be open with me." She tells them to let her know what they need—and she lets them know what she needs (and what she doesn't need) from them. She is clear with her expectations for classroom routines, homework assignments, behavior, and communication.

> *I'm very fortunate to have kids who know I mean what I say, and they will tell me. One time I had a student who told me: "Dumb-ass teacher, you don't know what's goin' on!" And I was more offended by the "you don't know what's goin' on" than I was by her language. And after she explained to me, she was absolutely right! I did not know what was going on. I think you learn from kids as much as they learn from you.*

Identifying expectations and getting to know the students is just the beginning. The real business at hand is the understanding of the biology concepts. Barbara uses various techniques for assessing what the students are learning, and for identifying weaknesses or misconceptions that need further attention. "If there's a challenge that they're having a hard time getting over, you find different ways—the best teacher has the biggest bag of tricks, and knows how to use it," she laughs. And through the years, Barbara has filled her bag of tricks from multiple resources. She takes professional development seriously, always searching for adaptive strategies and always eager to learn

from other teachers. During interviews with me, she was just as eager to share what she had found. On one occasion, she gave me a copy of Ron Clark's The Essential 55: An Award-Winning Educator's Rules for Discovering the Successful Student in Every Child (Clark, 2003). She also provided copies of articles and handouts she has used from workshops and conferences.

Barbara likewise demands support from administrators. She gives former administrators credit for doing good things for her students, "I've been very fortunate to have principals who just kept encouraging me and encouraging me, supporting me and supporting me, whenever I wanted to try something or do something." She says they understood her priorities for the students, "but they valued those priorities, also." Whenever she told them, "this isn't a good idea for kids," she is grateful that "they were really listening to what I had to say." Her current administrator is the same way. He asks her what she needs, and then he attempts to get it.

All of these strategies and support systems set the stage for what happens in Barbara's classroom. She takes advantage of the school's block schedule to organize her lessons, set priorities, offer lab opportunities, and direct the progress of the class. Although this offers a tight structure for instruction, she also provides many options for student choice. For example, they begin each class period with silent reading. The procedures are rigid, but the students choose what they want to read. And if they forget to bring reading materials of their own, she guides their choices toward productive options.

> *If they don't have something to read, right in front of my room I have a cart, and on there they're free to pick up Sean Covey's The Seven Habits of Highly*

> *Successful Teenagers, and they read that. So there's always something for them to read, if they happen to not bring their book.*

Her biology instruction also includes choices. Students learn to make choices about working with other students, about participation with homework assignments, about seven categories of grading that indicate which areas need improvement, and about living organisms in the laboratory environment. She relates a story about three young ladies in this class who started the semester with little desire to cooperate with one another, and who have since become friends. Barbara had her administrator's support for allowing these students to do research about animals for the classroom, and where to obtain appropriate live specimens. The students decided where to go, and what to purchase.

> *I said, "Okay, girls, let's go shopping." I gave them each a cart, I hooked them up with one of the people in the store, and I said, "Get what you need." And I left 'em. That was the hardest part for me as a teacher. I have to stay out of their way—teachers need to get out of the way of kids, so they can learn.*

And she allows her students to make mistakes.

> *I actually hand out a sheet of paper that's a "license to make mistakes", and the bottom line is to correct it whenever possible. We don't put check marks; we don't put stars if it's right, we just make their papers 100% all the time. Every paper that's in their notebook is 100%.*

With all of the extra effort and time needed for a teacher to make curriculum adjustments for sight, hearing, language, and other special needs, to differentiate instruction and offer choices, one might think the challenge would be too difficult to

work with a group of mixed-ability students. But Barbara reiterates: "My bottom line is kids—what's best for kids—not what's easiest for me as a teacher, because it wasn't always easy at times, but this is the best thing for kids." And yet she recognizes the work load.

> *I think one of the problems teachers have is they feel like they are just overwhelmed with all of this responsibility. And what they need to do is quit taking on responsibility that belongs to the kids!*

After all, Barbara wants to focus on the development of the students, and that includes helping them to become responsible.

> *You help them figure out how to solve problems. And don't make it <u>your</u> problem. Let their problems be <u>their</u> problems. And help them learn how to solve those problems.*

For her part, Barbara reaches out to fellow biology teachers to team up on lesson planning and lab preparations. She collaborates with ESL teachers and Special Education teachers to get assistance as needed. But more than anything, she brings her students along with her as they tackle obstacles in the classroom. The students themselves are her top priority. "I don't care about me, I care about kids."

Major Themes in Barbara's Case

<u>Student-Centered</u>

Barbara places her students at the center of her attention. From the very beginning of each school year, she learns about each person so that she can tailor the instruction to fit them individually.

> *If you're in a classification project, have them bring in twelve to fifteen items that would tell the class something about them. So are they bringing in tools, hammers, and nails, and stuff like that? Or are they bringing in baseball cards? Or are they bringing in trophies they won from something? Or are they bringing in earrings? You learn. You personalize the education for the kids.*

As she gets to know them, she learns to adjust to their needs.

> *Everyday, there's adaptations teachers make. And some days, I know, a student is just having a bad day. And I tell them to freely tell me that, "This day isn't working out for you, you're having a bad day, let me know and tell me what you need." "Tell me what you need," they hear that 100 times.*

It's the knowing about each individual that creates a setting for educating each person.

> *You need to develop those relationships with your students, so that you can honestly talk to each other and say, "What do you want to do," or, "What are we going to do about this now?" And not only from the positive side, but the kids who are struggling: "What do you need? What do you want to do? How can you show me you know this?"*

Having established the relationships, she does not need to rely on labels or preconceptions to determine whether or not a particular student belongs in this mixed-ability setting. She treats students according to their own needs, not as members of some category or statistical grouping.

> *I cannot say, "<u>These kids</u> belong in different areas." It's <u>knowing</u> that one kid, and visiting with him—that personal one-on-one. I don't want to say,*

> *"All Special Ed kids should be in Special Ed science." I don't believe that. I don't believe all ESL kids should be in ESL science.*

Barbara works with students according to each individual's needs.

Teacher Beliefs

But when the individuals have such varied needs, how does Barbara feel about teaching a class like this which has no prerequisites?

> *You know, that's okay with me. I just assume I'm going to have that all the time, I guess. You work with what you've got. I mean, parents send their best, and I became a teacher for this kind of challenge. You know, it's always something new, there's always something happening. And even the kids, I learn these things about them, and find out their health issues, and if they need help with ESL or SPED, what's their disabilities, and that's the challenge of teaching, to be able to reach them.*

And yet she does not look at this challenge from a negative view. Instead, she declares that this kind of classroom is best for preparing her students for real life.

> *I believe kids need to work together in mixed abilities—and disabilities—and challenges. I think that makes them more humane, more empathetic, so when they do become our politicians and our teachers and our leaders, they've actually had some experiences that they can relate to.*

And so her beliefs regarding diversity support her teaching, and yet for many teachers this is easier said than done. She does not allow the varied needs to break her classroom into chaos. Instead, she creates a firm structure to guide the class: "I'm very disciplined and structured with my kids, and I think kids *like* structure; they like

discipline; they like to know what is expected." She believes that communication is a two-way process.

> *I think you need to tell kids what you need, but you also need to tell them what you don't need. So you need to tell them these are the "yes" behaviors and these are the "no" behaviors. You know, just be very, very clear. I'm trying to teach them to tell me what they need, so I need to tell them what I need, also, in order for this to be successful and work.*

Concept Development

Along the way, Barbara never loses sight of what she is trying to teach these students. Beginning with the school district's goals, and breaking each unit down to daily objectives, she wants her students to know what to expect. She maintains that teachers "need to get organized and *keep* organized." She posts topics on the walls and outlines daily lessons on the board. She reminds students of the weekly theme, and she fits the themes together for the "big picture" of the unit. She uses vocabulary development, differentiated instruction, collaboration, scaffolding, investigative lab experiences, interactive discussions, small-group activities, thought-provoking writing assignments, and multiple opportunities for student choice. For Barbara, if the kids are the bottom line, then demonstrating that her students have mastered the concepts is the ultimate measure of success.

> *I'm here to teach the kids so they understand the content, and are able to move on and use that content in their life later on, read a newspaper and know what the heck they're talking about.*

Student Behavior

Barbara also sets high expectations for cooperation so that her students can enjoy an environment conducive to developing the target concepts.

> *I never deal with discipline during class time. I'm not here to deal with discipline. I am here to help students learn biology and succeed at it, and be ready to go on. So, I think one of the mistakes that teachers make is taking class time for discipline.*

She makes these expectations clear from the very beginning when she hands out "general information" in the student folders. Right along with a list of required supplies, the information sheet announces, "Discipline is dealt with before school or after school, never during class time." She lets the students know what she needs.

> *And you have to tell the kids what you need. Whether it be, "I need you to be quiet," whether it be, "I need you to be in your seat," whether it is, "I need you to get out a piece of paper," or, "We need to finish this by Friday so we can test," or, "We need…," you work right in the classroom with what you have.*

What if a student won't accept the request to cooperate? Barbara has pre-arranged with various colleagues (department head, counselor, fellow biology teachers, etc.) to accept a student at a moment's notice.

> *I'll explain to her what it is, "and this is what I need you to do," and she'll do it. She will keep the child and visit with them about what I asked her to, see that they understand what's expected, and give them back to me in five to ten minutes. I don't want them to miss class time.*

For Barbara, the entire education package, from classroom behavior to concept development, is all about the needs of the students. She consistently validates her contention that “the kids are the bottom line.”

Chapter Five: Charles' Class

I'd be very uncomfortable with having my child in that middle level group. And that's just because there is such a wide spectrum in there. You've got everything. You've got everything you could ever imagine in there.

—Charles

How Charles Got Here

Charles had always considered being a teacher. His own father was "an extremely scientific-minded individual" who earned a college degree by majoring in entomology with a minor in botany. Charles has always enjoyed conversations with his dad, who "still to this day calls me up" and probes with questions such as "Have you read this author?" and "What are your thoughts on that?" His father's scientific influence was enhanced by "just wonderful science teachers in high school" who inspired Charles to pursue the science teaching profession for his own career.

I didn't exactly know specifically what type of teacher [I wanted to be], then I ran into three gentlemen in consecutive years in high school that just inspired me, really, beyond all belief. They were a very good physical science teacher, and then a great biology teacher—just awesome biology teacher, college was actually a step down from his high school curriculum. Then I ran into a chemistry teacher and physics teacher—same gentleman—who was very good. And they just had so much fun in the classroom. I just really didn't consider anything else after that.

When Charles went on to college, then, he majored in physical science, never even considering a change of major from beginning to end.

Looking back, he thinks the biggest influence on his view of science was the way he experienced biology in his sophomore year of high school. That teacher made education relevant to Charles' own life. It happened that several members of his family were facing medical problems at that time, and Charles was eager to understand human anatomy and medical techniques.

> *For me it was just fascinating, the fact that we were discussing in class the exact same things that were going on in my life at that point in history. And to have an explanation to understand why, you know, why, how, what this is related to.*

He enjoyed taking information from the classroom and making sense of it in his own life.

> *Then we went into the hospital, with the doctor explaining "well, this is connected to this" and "this is how this works," and to know exactly what he was talking about—and actually be almost a step ahead of him, as a sophomore in high school—was really interesting.*

For Charles, this was serious business. And he was impressed by the rigor of the curriculum. He remembers it as being so rigorous that "there's things that we did in that classroom that are not done in present-day classrooms, that I know of."

> *We did things like memorizing the protuberances on bones, not just the names of the bones, but we memorized every name of each bone, and all the bones in the body. Even on major bones, we were talking about protuberances, and everything like that.*

Charles also can recall that biology teacher's structured routines. "Monday was pretty much lecture day—I remember that much—he would discuss the topic for the week, and in pretty great detail." The middle of each week was filled with a "pretty wide range" of lab activities and projects. Then on Friday each week,

> *I remember this quite specifically. He had us outline (he taught us how to outline at the beginning of the year) every Friday was spent just religiously, <u>every</u> Friday, was outlining the chapter of the book that we were working in.*

The other high school science teachers were "a little less structured" but they taught in a similar style that involved "one to two days of notes, lecture type, and then usually an activity of some sort." His freshman physical science teacher also introduced him to library research. "It was fun to go play in the library—it was fun and games at that point in time, but it paid off later on."

And so Charles became hooked on science while in high school, went to college to become a science teacher, and then moved to the city of his current assignment when his wife (a chemistry major) was seeking employment in this larger urban area. His first job in this city was actually in a tutoring center where he worked as a "curriculum person." Charles describes that job as "kind of a tutor executive program director." However, that job was "extremely time-consuming" and as his marriage fell apart and his career made him feel "burnt out," he recognized the need for change. And so he started applying for other jobs. His current school district was the first potential employer to respond to his application.

> *And I came down here and talked to [the principal of this school at that time] and toured the facilities. And the facilities here were nothing that I had ever*

> *seen before. They were just awesome labs. The people I talked to were real friendly, and they described the situation—they were very honest about the challenges that we run into—they didn't try to hide anything.*

Charles went home that night, excited about the possibilities yet nervous about the fact that he was from "a pretty small town" and the idea of teaching in this large urban high school "was kind of scary, for me." But he called his dad, had a long talk, and decided that this was right for him. The next day "I just went and signed on the dotted line, and have been teaching ever since. Fell in love with it."

He loved the school and he loved his co-workers. "The people that you work with here are just outstanding." But he still needed to adjust to the new situation.

> *First year was definitely a [*pause for thought*], kind of a [*another pause*], it was a big eye-opener, it really was. A lot of the things that you hear about and see about—and you don't know exactly what to believe or what not to believe—and you see some stereotypes that are relatively true, and you see other ones that are nowhere near true.*

In his own home town "there was not much diversity at all." He remembers that in the entire time he lived there, "there were maybe two or three African-American families that were in the area." He added that when a meat-packing plant opened on the edge of town, "the Latinos were just starting to appear on the scene in force."

> *Fortunately, I had two parents that were extremely open themselves. They really had no prejudices, no discriminatory tendencies, or anything like that. So far as diversity, I won't say I was raised to embrace diversity, but I was definitely raised not to fear it.*

His college experiences did not help as much as he would have liked. "They gave us multicultural training—or whatever class that you wanted to call it, that's required now for certification—but that does almost nothing to prepare you."

> *It didn't talk about any specific cultures or differences. It was just the fact that there are different cultures, and that they react and behave differently. Just a reality-check type of class that says, "Hey, not everybody is the exact same as you, or where you came from."*

During that first year at this school, Charles accepted a long-term substitute position teaching biology to replace another first-year teacher who started the year "and she basically quit."

> *It was pretty much in survival mode, from day one, when I came in there, trying to figure out where she left off, pick up from there, learn about [this district], and how[this district]does things. New curriculum, new book, first-time teacher coming in part-way through the semester.*

He never felt that he had an adequate opportunity to prepare for this biology. At the end of the school year he was told that he would be teaching chemistry the following year, so he spent the summer preparing.

> *I did a lot of independent research. Just read, read, read. Read a lot of textbooks, multiple textbooks, reopened my college textbooks, to relearn things from the other side of the coin, instead of as a student, looking at it from a teacher's perspective. There was a course I took over the summer that was "Teaching of Chemistry" that was offered by [the local university] that was spectacular! It was very content-organized, and it was a combination of*

> *former high school teachers—retired teachers—and one of the current college professors for chemistry, and they kind of co-taught.*

Charles considered this summer course to be "invaluable" as it "covered, pretty much, our entire textbook" that he uses in his school. He was able to review the material and relearn the content "while getting the perspective of all the other teachers and the way that they approach it, and just the way that they think about it and how they teach it."

And so his teaching has improved since his first year, and now he is in his fourth year at this school. For the past two years he has been teaching three different levels of chemistry. This year he has several sections of Fundamentals Chemistry 1-2 (in which the students are assigned according to their special education IEP); he has one section of Honors Chemistry 1-2 (for students who meet the prerequisites); and he has one section of Chemistry 1-2 (which includes a wide range of students since there are no prerequisites). It is this mixed group that I observed for this case study. Charles laughs as he talks about teaching this kind of class: "I am still as open-minded as I was the day I came in; you never really know what you're going to get with these students, because of the diversity."

A Visitor's View of Charles' Class

This classroom has a clean and orderly appearance. The walls are light gray, cabinets and mini-blinds a darker gray, with black-topped tables and counters. The front (west) of the room has a teacher desk and computer in the southwest corner, a demonstration table in the center, and a TV on a cart in the northwest corner, next to the only door. A whiteboard covers the front wall, with a screen hanging down for overhead projection. Above the whiteboard, from left to right, are a poster about the universe, a

clock, the district outcomes for chemistry, a poster showing a mountain climber with the word “Goals” dominating the scene, and a poster about the Hubble telescope.

The north wall of the room has a bare, clean counter with cabinets below and above. On the wall above the cabinets, starting at the door in the northwest corner, are another clock, a map of the world, a “rocks” poster, a “minerals” poster, and seven posters in a row showing steps of “The Scientific Method.”

The back (east) wall of the room has a bare counter with cabinets below. Above the counter at each end of the wall, there is a glass-doored cabinet filled with chemicals and glassware. The center portion of the wall, between the corner cabinets, has a large Periodic Table of the Elements, flanked on each side by three safety posters.

The south wall has a counter with cabinets below. This counter has two small sinks. There is a world globe on the counter near the front corner of the room. This wall is dominated by large windows, covered by closed mini-blinds. On the wall near the front are posters for the Frayer Model and Combination Notes. A poster next to those says: “Be Safe, Be Respectful, Be Responsible.

The black-topped student lab tables are arranged in three rows of four, each with two chairs. In the back of the room there is an extra single student desk (an additional single desk is broken and not usable). As observer, I am sitting in the single desk behind the middle row of lab tables.

Students are filing into the room as the tone sounds to end the passing period. Charles is standing at the door greeting the students as they enter. He tells them, as they walk past him, “Grab a calculator—you’ll need a calculator today.” Once the students

have all settled in, he says, "Last call—anyone who needs a calculator." He turns on the overhead projector, showing an outline of the quiz the students will take on Friday.

This chemistry class has 29 students enrolled. On this day of my visit, there are 21 students in the room, twelve males and nine females. Of the 29 students enrolled, 66% are male and 34% are female. Of the 29 students, 23 qualify for free or reduced lunches, none are currently served by Special Education, three are in the ESL program, and none is identified as Gifted. These 29 students live in twelve different zip code areas of the city. Thirty-one percent identify themselves as African-American, 28% are Caucasian, 41% are Hispanic, and there are no Native Americans or Asian-Americans in this group. The student population of this entire school is 19% African-American, 36% Caucasian, and 43% Hispanic. In terms of age, the oldest and youngest students in this class are separated by four years and four months.

The abilities and academic backgrounds of the students in this class are mixed. All students in this school district are required to earn two semesters of chemistry credit for graduation. There are three different options, however, for students to master the required chemistry standards. There is an "Honors" offering (which happens to have the opposite gender mix—33% male—as Charles' class, and has a different racial mix, with 11% African-American, 62% Caucasian, and only 27% Hispanic). There is also a "Fundamentals" offering for students served by Special Education, and these students tend to be male (77%) with 25% African-American, 16% Caucasian, and 59% Hispanic. The third option, "regular" Chemistry, is the type of class that Charles is teaching this period.

There were specific prerequisites for students who wanted to be in one of the "honors" sections, and at this school 31% of those enrolled in Honors Chemistry 1-2 are identified as "gifted." But there were no prerequisites for the regular level of Chemistry 1-2, and therefore Charles' students have a wide range of backgrounds. Their grade point averages (GPA) are as low as 0.15 and as high as 3.37. Their daily attendance this year ranges from 27% to 98%. On their 8th grade California Achievement Tests (CAT), the national percentile scores range from a low of 4 to a high of 72 in reading, and a low of 4 to a high of 67 in math. On the 8th grade Test of Cognitive Skills (TCS), the scores range from 65 to 108, with 141 points possible. Of the 19 members of the class who previously attended this same district for middle school, only seven of them successfully completed the 8th grade science course. Only seven members of this chemistry class have successfully completed 9th grade biology. Seven of the 29 students are repeating chemistry after failing previously.

Charles begins today's lesson by announcing that "today's review will be for 10, 15, 20 minutes max," and that the students will have the remainder of the period to work on their notebooks, which will be collected tomorrow for grading. A student asks: "Can we use our notes during the quiz tomorrow?" Charles ponders the question and replies that he had not given that any previous thought. After a pause, he says, "Yes, that's fine."

The quiz outline on the overhead screen shows that the students will be expected to know 15 vocabulary terms and to understand diagrams about potential and kinetic energy. He asks the students where they might get help finding the definitions for the vocabulary words, and one student quickly replies, "In the back of the book." Charles adds: "In that

place called the *glossary*." He goes to the board and draws a picture of the cartoon character Road Runner about to fall off a cliff. (A student points out that it's the Wily Coyote who always falls off the cliff—Mr. C replies that he understands that, but the Road Runner is easier to draw.) He uses the drawing to spark an interactive discussion with the students about the relative amount of potential ("stored") energy as the character in the drawing falls from the cliff and picks up speed on the way down. Another student asks about the term "maximum velocity." The teacher replies that it is a term that they will study later in physics, and that question should wait for their physics teacher. Charles continues describing the relationship between stored energy and the energy of motion. He goes again to the board and quickly constructs a simple graph showing "energy vs. time" during a chemical reaction. He asks the class what kind of reaction this is. A female student responds, "Exothermic." He asks the class, "Why did [student name] say exothermic?" The same young lady answers, "Because it's releasing energy." Mr. C compliments her: "Excellent! I'm <u>really</u> impressed!"

Students continue to take notes silently while Charles draws a second diagram on the board. He then asks the class, "[Student name] answered last time—who know this one?" Another student responds, "Endothermic." Charles asks the class, "[Student name] says it's endothermic—why did he say that?" Another student replies, "Because it's the opposite of the last one." Charles quips, "Well, that's one way to look at it." A different student adds, "It's gaining energy." As the discussion concludes, Charles reminds the class, "That's all you need to know about energy diagrams. If you know that, you're in great shape."

Next he points again to the quiz outline on the overhead screen and moves from the "Energy diagrams" to the next steps which say "Be able to use data to calculate calories in food" and "Specific Heat." He tells them, "This is what you need the calculators for." Then he points down to the final item on the outline, "Green house effect." "You remember this from yesterday," he declares. "No, I don't," responds a student. "You don't? It was a brilliant lecture!" replies the teacher. As the discussion continues around the green house effect, the teacher shares his "personal belief" that the environment faces a "balancing act" and that "we must be careful" with it. He then returns to the topic of calculations and uses the overhead screen to lead the class through several practice examples that he describes as "brutally simple." As he explains the first one on the screen, a problem about quantity of energy (in joules) needed to heat a piece of iron (1.3 g) from $25^{o}C$ to $46^{o}C$, students are writing notes and using calculators. Then the teacher says, "Specific Heat—now here's the fun one." He tells them that when they see "S" in the equation, "that means it's book time." He instructs them to look on page 297 for specific heats. The students are busy writing, but I do not see or hear any book pages turning. Other students begin offering answers from their calculators for the problem the teacher is working with them on the overhead. He walks over to several tables to check student work, and then he returns to the overhead to record the correct answer for all to see.

A student asks, "Can we do another one?" Charles leads them through another example with discussion, and then announces: "Okay, that was the review. The rest of the time," (he looks at the clock), "…Oh, that took a lot longer than I thought! In the last five minutes, work on getting your notebooks ready." The review had consumed more than 30 minutes of the 41-minute period.

During the remaining five minutes, Charles speaks quietly with a group of female students at the front left corner of the room, telling them, "Ladies, I need to set up a new seating chart for you—too much talking today. I've given you a 2nd chance, 3rd, 4th, 5th—no more chances." He then proceeds to answer questions coming from four students who approach him near his desk. Four other students stay at their own desks, writing in their notebooks. The other members of the class are either visiting quietly or resting, until a tight crowd forms at the classroom door, anticipating the end of the period. Charles sees that one student has exited early, and he tells her to come back into the room and close the door. When the tone sounds to end the period, the students leave the room.

Charles' Description of his Class

Charles talks about the many differences ("just about every one that you could imagine") between students in this mixed-ability class.

> *We have academic backgrounds, for example, I have one student that is borderline special ed, but isn't in special ed, all the way to students—I can think of two or three, in particular—that should be in Honors, but have opted out of the Honors program because [*pause for thought*], well, because they're lazy, frankly, they just don't want to do the work. I have students that come to school every single day, to students who do not show up at all. I mean, I have one student here—we are now in the middle of February—and I have a student who showed up [only on] the first day—period.*

In fact, although there are 29 students enrolled in the course, "I think we are about down to 24 now," some of them seldom attend class. For example, one of them "shows up

once every 20 days, just enough to keep his parole officer off his rear end." And there are others who are present, but struggle for other academic reasons.

> *I've had folks that this is the hardest chemistry—or the hardest science class—that they have ever had, and I have folks that this is practically the first science class that they have ever had. So [*pause for thought*], pretty much, every extreme you could ever imagine, I've got. [laugh].*

For some of the students who struggle, there is a language barrier. Charles describes the situation with one particular student who "is one of those students that sits in class every day and just does nothing—he is an ESL student—he struggles with speaking English a lot. This is his third time around with chemistry, second or third time through it."

In addition to the academic diversity, there are also extremes of financial background. "I have students that I know have trouble getting money to eat, versus all the way to students, I know, who live pretty well." The extremes of family wealth add to the dynamics in the classroom.

> *From what I've seen in the classroom, it really isn't a cultural thing, as much as it is an economic thing. Each economic level has specific challenges, specific issues, as well as the cultural differences. I mean, each culture's a little different—don't get me wrong—but it seems to be as much wealth and monetary driven as it is cultural driven. You know the [*pause for thought*], the really lower [*another pause*], lower class, now they behave the same no matter what culture they are—White, African-American, Latino—you see the same [*another pause*], pretty much the same issues from them.*

At times, cultural differences do influence classroom interactions.

> *There's certain individuals in certain cultures that really [*pause for thought*], well, you know [*pause*], specifically African-American students that I know, they [*pause*], any opportunity that they get, they'll come after you and call you a racist—because you're White. I'm still very comfortable with it. [Pause for thought]. There's just some [*pause*], you know, there's little things that bother you from day to day, but they're [*pause*], they're easy to work by. Like I said, you get called racist now and then from [pause], you know, African-American students or Latino students, you get called racist, I'd say, once a month, maybe more. [Pause for thought]. And that part's hard to swallow, and that makes you really uncomfortable.*

Charles explains several examples in which a student tried to shift the blame from the student's own rule infraction onto the teacher attempting to correct an unacceptable behavior.

> *A lot of the time when that racism word gets thrown around, nine times out of ten it is because of a disciplinary action of some sort. It really has absolutely nothing to do with education issues, it's just that you're there enforcing a rule and a policy on them that they don't like, and they just throw it out there to try to get you to jump—just to get you to flinch.*

But what really make Charles uncomfortable about this diverse class are the difficulties involved in trying to teach the mix of students heading in such different directions. He says that he has "concerns about equity," and the "cookie-cutter" approach that attempts to treat all students the same, but does not meet their real needs.

> *You've got your students [pause], these upper-level students that have the potential to be college-bound, [I am] worried a little bit about them getting enough to potentially go on to college, because I can't cover as much as I need to, with the [other] students who are non college-bound [present in the same class]. And then there's the other side of it, these non college-bound students that are on kind of the low end of it, being fair to them, not teaching the material at such a level that is above them that I'm failing them. And having such extremes, you can teach to the middle of the road and you're hurting about [pause], because the spread is so wide. You can teach to the middle of the road, and you can still lose the bottom quarter and the top quarter.*

Strategies for Success

How can a teacher bring success to such a wide range of chemistry students?

> *I can raise the curriculum, but then I'll just lose more of the lower end. Or I could lower the curriculum—make the curriculum a little easier—and then it would be totally unfair to the upper end, as far as being prepared for college. So there's a lot of decision-making going on, on what to sacrifice and what to cover, because of it.*

What really matters to Charles is how well he is prepared to teach the content to such a variety of students. When he considers all of the professional development opportunities that he has experienced during his four years in this school district, he believes that the best support for dealing with heterogeneous groups of students has come from resources that help him to understand the content of his assignment.

> *Without a doubt, 100%, totally, completely, has been actual core—like chemistry and physics classes—where you aren't necessarily learning any particular strategies or anything like that. For me, it's been just learning the material—100%, without a doubt, so that you know it and can explain it a million different ways, from a million different directions—has been, by far, for me, the best.*

When a teacher truly understands how something works, he says, you can explain it one way, and if the students do not catch on, you know enough about it that you can apply it to a completely different situation that they might be familiar with, and then approach it from a different direction.

> *Like we're talking about net forces right now in physics, knowing enough about the way the net forces work that you can explain it in terms of how the brakes and accelerator on a car work. And if you get the blank look, you can talk about skydivers and you can talk about how the gravity and air resistance work on skydivers. And if that doesn't work, then you can talk about the motor on a boat. And if that doesn't work, you can just approach it from many, many different ways. You can talk about a rocket lifting off a launch pad. It's just [pause], the more content you get, I think, the better you understand it.*

He feels that his physical science degree was quite broad. He took a lot of strong science classes, but his training was not specialized enough to "get into the extreme nitty-gritty of chemistry, and the extreme grit of physics." He felt that his undergraduate program "kind of glazed over everything."

> *I think if you got a teacher—at least from my experience with the other teachers that I've had around here—the best teachers are the ones that are certified specifically in their areas and they just know everything there is about it to the core. Because they can approach it from <u>any</u> direction and <u>every</u> direction, and the folks that truly understand it—the good teachers—they can break it down into such simple terms that anybody can understand it.*

Charles has a three-phase instructional routine that he follows for every lesson. First, he begins with an introduction in which he and the students discuss the topic and do sample problems on the overhead. Second, he offers them practice problems which they do "with no fear involved," sometimes on small erasable whiteboards at their desks and at other times on scratch paper. This second phase is "just a pass-fail thing" where they either participate and get points, "or they don't do it and they don't get points." During this phase the students have the opportunity to attempt solutions without fearing mistakes. It also gives Charles an opportunity to use a "diagnostic teaching style" to assess what they already know and what they need to understand better before the third phase, during which "they actually do something for grade." Along the way, getting to know the individual needs of the students comes from direct experiences with them, "monitoring work with them as best I can."

Finally, he addresses the task of helping the students understand the concepts that are not being mastered. "I've tried lots of different things—still do lots of different things—trying new things all of the time, and there are varying degrees of success with all of them." He helps them with their reading assignments by beginning with pre-reading exercises. He tries to "link it to the real world" by keeping up on current events

and knowing what the students are seeing on television. And he searches for "hands-on models" that allow the students to "actually mess with it while we're talking about it—they can *see* the connection—and it works well to get the little light bulb to come on, and actually *see* it."

But the most important strategy when working with students who have such low math skills seems to be "repeat, practice, practice, practice, repeat, review, repeat, review, reteach, review." In fact, during the second phase of instruction, when students are practicing with "classic worksheets," Charles takes advantage of the student diversity.

> *During the review and repeat, really that's kind of where I use them [laugh], the more talented kids, you know, you try and keep in the area of the group of not-so-talented kids, and during practice time they become very precious there, because they can help reteach, explain, demonstrate, in the different groups, or in the different areas, during the practice time. Because I can't get around to 25, 30 kids—it's tough for me to get to every single kid throughout the class efficiently. And if there's a talented kid in the area there, the kids that are not so talented, they know that if they can't get a hold of me, they'll ask <u>them</u>, you know. So, they're kind of my re-teachers—accidental helpers [laugh].*

Nevertheless, Charles has not yet found the way to effectively deal with this awkward mix of students.

> *My first year of this chemistry format that we're using right now, I had about a 50% pass, 50% fail, rate. So out of my kids, only half of them passed. The next year I was able to change a few things, and I got it up to about 55%.*

> *This year I think I'm going to hit 55-60%. My target is to get 80%, personally. What I'm aiming for and what I actually get are two different deals. I'm aiming for 80%. If I can get 80%, I would do a dance, I would just be absolutely thrilled, with my past experiences being what they are.*

Major Themes in Charles' Case

Teacher Beliefs

Charles agrees with the school district's attempt to bring more science to more students, but he was "not completely on board for that one" when the district decided that every student must have biology, chemistry, and physics as part of the graduation requirement.

> *I like the idea that every kid is going to get science. I think that is needed, I think that is perfect, I think that is the concept that we are aiming at, as a whole. I really don't think we are going about it quite the right way [laugh], but as far as every kid getting science, I mean, yes. Yes, yes, yes, yes, yes. Every kid should get science. As far as I'm concerned, every kid should have four years of science. I don't think three years of science is good enough—they ought to have four. I mean, we're getting into a more and more scientific society, we're teaching problem-solving skills, we have inner-city youth that aren't exposed to much, and science, I think, exposes them to a lot of the world, and the world around us, and how it works. And so, I mean, the kids need science.*

However, he feels that the new graduation requirement is too difficult, as well as unnecessary. He does not believe that the majority of students are headed toward college.

> *Saying that every single student in a high school, that every single student that steps into a classroom is "college-bound," that's like saying every single football player that steps on a football field is going to be professional. It's just [pause], it's an unrealistic goal.*

He believes that the new graduation requirements are too rigid and are setting the students up for failure.

> *This is going to so bite us in the butt next year, because now we've got juniors [pause], or well, our next year's seniors, the ones that are going to require three years of science in order to graduate. This is the first bunch that we are going to be graduating that's required that. And next year is just going to be bloody, because a lot of the juniors now have not passed chemistry and have not passed physics, and now as seniors they're going to have to pass chemistry <u>and</u> pass physics, and for the ones that maybe struggled in biology, now they've got to pass biology, too. So, I mean, there's three of their classes right there. And I can't imagine taking three science courses at once. That just would be brutal.*

However, even though Charles believes that the system has placed this mix of students into a situation that is not in their best interests, he still thinks that most of the students would be able to pass this class if they really put their minds to it. He is saddened by the "huge work-ethic issue" that results in many failures due to poor attendance, as well as seeing "kids that just shut down and do nothing."

<u>Frustration</u>

Charles sees the mixed-ability class as part of the cause of student failure.

> *It causes severe pacing problems. For half the class you can't move fast enough, for the other half of the class you can't move slow enough. So pacing is a huge issue. And then the other thing that I always find myself constantly making the decision on, is when to pull the plug and leave kids behind. Constantly making that decision.*

And when a student fails the first semester of this course, as 11 of the 29 students did, Charles cannot agree with the administrative decision to keep those students in the class during second semester.

> *Just logically as an educator, to me, it does not make sense to have a kid who has failed Chemistry 1, throw them immediately into a second semester course that is based on Chemistry 1—that they didn't pass already—and then throw them into that second semester Chemistry that's based on something they haven't passed! Educationally to me, that seems like you're just throwing a kid that's already struggling or failed into a no-win situation where you're going to be basically wasting half of their year for them.*

In addition to scheduling difficulties, extremes in learning rates, and concerns about student failure, the new graduation requirements have also put pressure on the limited classroom laboratory space. The Honors Chemistry 1-2 sections get the well-equipped labs, while the mixed-ability classes, such as this one, have insufficient gas and water and safety features that would all be needed for extensive chemical experiments. Therefore, Charles can only "work in about one lab a week" and even those lab experiences "end up being extremely qualitative" because the inadequate lab facilities make it "very hard to do anything involving numbers or specific reactions." The

frustrations mount as Charles sees limited opportunities for students to succeed in this setting.

Achievement Levels

There are three different courses that satisfy the graduation requirement for chemistry. Charles sees that the honors sections are "more focused" because the "college-bound kids" have met very specific criteria "to be where they are." Subsequently, those students "are very close to each other, ability-wise" and those "honors classes do very, very well." And he sees that the fundamentals classes, for students with special needs, are also homogeneous, so "our fundamentals classes, they do very, very well." But it's the mixed-ability group in the middle that is "really running into the problem" because "they have no criteria."

> *So you've got kids with "above average" abilities, grouped in with kids with the other end of the spectrum. It's that middle group that's really the one that's the problem right now. The majority of our issues are there.*

Charles suggests that there needs to be a way to group the students by some kind of criteria to produce more balanced courses. "The magic division at this point seems to be the mathematics skills." By scheduling students into one of three levels of chemistry according to whether or not they have successfully completed algebra, he believes the entire student body would be offered the appropriate chemistry to fit their needs.

> *Now the honors [the top level] would be the true kids that are—where their goal is to go to college. The algebra[-based level], then, would be the "non college-bound." And then your pre-algebra[level] would be, basically,*

> *students that have not had [algebra]—or have not had pre-algebra. It would be a very conceptual-level type course.*

Student Behavior

But in this mixed-ability class under the current system, the presence of extremes causes even more problems.

> *With the upper-level kids, they are so bored to death that they do one of two things, they either become behavior problems—and there's nothing more frustrating than a kid who's got an A and is a behavior problem, cuz then what do you do to them?—and then you've got the kid that, no matter what you do, can't pick it up.*

Sometimes in these situations, "the kids flat-out refuse to do" the assignments in class, and "once they get outside of class, they do little to no homework." It is this kind of uncooperative classroom environment that reduces motivation for success.

> *I think if I had a kid, if I had a child [of my own], I'd try to get him into the Honors, obviously, because I know that they'll be with the other kids that are kind of like-minded.*

Chapter Six: Diane's Class

I will never, ever tell a child that they are not bright enough.

—Diane

How Diane Got Here

Diane always wanted to be a teacher. Her father was a college professor and one of her favorite aunts was also a teacher. As a child Diane frequently attended college football games, visited the college museum, and spent time at school on Saturdays with her father. "So it was an atmosphere in our family that I always enjoyed."

She grew up in a city that was much smaller than the one in which she now lives and teaches. Her home town had a population of about 50,000 people, the vast majority of whom were middle-class White. Her high school graduating class had somewhere around 600 or 650 students, so her school was quite large for a small city. One of her school memories had lasting influence on Diane.

> *I had a very distinct experience as a ninth grader in algebra. I remember asking questions, and the teacher basically told me, "Quit asking questions, you're only a girl." I didn't need to have math [according to the teacher], because I would be a wife someday. And I wasn't quite as smart as my brother and sister—but of course, I got that a lot as a child. So that was a big shaper, I did not go on to any more math or science after ninth grade.*

This negative incident led her to shy away from math and science in high school because, as she put it, "I just didn't think I was *smart* enough." On the other hand, she excelled in English classes.

> *Oh, my English teachers—that's why I loved English. They encouraged—I love to read—they encouraged it. And there were a lot of discussions about it, and I enjoyed that very much. Yes, I had some excellent high school teachers.*

So when she went to college, her lifelong dream of teaching began to take shape through a program in elementary education. But elementary teaching began to look less attractive when she "found out we had to do bulletin boards, and artwork, and I have very little talent in that area." So she switched her major field to English. That target also seemed unreachable once she "found that I wasn't real good in English—according to my college professor—even though I won third place at the college writing contest." That English professor "would always find a word that she felt was inappropriate, and her word was better, and every word you missed you got docked a whole letter grade." What Diane felt was missing was an element of "encouragement."

Then along came a professor of chemistry who taught "Chemistry in the Modern World." She loved the class: "That was my little area in the world that I just found fascinating, and it went from there; I'll never switch again." Diane found encouragement in his chemistry class. "When somebody encourages you, it boosts your morale, but when you get the discouragement…," she pauses briefly, "we all find enough of that in life [pause]." This chemistry professor had an "open-door" policy.

> *If you had questions, you could come in at any time—you did not need an appointment. He was very open to questions during class. I think his biggest philosophy was "no question is stupid." And that's a philosophy I agree with. No question is stupid. I think that encourages kids to ask.*

His class was a typical lecture format, as were most of Diane's classes. "All my classes were very heavy lecture—heavy notes—but that's all I ever experienced in college." He did include a lot of laboratory experiences and real-world applications for the concepts introduced in lecture.

> *I think where I liked him the best is, he always took the chemistry and he would relate it to the world around us. He was very good at saying, "This bonding situation works real good in permanents," or "This hairspray situation was good" with different things. And I could relate to that. So that's another aspect I try to get to my own kids. Relate it to the real world, so it makes sense.*

As Diane's life moved forward, however, teaching was not the highest priority. Raising a family came first. Later, when her children became older, she took a position teaching chemistry, physics, Earth science, and astronomy at a small, rural high school. There were "maybe 400 kids in the whole high school" and, again, the situation was "predominately White, middle class." Very few students represented minority populations. If there were any minority students, they were usually Latino. Diane taught in that setting for five years.

When her children moved to another state for their own college work, Diane moved to the same area to be closer to them, and she applied to the urban school district where she now works. They offered her a position. "It was a *huge* adjustment!" she says with a hearty laugh.

> *I actually enjoyed moving to a bigger city. Probably the biggest adjustment was the number of papers to grade [laughing], because my quantity of*

> *students tripled. But I actually enjoy a larger high school more. I enjoy the diversity of the school I'm at, very much.*

Nevertheless, this diversity became part of the adjustment. Her home town community had displayed some degree of racism, and she had never taught in a school with such a culturally diverse student body. In adapting to this unfamiliar heterogeneous setting, she relied on the support of the many people who empowered her, including new colleagues, former mentors, and her own family members.

> *I think my biggest influence was my husband. He has a very positive outlook on life, and he has a very positive outlook on people. He was always more caring about what the person was, instead of how they looked.*

She developed an authentic enthusiasm for working with the student body in her new school. Armed with a compassionate personality, a solid work ethic, and a contagious passion for science education, Diane began teaching physics at this century-old, inner-city high school. She has been here now for eight years.

A Visitor's View of Diane's Class

Period 8 is about to begin as I take my place at an empty table in the back, left (northeast) corner of the classroom. The tone sounds to begin the class period. An announcement comes over the speaker in the west wall to my right, but the rustling of the students settling into their seats partially obscures the message. I look up to the speaker and see that it is recessed several inches in an unfinished opening of the wall. Diane tells the class that recent room renovations left the wall speaker poorly positioned for the proper movement of sound waves, making it difficult to hear announcements.

The renovation of the classroom was the result of the district's new graduation requirement that all students pass physics, causing a severe shortage of teachers and lab space in many buildings in the district. This building did not have enough rooms for the new science requirements, so several areas of the building were converted into new lab science space. The front (south) wall of this cream-colored classroom has a green chalkboard covering the left half of the wall. There is an overhead projection screen in the middle of the wall, and to the right are two rolling boards, the first providing more chalkboard and the second a bulletin board with a Stellar Evolution poster. On the wall above the main chalkboard are eight posters, each prominently displaying a physics equation. In the southeast corner of the front of the room is a TV, with a smaller monitor on a cart in front of it. Also at the head of the room are a teacher desk and a lab demonstration table. The one door of the room is located to the right, at the southwest corner of the room through the west wall. The west wall is empty, but there is another rolling bulletin board on the west side near the back of the room. The back wall is also empty. There are three large windows with mini-blinds in the east wall. There are 16 black-topped lab tables arranged in four rows of four. Each table has two chairs.

This physics class has 27 students enrolled. Today, there are 22 students in the room, ten males and twelve females. Of the 27 students enrolled, 46% are male and 54% are female. Of the 27 students, 16 qualify for free or reduced lunches, three are in the ESL program, one is identified as "gifted", and none are currently served by special education. These 27 students live in thirteen different zip code areas of the city. Thirty-seven percent identify themselves as African-American, 54% are Caucasian, and 8% are Hispanic; there is one Native American student and one Asian-American in this group.

The student population of this entire school is 34% African-American, 51% Caucasian, 13% Hispanic, 1% Native American, and 1% Asian-American. In terms of age, the oldest and youngest students in this class are separated by four years and six months.

The abilities and academic backgrounds of the students in this class are mixed. All students in this school district are required to earn two semesters of physics credit for graduation. As with the biology and chemistry requirements, there are three different options for students to master the required physics standards. The Honors Physics 1-2 offering (which happens to have a 50-50 gender balance at this school this year) has a different racial mix than Diane's Period 8. Most notably, the honors sections are 73% Caucasian and only 16% African-American. The Fundamentals Physics 1-2 sections have a 52 to 48 male-female gender ratio. Racially, the Fundamentals Physics 1-2 sections are 65% African-American, 29% Caucasian, and 6% Hispanic.

There were specific prerequisites for students who wanted to be in one of the "honors" sections, and at this school 54% of those enrolled in Honors Physics 1-2 are identified as "gifted." However, there were no prerequisites for the regular level of Physics 1-2, and therefore Diane's students have a wide range of backgrounds. Their grade point averages (GPA) are as low as 0.34 and as high as 3.57. Their daily attendance this year ranges from 79% to 97%. On their 8th grade California Achievement Tests (CAT), the national percentile scores range from a low of 10 to a high of 96 in reading, and a low of 12 to a high of 96 in math. On the 8th grade Test of Cognitive Skills (TCS), the scores ranged from 72 to 133, with 141 points possible. Only 13 members of the class have successfully completed Chemistry1-2, and only 18 have successfully completed Algebra1-2.

Diane tells the students to dig out their notebooks, “We’re going to talk about sound today and tomorrow.” She turns off the room lights and turns on the television monitor. “Speed of Sound with Temperature” appears as large white letters on a green background. The PowerPoint presentation on the television screen shows the first question, “What is Sound?” accompanied by the sound of waves crashing. The teacher and students have an interactive discussion about vibration of an object affecting the movement of air molecules. Students copy definitions from the television screen as the discussion continues. Diane asks if there is any sound in space. The students discuss the situation in which there are no air molecules. A student declares, “I still don’t understand why there is no sound in space.” The teacher continues the explanation about the lack of molecules required for the vibration to bounce. After the students are satisfied, she moves on to the next question.

During the ensuing discussion, Diane reminds the students that this principle is something they learned last year in chemistry. They discuss the idea that molecules spread out because heated molecules are moving faster. The next question, regarding movement as molecules cool down, leads to a discussion of events in the movie “Apollo 13” when the space capsule lost heat. The teacher helps the students pull the ideas together as she asks them to describe the speed of sound in air. Two students (one male, one female) in the front left corner of the room start to play. Diane asks the female at the table to move over to another table. The student responds, “I promise to be good.” She stays at the table and the class discussion about sound continues. The students in the room are actively taking notes from the information on the television screen. When the same two students in the front corner start to get loud again, Diane again tells them to separate, but they both respond, “I’ll be good.”

The discussion now turns to examples of things that make sounds, including the human voice, brass musical instruments, woodwinds, and stringed instruments. The PowerPoint presentation has the sound of an electric guitar accompanying the picture for stringed instruments, and a student observes, "Hey, that sounds like my alarm clock." The discussion continues as students hear sounds made by the brown bat, which leads to explanations about how bats use the Doppler shift to detect and catch flying insects. Diane and her students next apply the concept of Doppler shift to other uses in daily life, such as weather observations and radar guns for traffic. As the students copy notes from the screen, she reminds them about speeding fines doubling in construction zones.

It is now 20 minutes since the beginning of the period. Diane distributes worksheets to the students, and she uses her PowerPoint presentation to guide the students through some of the calculations step-by-step. The first seven questions involve calculating the speed of sound at various temperatures on the Celsius scale. The 8th and 9th questions are quick review questions. The bonus question asks about the speed of sound at 68 degrees on the Fahrenheit scale and requires the students to show their work for credit on this problem. The answers to the problems are actually on the worksheet itself. The goal of this worksheet is for each student to demonstrate how to calculate those answers.

After ten minutes of the PowerPoint-guided work together, Diane turns the classroom lights back on, and tells the class that the worksheet is due tomorrow. The students are all working silently. One student asks the teacher a question, to which she responds, "That's the bonus—if you're that far, that's super!" A student from the back center table takes her paper to the front desk, telling the teacher that "My paper's up there."

Diane tells her, “Thank you,” and then announces to the entire class, “If you are done, you can bring it up—I’ll get the 8th Hour folder for you.”

The student who had been the first to hand in her paper now goes to the table in front of her and explains something to the two students sitting there. She then returns to her table and puts her head down to rest. Diane is circulating from table to table, assisting students as needed. For one student, she goes to the bookshelf and says, “This old book has what you need—I’ll trade you.” She continues circulating, asking students if they have questions. One student has stopped working. Diane asks him if he needs a calculator. He nods. She asks the class, “Does anyone have a calculator we can borrow?” The student resting in the back says, “I have one,” and gives it to the other student.

One of the formerly disruptive students is doing nothing. The teacher asks her if she successfully completed the extra credit. “No—I don’t know how to do it,” is the reply. Diane offers to help her, but the student shrugs it off and says there isn’t enough time. Both teacher and student maintain friendly voices and friendly facial expressions throughout this exchange. “Oh, there’s over five minutes still left!” chides the teacher. Diane then turns to the class and reminds everyone that the “dark navy book” has what they need for the extra credit problem—but “only if you’re interested.”

During the final minute of the period, the class is still working quietly while Diane continues working with students one-on-one. “Great! Now let’s do # 6,” she tells one. Two students have their heads down, several others are sitting back relaxing. The rest are still engaged in the lesson. “You can turn it in if you’re done,” the teacher announces. Several students begin to rise. The teacher quickly reminds them to stay seated until the

bell rings. The tone sounds. Students rise and exit. As they leave, some of the students turn in their papers. "Excellent job!" Diane tells them, "Good work!"

Diane's Description of her Class

Diane talks about a wide range of ability, social backgrounds, and even a wide range of motivation for being in school in the first place. "A lot of these kids in this class love to come to school just to be social; they're very outgoing, and they love to talk with their friends, and that's a big aspect of their life—and that's a typical teenager, " she says with a laugh. So maybe physics is not their top priority sometimes, and there are many other differences that can interfere with learning this subject. There are "two students from ESL, who struggle with the language." And while mathematics is a critical component of physics, "I have a couple students very strong in math, and then some that are very, very weak in math." There are also other circumstances that affect the classroom.

> *I have a student on probation—I talk to her probation officer generally on a daily basis (they send a card around). I have one that I know has currently dropped out of school and is in jail. I actually have one student who is married with two children. I've got a couple who have dropped out of school. I have one that I know is currently very upset with school—wants to drop out—in fact we've had several discussions about how she hates school, and it's not the academics, it's the kids, and so she's really struggling with that. Race-wise, I have a mixture of about even-steven with Hispanic boys, White boys, African-American boys. I have about double the African-American girls than I do Hispanic girls, and also close with that with the White girls.*

This is certainly far from a homogeneous class. So how did Diane react when she learned that she would be teaching physics to a diverse group having no prerequisites for sorting them in any way?

> *You know, to be totally honest, I've been teaching physics a long time, and when they did have prerequisites, I still had to teach kids how to do the math, how to do the trig, how to set up a story problem, how to solve a story problem, because even though they "had the math background," they don't always retain it. So to me, it's just like—I love the Nike slogan—"Just Do It!" [Laugh] And that's what I do. Because I want them all on the same page if at all possible. [Pause for thought.] Basically, I'll just roll with the flow on it [laugh].*

But that doesn't make the task any simpler. Diane has real concerns about the range of math backgrounds, observing, "To be honest, it's a lot more work." She points out that the teacher must do so much more, and in a variety of ways, in order to capture and keep the attention of so many different kinds of students.

> *I think the biggest aspect is, for the teacher, is how do you keep the kids with the higher-level math skills from being bored, and yet teach all the low-level math skills—or, the children with lower-level math skills—the material they need to have a good shot at success, also. That's where I struggle the most. Because the high-level kids, they don't need the practice, practice, practice. I mean, it doesn't hurt 'em, but most of them just don't need it.*

Even so, with the wide range of abilities in this class, Diane is pleased that most of her students are gaining physics understandings while in this setting. She points out, "The

kids who have been really, really trying, they're all succeeding." For those who are failing, "absenteeism is still the biggest issue."

Strategies for Success

Most of Diane's students in this mixed-ability class are showing up for instruction and they are learning physics—not that it's easy for the students or for the teacher. Diane cautions: "You definitely cannot be stuck in a rut, doing the same thing every day, or all of the time; you have to have variety, just due to the diversity in the classroom." First of all, she starts out by finding out as much as she can about who her students are, and what their levels of understanding might be. On the first day of school, as she has them fill out personal information cards, she includes a question about what math class they are currently taking, and she is amazed at the answers: "You get kids that are—lots of kids—low, low level math all the way up to calculus." However, she does not want to "pigeon-hole the kid" by finding out their math level. Instead, she wants them to have an opportunity to prove to her what they can do.

> *Because some kids, even though they're in the low-level math classes, they can do it—they learn to do it. And the kids in calculus may have the high-level math, but sometimes they're not real good at solving story problems, or just thinking critically. They're used to just plugging in a formula.*

It turns out, then, that learning about the student's ability level is not a filtering system for writing off potential success. What Diane does with the information is prepare to meet their needs.

> *The school is not going to change it if I go to somebody and say, "Their math ability is very low." They're not going to [drop them from the class] anyway, so I just figure I have to work with what I've got. [cheerful laugh]*

Another step she takes in learning about her students is that she simply observes them. She watches their body language, which she says "tells you right off the bat" about their comfort level in the classroom and their degree of confidence with the subject.

> *Next, just downright ask 'em. Talk to them, ask them how they're doing when they walk in the door, if they're having a good day, bad day. They are usually real forthcoming, if they like it or not [laugh]. Another one is just walking around the room while they are working on things—it's amazing how much you can learn about their ability just to actually physically do it, or when they cannot do it. It's not hard to spot.*

Finding out what they can or cannot do is still at the beginning of the process. Next she must find ways to deal with the range of differences. She tries to teach the course to meet the diverse learning styles. She offers a large variety of activities, insisting that "I need to show them how to do it differently." She pushes the students by "trying to encourage them to keep trying, keep trying to succeed."

> *In the beginning there's frustrations and anger and "I want to quit." But we try—the school doesn't want them to quit, and I don't want them to quit. [Later,] it's wonderful to see their faces light up and say, "I can do this!"*

This drive to succeed is rooted in Diane's own educational experiences, as she recalls, "When I was in high school, math and science was *not* easy, so I really, really relate to how the kids feel." Even when she is not successful with a few students at first, she

keeps giving them the encouragement she wishes she could have felt in high school. For example, if some of them fail the first semester, she does not want to give up on them. Rather, she gives them positive guidance: "Maybe you didn't quite succeed the first semester, but look at the skills you did learn—let's build on those skills—so we can succeed the second semester."

She promotes tutoring before and after school. She monitors the students' levels of comprehension: "I *care* if the kids do the homework—not only *care* that they do it, I want them to do it *correctly*, so they have an understanding of it." She rotates the seating arrangement every couple of weeks. She invests personal time in her students: "Yes, it does take time, but it's important to them, so that they know somebody cares! Somebody cares about their life outside of school." She finds ways to get them involved in classroom projects: "Anytime we can get them to be excited about something, that's wonderful." She tried to treat them fairly: "If I care and be honest with them, the majority of the kids return the same way." She makes a serious effort to see things from the perspective of her students.

> *I'm very patient. I really feel like that, as I was growing up, [pause] math and science were not easy for me. So, when I see kids struggling, I can relate to it. I don't sit there and automatically say, "What don't you understand—it's so easy!" I can relate to that. And I think that's probably my biggest strength.*

Another one of Diane's strengths is her desire to use support systems whenever possible. "I love parent-teacher conferences—it's amazing what you learn from them." She makes a lot of phone calls to parents, "just trying to encourage the parents to work with me, trying to encourage the kid to *try*." In addition to using the support of parents,

she also enjoys the teachers around her: "I have a wonderful staff—we share a lot of ideas—we share a lot of things that are successes, we share our failures." She deeply appreciates the efforts in her building to assist the students with reading strategies and math strategies, and she adds with a warm laugh: "I like the concern they show that they also worry about *every* student trying to make it—that just makes me feel better." Likewise, she values her school's emphasis on safety issues, as well as her administration's practice of seeking teacher input and then responding accordingly.

Another layer of support is provided by the school district's professional development opportunities. As a participant in one of the district initiatives, Diane was guided into a class at a local university where she learned a great deal about social issues.

> *[The professor] talked a lot about the rules of how poor people looked at life, how middle class looked at life, how the wealthy looked at life. The hidden rules of society—we discussed it at length—especially how the school systems are really geared to the White middle class.*

That district initiative also focused directly on the content of physics. Diane wanted to participate because she was interested in expanding her own knowledge base.

> *I do not feel that we all know it all. I think there's always room for improvement. I think there's always room to learn things, because, in science, there's just trillions and trillions of facts. So I was just interested in that aspect. Learning more.*

District professional development also emphasized inquiry-based education.

> *We were really encouraged to work with that. Yes, it's very, very time-consuming. But I found a lot of kids, they liked it. And then I found kids that*

> *got real frustrated with it, and usually those kids just wanted the answers. They didn't want to understand it, they just wanted the answers. So there was a variety, and I found that a lot of different things helped my kids. I think that's one of my own personal philosophies of education. Do lots of different things so I can reach as many kids as possible.*

Whether she was learning about society, physics, teaching methods, or technology, Diane has been pleased with the programs offered by the district, and she "would encourage all teachers" to make use of such opportunities.

Major Themes in Diane's Case

Teacher Beliefs

You might think, after reading so far about Diane's enthusiastic work with this mixed-ability class, that she agrees with the way her students were grouped for their physics instruction. Actually, she has some very serious reservations about it.

> *I really do believe, after this year only—because after going through it—I think we would have more success if we did ability-group the kids. I think the kids would have more success. I think they get discouraged because maybe somebody else next to them gets it, and they don't get it. And the thing I really, really see with this particular class especially, is that if they don't understand something, they shut down and they don't try. They just shut down and quit. And I think that if they were in a class where it wasn't quite such a variety, I think they would experience some success.*

She believes the grouping should be done according to math ability, since physics depends so much on mathematics skills.

> *In an ideal world, if we could separate them by their math ability in physics, they probably would get a better education, because they could go faster, and learn more.*

She feels that the students with better understanding would face less boredom, while the students who struggle with the concepts could slow down and better deal with the challenge, rather than giving in to a hopeless frustration.

She recognizes that her school district is already dividing students into three levels of physics, and she thinks the levels at both ends of the spectrum are appropriate and doing well. It's the middle group, she believes, that has an ability range that is so wide that it can limit student success. Her recommendation is that there should be four levels of physics offered to meet the needs of the students.

> *I do think they need an Honors, because there's a lot of kids that get very bored quickly, and the Honors is excellent for them. [pause] And then I think they should have a regular, math-based physics, so that these are the kids that will go to college and they will understand the math behind the physics, if they take a physics class in college. Then, in my opinion, they should offer a Conceptual class, not very much math—I mean, you can <u>have</u> the math, because basically physics is not physics unless it's math, because that's what explains it. And it doesn't have to be <u>complicated</u> math. It can be something that's very basic. It can be something where you take your time and explain it. It's something where you go over and over and over again. [pause] There should be a [fundamentals level], because they have special problems that need to be addressed, and they can meet them there.*

In Diane's mind, it might have been better for this group of students if this "regular" level might have been divided into a more math-based group (for those headed toward college) and a "conceptual" group that would develop physics understandings to prepare them for technical training or for life in general, whether or not college might be in their plans.

She proceeded to lead me through her class list, commenting about how each of her students would have fit into her recommended levels. She found four who would have met the prerequisites for the honors level, but she hesitated to say they all would have been successful there, citing family issues or personal problems that might hold them back. Likewise, she pointed out a number of students who she felt might benefit from a less-frustrating conceptual course that could slow down and allow more explanation and practice. In most of those cases, however, she also pointed out personal issues—not academic ones—as the major obstacles in the prospects of success.

> *...she has two children…*
>
> *...basically he's bright, but lazy…*
>
> *...the skipping actually had to do with a boyfriend…*
>
> *...she's having a lot of problems right now at home, a lot, a lot of problems, so I'm not even sure she'll finish school…*
>
> *...language is another issue with him…*
>
> *...in fact, there's three in this particular class that were suspended the same five days for fighting…*
>
> *...she was just in a really, really bad car accident—they don't think she's going to come back to school this year…*

Whether or not Diane agrees with the district's plan for teaching physics, it is clear that she knows her students personally, and she cares about their best interests.

Student-centered

There is sadness in her voice when Diane talks of her own high school and college experiences with teachers who were less than encouraging. In fact, she says that some instructors taught courses in which "the whole purpose was to weed people out of the program." She does not want to be a negative influence on her students. Nevertheless, she does accept the fact that some of her students are not pleased with the new district requirement that they must pass physics in order to graduate. Given the option, many of her students would not have enrolled in her class. "Oh, heavens, no!" she laughs freely, "and they're very vocal about that at the beginning of the year—you know, they're here because they *have* to be!" Still, Diane has their best interests at heart.

> *I know they've been forced to take it, but I look back at my high school and I had to take one year of science. And I think, in all honesty, I lost out on a lot of things I could have learned when I was in high school, that I didn't get because I made the choice—but I don't think I was old enough to make that choice. I don't think it was a wise choice on my part. But I do think that they can walk away learning some good things! It's amazing to me how many kids—especially, like in an ice storm—they're all coming in and go, "Boy, now I see what friction's all about!" You know, and we talked about it and talked about it, and showed examples, but when they see it in the real world, they say, "Okay, I can take this information and apply it to the real world," because it really does apply. It does—there's so much physics around us.*

Adapting to Needs

Diane really believes that physics understandings can improve life for her students. How to motivate them, however, so that they can reap the benefits is a problem: "That's not easy, because you have to do oral, you have to do written, you have to do visual, you have to have labs." Additional planning and preparation are necessary to offer variety, quality, challenge, and excitement. Interestingly, however, the presence of such diverse needs actually becomes a solution to meet other needs.

> *I really, truly believe in human life. We need students to experience a wide range of things. I think they need to have an understanding of the arts, the music, the math, the sciences, the histories, etc. I personally think a well-rounded individual makes a more understanding individual. And I see nothing wrong with students being put in the classroom so they can see kids of different cultures, see children of different abilities. It doesn't make it easy to teach—no, it's much, much harder to teach. But I do think, as a whole, in the long run, I think it's good for kids to experience differences. I think in the long run, it makes them a better human being.*

Concept Development

Diane worries about the students who are not being successful, and she is delighted by those who are. She wants all of her students to finish her course with a better understanding of forces in their natural world. For her, "physics is a big puzzle—conceptual is one aspect of it, math is one aspect of it, labs is another aspect of it—if you make everything put together, it's a good, solid whole." So she makes the instruction relevant and she helps the students grow in comprehension. When she faces the fact that

each of her students comprehends different pieces of the puzzle in different ways, she works with whatever she has.

> *… a lot of times when they are very good in math, they struggle with the concepts. I mean, they can solve the math problem aspects very, very quickly, but sometimes they really just do not understand the conceptual aspects of it. And I find with the lower-level math kids, a lot of times they pick up the conceptual part really quickly, and the math is just a struggle. So my goal is to try to blend for everybody so that they can get some good math skills, get some good conceptual background, and walk away with a nice solid background in physics.*

Chapter Seven: Cross-Case Analysis

It is time to show the respect for diversity that we so easily talk about.

—Nel Noddings (2007, p. 76)

In this chapter I compare the four cases described in the previous chapters. First we will take a look at the similarities and differences in the four teachers' situations, and then we will investigate whether or not the themes in each single case resembled the themes that emerged in the other cases. Finally, I will illuminate the over-arching themes that are supported by the comparison of the four cases.

Comparing Demographics

Each one of these four teachers experienced a heterogeneous secondary science class in unique ways. All of these classes were required by this urban school district, but each case represented a different grade level, specific course content, and various student combinations. Moreover, each teacher worked with a group of students that included an incredible range of backgrounds and skills. Table 7.1 (on the following page) summarizes the demographics for the four cases and demonstrates the complexity of the diversity facing each of these teachers. For all of the classes, students were traveling from many disparate parts of the city. All four of these schools served the same metropolitan area, but each school in the study drew its student population from no less than nine different zip codes. (You can imagine the lines of school buses every morning and afternoon!) While the students were coming from many areas of the city, it is critical to note that the majority of students in each of these four classes were members of low-

income families, as verified by the percentage of students who qualified for free or reduced-price lunch.

Table 7.1: Comparison of student demographics in four cases

	Angela	**Barbara**	**Charles**	**Diane**
Grade Level	8	9	10	11
Subject	Integrated Science	Biology	Chemistry	Physics
Class Size	23	25	29	27
% Caucasian	30	52	28	33
% African-Am	57	12	31	41
% Latino	9	32	41	22
% Female	39	56	34	52
Age Spread	1.8 years	4.5 years	4.4 years	4.4 years
# of Zip Codes	9	9	12	13
% Free/R Lunch	69	52	79	59
% ELL	9	16	16	11
% Special Education	30	12	0	0
% Gifted	4 (N=1)	4 (N=1)	0	4 (N=1)
GPA Range	0.19-3.56	0.19-4.00	0.15-3.37	0.34-3.57
CAT Read Range	2-81 (NP)	2-72 (NP)	4-72 (NP)	10-96 (NP)
CAT Read Median	26 (NP)	38 (NP)	36 (NP)	54 (NP)
CAT Math Range	5-91 (NP)	4-91 (NP)	4-67 (NP)	12-96 (NP)
CAT Math Median	29 (NP)	44 (NP)	36 (NP)	56 (NP)
% Proficient in Algebra CRT	-	8 (N=2)	10 (N=3)	41 (N=11)
TCS Range	61-129 (141)	58-130 (141)	65-108 (141)	72-133 (141)
TCS Median	93	92	90	97
Attendance Range	51%-98%	55%-100%	27%-98%	79%-97%
Attendance Median	92%	91%	90%	92%

All of the classes included a few students who were learning the English language (ELL). But the most critical factor for these four science teachers was that they all were teaching a heterogeneous mix of students regarding previous overall academic success, as shown by their GPA (Grade Point Average). The reading CAT (California Achievement Test), which all of these students took while in the 8th grade, indicated that many of these students struggled greatly in reading. With the exception of Diane's 11th grade physics

class, the median CAT score for reading was well below the national average. The CAT results for math followed the same pattern. In fact, only in the physics section was the median score above the 50th percentile. Even so, in a physics class that essentially depends on algebra skills, less than half of the students had already demonstrated CRT (Criterion Referenced Test) proficiency on at least seven of the nine district algebra standards before entering the physics course.

While these data reveal that some of these students could barely read English or understand mathematics, the table also shows that some of the extremes of ability had already been skimmed away from the top and bottom of these classes in grades 9-11, for which the district offered both an Honors level and a Fundamentals level to better meet the needs of certain students. As a result, there was no more than one "gifted" student in each of these classes, and there were no special education students at all remaining in the chemistry and physics cases. Indeed, the school district recognized the diverse needs of students and had already established three different levels of coursework to attain the same required science standards. Nevertheless, the table clearly verifies that a tremendous range of abilities was still present in every one of these cases at the "regular" level. The range of scores on the TCS (Test of Cognitive Skills), which measures aptitude for thinking, reasoning, and remembering, emphasizes the challenge facing these teachers as they attempted to bring science understandings to a group of students who were not similar in basic skills.

Even the student attendance patterns add to the heterogeneous mix, as Table 7.1 points out that some students are present in the room for instruction less often than other students. While varied attendance should be expected among any group of students in

any classroom, when the teacher is already facing so much need for individual attention, the added burden of re-teaching lessons and compensating for lost time cannot make the teacher's job any easier.

Considering the national movement to implement new curriculum expectations and assessments, it should come as no surprise to find such a wide range of student needs in a heterogeneous classroom. Linda Darling-Hammond pointed out:

> *Teachers are also being asked to achieve these goals for all children, not just the 10-20 percent traditionally siphoned off into gifted and talented programs or honors courses. Furthermore, students have more extensive needs: as education becomes more important to life success and schools both expand the range of students they educate and include more of them in "regular" classrooms, teachers encounter more students with learning differences and disabilities; with language learning needs; and with difficult family circumstances, from acute poverty, homelessness, unemployment, and lack of medical care to violence, abuse, and abandonment. (2006, p. 4)*

How can a science teacher effectively work with such a range of students?

Research Questions

Table 7.2 (on the following page) condenses *etic* data (the kinds of information which I, as researcher, wanted to find out) regarding these teachers' experiences in these heterogeneous science classrooms. First of all, the table shows that none of these teachers had even encountered racial diversity in classrooms during their own upbringing. None of the four teachers grew up in a large city. All of them began their education in predominately white schools. Their first real exposure to racial diversity was provided by

Table 7.2: Comparison of selected descriptors in *etic* themes

	Angela	**Barbara**	**Charles**	**Diane**
Years of Teaching	2	29	4	13
Background	• Small, Caucasian town • Inclined toward Art • University studies led to science teaching	• Catholic elementary school • Inclined toward Math • College professors led her to science teaching	• Small town • Father was role model for science • High school teachers affected choice to become a teacher	• Father and aunt were educators • Encouraged by high school English teachers • Chemistry in college turned her to science
Observer's view	• 8th grade Integrated Science • Student work displayed • Lively posters about course content • Active students and varied plan • Co-teacher	• 9th grade biology • Highly organized • Student work displayed • Inspirational posters • Students are mobile and engaged	• 10th grade chemistry • Neat and orderly room • Students seated at lab tables • Teacher directs review of vocabulary and concepts for an upcoming test	• 11th grade physics • Renovated classroom serving as lab • Interactive discussion based on PowerPoint • Students do worksheets
Teacher's view of own class	• Special education students need extra time and effort • High achievers are bored	• Diversity is a challenge • Stimulated by student needs • Anticipates success and plans for it	• Mix of abilities is detrimental • College-bound students cannot cover enough • Too many of the rest will fail	• Diverse math backgrounds makes physics class difficult. • Students are really learning physics
Strategies for Success	• Develops personal connections • Makes curriculum relevant • Uses cooperative learning • Plans with middle-level team • Collaborates with co-teacher • Seeks help from veteran teachers	• Identifies learning goals • Knows her students • Gives students options • Clarifies expectations • Assesses understanding • Seeks professional and administrative support • Holds students as top priority	• Decides what concepts to cover • Expands his own understanding of the concepts • Follows a routine in lessons • Pushes students to practice, review and repeat • Wants 80% of his students to pass the course	• Learns student backgrounds • Diversifies instruction • Empathizes with students and their needs • Monitors comprehension • Gives personal encouragement • Communicates with parents • Seeks professional development

their college experiences and pre-service training. But the cultural adaptations would be just the beginning; it was the diversity of academic backgrounds and wide range of abilities that these teachers also needed to address. When students enter any classroom, it is essential that the teacher find out what those students already know, discover their misconceptions, and help them comprehend new ideas and information (Bransford *et al.*, 1999, p. 229). But when the students are so spread out with their background knowledge and understandings, how can the teacher get the job done?

Table 7.2 provides a glimpse into the classrooms of the four teachers to see how they sought solutions. Each of them created a learning environment and used their own personal strengths to develop a unique style of teaching. Angela and Barbara displayed personal information and/or work of the students, whereas Charles and Diane maintained classrooms that were focused mainly on the subject matter. The two classrooms that displayed student work were also the two classes in which students actively moved throughout the room and were given options for participation. In the classrooms of Charles and Diane, students remained at their lab tables for most of the period when I was present for observations. Each teacher, in his or her own way, took the time to make the classroom a welcoming place, by greeting them at the door, by displaying student photos and work, and by showing concern for their progress. Nevertheless, each teacher had to face the fact that some of their students were reluctant or unable to come to school regularly.

Attendance issues aside, the daily challenges in a mixed-ability science classroom create an arduous responsibility for a science teacher, and these teachers' responses to the situation varied. Barbara was excited by the challenge, Diane was thoughtfully resigned

to doing what needed to be done, Angela seemed threatened by the hardships, and Charles was adamantly opposed to the mandate that college-bound students be taught science in the same class with students who may not be capable of college success. The varied methods employed by the four teachers mirrored their own attitudes about the students in their classes.

The Teachers Speak

Table 7.3 (on the following page) highlights selections of the teachers' words. Direct quotations are arranged by the *emic* themes that emerged from the teachers' own voices in their cases. Quotations in bold type represent themes that stood out most strongly in each of the four cases, but the table also compares quotations for each theme even if that was not a major theme in a particular teacher's case. This allows the reader to better compare the perspectives and the experiences of the four teachers.

As we look through Table 7.3, we see that the "teacher beliefs" of Barbara, Charles and Diane emerged in the coding as a major theme for them, while in Angela's case there were other themes that stood out even more than that one did. Nevertheless, all four of the teachers made statements that expressed their strong opinions. The table offers only one selection of such a statement, and yet all of the statements examined together spark new insights into the experiences of these teachers. For example, the second theme (view of students) evolved from the codes regarding each teacher's student-centeredness. Angela, Barbara and Diane all expressed deep personal concern about their students, and this emerged as a major theme in each of their cases. In the case of Charles, however, the coding did not bring out the same kind of emphasis. He spoke with conviction about his real concerns for the students, but those concerns were more

Table 7.3: Comparison of teachers' voices in *emic* themes

	Angela	**Barbara**	**Charles**	**Diane**
Teacher Beliefs	Considering the differences, whether it be gender or race, it wasn't the right mix of higher-level, lower-level students.	**You work with what you've got. I mean, parents send their best, and I became a teacher for this kind of a challenge.**	**You can teach to the middle of the road, and you can still lose the bottom quarter and the top quarter.**	**If it doesn't help the kids, what are we here for?**
View of students	**Just show interest in who they are as a whole person, rather than just who are they in my classroom and what do they know about science.**	**This all goes back to working with your kids one-on-one, knowing what they need, having them be able to tell you what they need.**	It seems like you're just throwing a kid that's already struggling or failed into a no-win situation.	**I like the concern they [the administrators] show that they also worry about <u>every</u> student trying to make it.**
Concept Development	**They probably can get the concept if it is given to them in a different manner.**	**I can break that down to each day, and just let them know what to expect.**	I kind of follow three phases with the students, with every lesson that I teach.	**These students are learning new ways of thinking.**
Assessment	**I think success for a student comes on so many different levels.**	There are many criteria that I use to decide if they were successful.	I still use that kind of diagnostic teaching style.	I try to look at each individual student, to see how far <u>they</u> individually have progressed.
Adapting to Needs	The chance to have a team dialogue about what's working with individual students is helpful.	Their whole life, they need to be able to tell people what they need to succeed.	There's a lot of decision-making going on, on what to sacrifice and what to cover.	**You definitely cannot be stuck in a rut, doing the same thing every day, or all the time.**
Achievement Levels	More of my time is spent off of those advanced learners, and onto my struggling learners.	If the kids want to learn, they're going to learn.	**You've got kids with above average abilities, grouped in with kids at the other end of the spectrum.**	It's amazing, you get the kids that are low, low level math all the way up to calculus.
Student Behavior	How can we get the behavior part under control, so that we can take the learning to another level?	**I never deal with discipline during class time.**	**They get bored, and can start becoming behavior problems.**	The discipline aspect, in all honesty, is with the student who has given up.
Teacher Frustration	**I want to slow it down for them, but I also want to keep moving along.**	It's hard to keep the gifted challenged and not discourage the slower students when you're working here.	**Just getting them to try and memorize simple facts is a very, very hard thing to do.**	Are we giving these kids a good, quality physics education, that they can take to college?

tied to the curriculum issues and were less personal than the statements made by the other participants in this study.

In a similar pattern, the analysis exposed stronger patterns of "concept development" in the cases of Angela, Barbara and Diane. They spent more time in the interviews and observations relaying their intentions to assist the students to create new understanding, whereas the case of Charles highlighted other themes with more intensity. One such theme for Charles was "achievement levels." He expounded on the difficulties of working with such a broad mix of student backgrounds and abilities in a chemistry course which has such specific demands on the students' participation. In fact, the coding also ranked "teacher frustration" as one of the major themes for Charles, mostly related to the difficulties of combining students having different achievement levels. Angela's case, likewise, produced "teacher frustration" as a major theme, and her feelings, like those of Charles, were centered on the nearly-impossible demand that they be successful with this heterogeneous mix of students.

The challenge facing science teachers when the students are so diverse naturally leads to concerns about behavior. Table 7.3 indicates that Barbara and Charles both concentrated to a high degree on student behavior in their cases. However, that does not mean that the two of them used the same approach or held the same convictions while doing so. Charles often referred to discipline matters in terms of how they were influenced by the mix of students, whereas Barbara was more likely to discuss student discipline in terms of how her lessons plans and teaching routines could be designed to minimize student disruptions.

As I studied the experiences of the four teachers, I found myself struggling to extract meaning from the comparisons. Were there clues about whether the school district had made the right decisions in their new science requirements? Could I find evidence to support the reduction in tracking and the inclusion of so many students in science courses once reserved for those who had passed all of the prerequisites? Could my data reinforce the hope that requiring secondary science for groups of varied academic backgrounds and interests would reduce the achievement gaps among students?

At the same time that I was searching for clarity in my research notes, my personal life took a dramatic turn. I had used a sabbatical leave of absence in order to design my study and collect data. Now that it was time to analyze the results, I also returned to teaching. Although I had already been a science teacher for 25 years in one of the district's middle schools, I had more recently served for three years as curriculum specialist in a high school, followed by three more years in the central office as science supervisor. So now I was returning to the classroom, hoping to complete my career working directly with students in the setting that I considered to be my true vocation. But seven years out of the classroom, away from the daily routines of teaching, had taken its toll. I faltered. I could not figure out what was wrong. Kerdeman (2003, p. 209) explains such experiences as she refers to the concept of being "pulled up short." Her discussion of self-understanding and decision-making reminds us that how we see our students and the world around us depends on who we think we are and where we think we are going:

> *In sum, lived understanding is pre-reflective practical know-how, intimately tied to self-knowledge and moral orientation. Lived understanding is not an*

> *achievement or state of mind we regulate and produce. Lived understanding signifies the existential condition of being human. To understand is to be at home, to feel we belong in our surroundings. (Kerdeman, 2003, p. 209)*

But I did not feel like I belonged in my new school. As the district's science magnet center, it should have been the ideal laboratory for living out my research. I was assigned to teach two different courses, one an honors biology course for the 8th graders who had demonstrated above-average academic achievement in their previous grade, and the other a general science course for the remainder of the 8th graders. What a fortuitous opportunity to study issues of tracking in science. What an ideal lens through which I could analyze my research data.

So why was I struggling? I was certainly not a rookie teacher. I had all of my years of teaching to prepare me, as well as the invaluable experiences of my doctoral coursework, my leadership in professional development activities, and even the insights that were emerging from my own research with the four outstanding teachers in my study. I knew the science content and I was familiar with best practices in teaching. I had a plethora of tools at my disposal, and I felt I ought to be ready to use them. Kerdeman (2003, p. 209) proposed that "a degree of tension always exists between what we believe, see, and hope and that which happens despite our expectations and preparations." But she explains that when a person is "pulled up short," he or she is caught off-guard and loses one's sense of security and control as one's level of "know-how" is being challenged. And I certainly felt challenged.

The feeling of being out of place kept me searching for information about how to teach effectively in urban schools. I wanted to find out why I was not making a

productive connection with my students. Lisa Delpit (1995) had written about the way teachers from the dominant culture often misdiagnose the needs and potential of students of color. Although I had worked in this school district since 1972, this was my first assignment in a school that was predominately African-American. Was it possible that my own unrecognized biases might be affecting the performance of my students? Could it be that my own feeling of not belonging was due to the way I was projecting myself? Herbert Kohl suggested that communication is a key.

> *New teachers, if they do not come from communities that are similar to those they teach in, are particularly vulnerable to miscommunication. The students do not yet know or understand their teachers' style of talking. The teachers don't know how they are being heard. There is a lot of literature about learning style but not enough about teaching language and styles. The presentation of self in the classroom is a major part of the effectiveness of connecting with students and enhancing their learning. (Kohl, 2002, p. 151)*

Granted, I was not a new teacher. But I was definitely new to this building and its community. As I stumbled along during the first few months, some of my students started to call me "Professor." No one had ever done that before. I naively took it as a signal that they were recognizing my wisdom and expertise. It took me a while to figure out that they meant they just did not understand my vocabulary and style of speaking. Likewise, when some of the students started calling me "Pops," I mistook it as a term of admiration, in the same way that I treasure the way my grandchildren call me "Gramps." Only later did I discover that the term "Pops" was more a reflection on how I represented a different and antiquated generation that was showing little promise of understanding

these 21st century 8th graders. They simply could not identify with this aging, nerdy white guy. Without an inclination to make a real connection with me, the students were not likely to consider my classroom to be an inviting or fun place. (Delpit, 2002, p. 39) Recognizing this, I made more deliberate efforts to allow my students to get to know my real identity, my background, my family and my intentions to guide them as they would build understandings about the wonders of the biological world. Likewise, I reinvigorated my attempts to get to know my students more personally, to learn about their hopes and dreams, and to reduce the impression that I was a stranger.

While my personal drama was unfolding at my middle school, I detected a new way of visualizing the codes of my research. My repeated examination of the four teachers' voices now prompted me to propose three over-arching themes for this multiple-case study: a sense of belonging, the teacher's focus, and successful learning.

A Sense of Belonging

One way of looking at this theme is through the teacher's description of how it feels to be in that place. Another vantage point is created by hearing what they say about whether or not the students belong there. This was Angela's first teaching position, and right away she detected a feeling of being out of place (see Table 7.4 on the following page): "Some of my students didn't know how to relate to me, particularly those that were not the same race as I." She described how "shocking" it was to have students complain to her that "you don't know where I come from." As hard as such statements hit her, she came to realize: "Well, I really *don't* know where you come from—but I *want* to know, if you want to tell me." And so she went about establishing relationships, not only with her students, but also with her peers because she wanted to "associate myself

Table 7.4: Comparison of over-arching themes

	Angela	**Barbara**	**Charles**	**Diane**
A Sense of Belonging as Teacher	When I came I didn't know if I felt out of place, but I felt that other people felt that I was out of place.	God led me here.	I was from a pretty small town, so it was kind of scary, for me, the idea of teaching in a large school.	I actually enjoy a larger high school more. I enjoy the diversity of the school I'm at very much.
A Sense of Belonging regarding the Students	I really want to be able to help those that are above and beyond, but they're just waiting and they're wanting.	This all goes back to working—knowing your kids individually—working with your kids one-on-one, knowing what they need, having them be able to tell you what they need.	Pacing is a huge issue. And then the other thing that I always find myself constantly making the decision on, is when to pull the plug and leave kids behind. Constantly making that decision.	[These two students], they *should* be in a Fundamentals class. They don't have the ability. They really, really struggle to do the very, very basic.
The Teacher's Focus	My primary focus in the classroom is, first, the student. Really getting to know the student, both academically and on a personal level, getting to know what interests them and how can I speak to them as they enter the room, getting them to really feel welcome. They really feel that I know who they are and where they're coming from.	I think you need to tell kids what you need, but you also need to tell them what you *don't* need. So you need to tell them this is the "yes" behaviors and this is the "no" behaviors. You know, just be very, very clear. I'm trying to teach them to tell me what *they* need, so I need to tell them what *I* need also, in order for this to be successful and work.	They [good teachers] can approach it [content] from *any* direction and *every* direction, and the folks that truly understand it—the good teachers—they can break it down into such simple terms that anybody can understand it.	I still want to have high expectations, though, because I really believe—as long as *they* keep trying and *I* keep trying—we can do it. And we can do it very well. I just know that with the regular kids that I'm seeing this year especially, it just takes longer.
Successful Learning	If you're accustomed to succeeding, you're going to strive to succeed. And if you're accustomed to *not* succeeding, you're going to live up to that standard as well, unless someone puts opportunities in front of you, puts a comfortable situation in front of you, and puts some actual beliefs in front of you, that you can change that pattern.	I guess I walk in with a whole philosophy that every student is successful. I need to figure out to what degree, and how far, *how* are they successful, and to what degree can I make them *more* successful.	My target is to get 80%, personally. What I'm aiming for and what I actually get are two different deals. I'm aiming for 80%. If I can get 80%, I would do a dance. I would just be absolutely thrilled, with my past experiences.	Well, at the beginning of the year, they couldn't do it, they failed. But they *kept trying*. And now—I have one young man in that class who comes to mind—he's got a B, and at the beginning of the year he was ready to drop the class, but they wouldn't let him. So he's come so far, because he kept trying.

with a group of science teachers who I knew I could learn from." She developed a stronger sense of belonging in that place as time progressed.

But for her students in the mixed-ability classroom, it started to become clear to Angela that some of her students would be in a better place if they were no longer in this class. One student in particular seemed to be diminishing his participation because he could not be stimulated by his classmates as much as he could if he were "in a higher-functioning class." (Students, as well as teachers, can be pulled up short.) She believed that her energy was directed so much on "lower-level" and "middle-level" learners, as well as on "behaviorally challenged" students, that she was neglecting the needs of students at the other end of the academic spectrum. She eventually succeeded in removing this young man from her class.

When Barbara first started teaching in this school district, the daily drive to a different community felt "foreign" to her, like "rocketing off to a different planet." And yet she cultivated a sense of belonging that she saw as a spiritual vocation. She belonged with her students, and they belonged with her, she believed. Nevertheless, she examined each student's place in this mixed-ability classroom. One student, for example, whose medical history had caused him to miss much school through his life, was a 17-year-old freshman. She got permission from her administrators to test him, find out that he already understood the concepts of the biology standards, and move him to another class that would better serve his needs. On the other hand, she had another student about whom she felt "I was starting to lose her—she was feeling she couldn't do it." Barbara described her as "a very nice girl, works hard," but Barbara decided that the Fundamentals Biology class would be a better place for this particular student.

Charles, like the others, grew up in a smaller community. The decision to teach in an inner-city school in a large school district was not an easy one. He gave it careful consideration, and then nervously accepted the position. Lo and behold, after he "signed on the dotted line, and have been teaching ever since, [I] fell in love with it—fell in love with the people." Not that it was a seamless adjustment: "It was an eye-opener, it really was." Once in a while a student might label him as a racist, and "that part's hard to swallow, and that makes you really uncomfortable." In the meantime, he discovered that many of his students did not really belong in this mixed-ability classroom. For example, he speculated that all of the students who failed during the first semester of the course would be in a much better place if they were removed from this class for second semester.

> *And a student that doesn't pass first semester, if you look at him—we haven't done any actual numbers, but just a gut feeling that you get—is that the kids who don't pass first semester <u>really</u> get into trouble second semester. Because second semester, when you start getting to things like the gas laws, and the reaction kinetics, and things like that, they're already weak in that background information. And then when you start into that second semester stuff, it just really starts getting extremely overwhelming.*

Charles stressed that the very concept of teaching to a wide range of academic backgrounds puts students at both ends of the spectrum into a place where they just don't fit. He reiterated that teachers "teach to the middle," and students at both extremes get left out in such a class.

Diane, on the other hand, said, "I see nothing wrong with students being put in the classroom so they can see kids of different cultures, see children of different abilities." In fact, Diane appeared to delight in the diversity: "I just enjoy listening to it as they walk in the door." She felt she was in the right place for her, and yet she still recognized that the mix of abilities did make it harder for her to teach physics. But she acknowledged that even when there were prerequisites for the students to take physics, she still had to re-teach the basic skills and content because even if they had it before, "they don't always retain it." And some of her students just didn't seem to have enough ability at all. But rather than complain or request a schedule change for them, she persevered in searching for ways to make them feel welcome.

The Teacher's Focus

This brings us to the second over-arching theme. How do teachers do the job of teaching the students who have such varied needs? What becomes their primary focus? Angela, the teacher with the least experience, feels at times that she just does not have enough tools for helping the students, so she searches high and low to find new information. She wants to know all about her students, and she wants to discover teaching strategies that will help all of them to learn the skills they need: "I do the best I can, but it takes a lot of time to pull all of those things together, and to find things that work." She has found success with cooperative learning, and uses opportunities to communicate face-to-face whenever she can.

> *I think the focus in my room—taking away from large group lecture format to either individual, or small-group based activities—allows me to interact with the kids more on a level where I can see "Are they understanding a particular*

concept?" because I'm not addressing a whole group, I'm addressing individual or small-group situations.

Barbara believes "there's always a way to make things happen if you want them to happen," so she goes about her teaching with a focus on the needs of each student. She really wants to make it happen: "You just expect your child to succeed." Yet, as I have already emphasized, she does everything possible to *make* it happen. "I don't believe in throwing any kid away," she says, so "I'm very disciplined and structured with my kids, and I think kids *like* structure, they like discipline, they like to know what's expected." She sets them up for success by teaching organization, by making the environment comfortable for them, by modeling expected behaviors, by building communities, by giving responsibility, by allowing mistakes. She makes their education personal. Again, like I already stated, she sets them up: "I do believe there needs to be someone who lights that match, gets them going, and eventually they'll do so well that they'll go themselves."

Charles has a passion for science. His classroom is focused on the curriculum. He wants to learn the material himself "100%, without a doubt" so that he can "explain it a million different ways, from a million different directions." When he encounters a student having difficulties grasping a concept, he wants to apply the concept to a situation the student might be familiar with: "With the Iraq war going on right now, in physics they're talking about tank-killing bombs and armor-piercing, and things like that—lots of great physics lessons in there." He wants to find successful methods to help the students make connections with the content, but most important for Charles is to give the students as much repetitive contact with the material as possible. He depends on "classic worksheets," practice problems out of the book, daily quizzes, "and just raw repetition."

At least, he says, “I don’t have to work particularly any harder” with a mixed-ability chemistry class, since the students are “always going slower than I thought” and the lesson plans last several days longer than anticipated.

Diane, on the other hand, teaching the mixed-ability physics class, finds the work load quite demanding: “This is not a forty-hour per week job.” She firmly believes that “if I didn’t spend all day Saturday—or the majority of my Saturday—working, I wouldn’t make it to the next week.” She wants her students to know that she cares deeply about them and their learning. She wants them to know she cares that they do their assignments, “and not only *care* that they do it, I want them to do it *correctly*, so they have an understanding of it.” It’s quite a challenge to reach many of them, but she says that she herself did not find math and science easy, so she relates to their predicament and keeps giving support. Even if a student fails the first semester of her class, she encourages them and tells them, “Maybe you didn’t quite succeed the first semester, but look at the skills you *did* learn—let’s build on those skills so we can succeed the second semester.”

Successful Learning

The final over-arching theme compares how the teachers perceive the success of their students. How productive were they in teaching science to their students? Angela sets high expectations for herself, on a personal level, as she explains that “my own idea for success has been an A, because that’s what I’m accustomed to.” However, she is reluctant to use a stringent criterion for labeling her students as successful or not: “It’s hard to put a percentage on it, though, [pause] you have to look at the kids.” Angela uses a wide variety of assessment tools and techniques, monitoring how her students are doing

Table 7.5: Comparison of final course-mark distribution by semester

	Angela		**Barbara**		**Charles**		**Diane**	
Class Size	23		25		29		27	
	1st Sem – 2nd Sem		1st Sem – 2nd Sem		1st Sem – 2nd Sem		1st Sem – 2nd Sem	
A's	2	2	3	4	0	0	2	6
B's	4	1	3	3	5	3	4	8
C's	4	8	2	2	6	2	9	4
D's	6	0	9	5	7	10	7	0
F's	7	4	1	2	11	7	5	4
New / Drop	-	8	7	9	-	7	-	5

"socially, academically, behaviorally." She wants to be able to commend them for "making gains," no matter what final course mark shows up on the report card. Table 7.5 compares the distribution of final course marks in all of the classes.

Barbara conducts her classroom with the philosophy that "you just have to truly believe that they are going to be successful in this class, and I'm going to help them be successful. She sets a goal for all students to earn an A or a B, and then she goes about her business of identifying strengths and weaknesses in order to lead them as close to that goal as possible. She uses "all kind of assessments" to discover what they need, and employs "a variety of tricks and a variety of learning styles to hit every one of those kids." When it is all said and done, not all of the students earn the A or B. But Barbara knows that all of her students were given the opportunity to grow while they were in her class.

Charles finds the mixed-ability nature of his chemistry class as a detriment to success for a lot of his students. Some of the students at "that upper-end range, they kind of take care of themselves, and they're gonna get an A no matter what—it's just a matter of keeping them engaged." But it's a different story for others in the class: "So you know with your lower-end kids, and that math situation, the highest grade that I'd expect

success for them is going to be in that D range, just barely squeaking by." Students' own low expectations for themselves become a barrier. For example, Charles has a student who "was absolutely convinced that there was no way in heck that she could pass chemistry, and there was nothing anybody could do about it." He worked with her through the year, and now "she's done her work and she listens in class and she's pulling about an 80%." He notes that "she's about a C student—for her that's success."

Diane does not want to judge all of her students by the same criteria, instead choosing to "try to look at each individual student, to see how far they individually have progressed." With the mix of abilities in the class, she finds that some of the students excel at the math calculations, while others in the class are better at conceptual understanding of the ideas. The presence of varied strengths adds to the quality of the discussion and student interaction as they all struggle through the course. She points out that "especially at the beginning of the year, there's a lot of kids [who say] 'I don't know what to do,' they feel very uncomfortable." Diane enjoys bringing them to new levels of understanding as they make "a huge, huge leap from nowhere in being able to think and solve problems." I asked Diane directly if—even with a wide range of backgrounds and abilities in the class—most of her students come out of the course with more physics ability than when they came in. Her response was immediate and punctuated with laughing: "Oh, I can *definitely* say that!"

Chapter Eight: Conclusion

Sometimes it is good to straddle the fence—you can climb up there and get a much better view of both sides.

—author unknown

Facing a Predicament

The science educators of our country are caught between the ideals of mandated achievement equity and the reality of limited instructional resources. On one hand, we see persistent achievement gaps which verify that certain members of our population have been denied adequate access to science education (Calabrese Barton, 2007; Lee & Luykx, 2007; Scantlebury & Baker, 2007). On the other hand, teachers encounter new difficulties when they attempt to correct the inequities and provide quality science education for all students (Gao, 2006; Tomsho, 2006).

The board of education of the school district in this study decided to revise the science curriculum in order to provide equal access to the science standards. Every student is obligated to pass biology, chemistry and physics as a requirement for graduation, so that every graduate of the district will meet science entrance requirements for college if they choose to follow that route. One might wonder how many successful adults at this time would have recoiled at such a mandate during their high school years. Recognizing the importance of individual student success, however, the district created three different levels (or "tracks") for addressing the high school science standards. But even after the students with special needs are offered a "fundamentals" version of the required science courses, and the advanced students are skimmed away into "honors"

courses, the middle group of science students embodies an incredible mix of academic backgrounds, goals, interests, and abilities.

Is a uniform mandate the right approach for resolving the inequities in science education? Cuban and Usdan (2003) observed that unintended consequences often follow reform movements in our nation's schools. They studied reforms in Baltimore, Boston, Chicago, Philadelphia, San Diego, and Seattle. Of those, the success of the reforms in San Diego was particularly relevant for this study, because in San Diego the science curriculum took on an entirely new configuration of requirements. As in the district of this study, all students in San Diego were required to pass high school physics for graduation. However, in San Diego, physics was mandated as a ninth-grade class. This physics-first approach assured that all graduates were prepared for college, but it carried with it some unintended consequences, one of which was a decrease in heterogeneity for most of the schools in the district (Darling-Hammond *et al.*, 2005, p. 151). Students became stratified according to reading levels, language proficiency, and achievement scores, resulting in unintended grouping that appeared to separate students by race and socioeconomic status.

Noddings (2005) suggests that the problem actually lies in the mandated rigorous science requirement.

> *From a perspective quite different from mine, some policymakers and educators believe that caring is a pedagogical virtue demonstrated by forcing students to achieve the skills and acquire the knowledge that has been prescribed for them. From this view, a teacher exercises the virtue of caring*

> *by making students do what is thought to be good for them. (Noddings, 2005, p. xiv)*

But is the science requirement really an advantage for the students? She thinks it is not.

> *We seem to have decided that there should be no "non-college-bound" students. Thus youngsters who are not attracted by academic studies are doubly cheated: They are made to feel like failures in the standard academic program, and they are deprived of the courses in which they might do well. (Noddings, 2005, p. xxvi)*

But in San Diego, the resistance to the reform effort came not from the parents of the students who were unable to meet the new rigorous requirement, but rather from the parents and teachers who were concerned about the college-bound students.

> *When San Diego's school district began overhauling its science-education curriculum five years ago, it wanted to raise the performance of minority, low-income and immigrant students. But parents in middle- and upper-income areas, where many students were already doing well, rebelled against the new curriculum, and a course called Active Physics in particular. They called it watered-down science, too skimpy on math. (Tomsho, 2006)*

Ultimately, the San Diego school board voted to do away with the mandate and give students more flexibility in science course work (Gao, 2006). The trustee who proposed the elimination of the mandate wanted students to be placed in science courses in which they have a reasonable chance to pass, saying, "Mandating is not motivating. If you mandate everybody to take it, it probably has a reverse effect on motivation." (Gao, 2006). But which group loses its motivation, the formerly "non-college-bound" that are

not able to master the rigorous requirements, or the "college-bound" who are no longer considered elite since "everyone" has to take the course? In this study, that question takes us back to the three themes that emerged in the cross-case analysis. Whether rigorous science for all is a good thing or a bad thing, it is a reality for the teachers in this study.

A Sense of Belonging: Who Belongs?

We saw in Chapter 7 the range of diversity in the classrooms. We wonder which students really belong in those classes, and which might be better served in other settings. But first, we need to ask what ever happened to the students who traditionally did well in science classes, the formerly so-called "college-bound." Table 8.1 displays the demographics of the three levels of ninth grade biology at Barbara's school. The intent of the "fundamentals" level is to provide extra support for students with special needs to meet the rigorous science requirements. The students in the "honors" level tend to be those more traditionally labeled as "college-bound." The students in the "regular level" of biology include a vast assortment of students from the newly-mandated "all students will be ready for college" group.

Table 8.1: Demographics of Three Levels of 9th Grade Biology at Barbara's School

	Fundamentals Biology 1-2	**Barbara's Class (Biology 1-2)**	**Honors Biology 1-2**
% Caucasian	40	52	68
% African-Am	28	12	10
% Latino	28	32	16
% Female	28	56	52
Age Spread	3.5 years	4.5 years	1.5 years
% Free/R Lunch	72	52	43
% ELL	9	16	1
% Special Education	96	12	3
% Gifted	0	4 (N=1)	25

In tenth grade chemistry, additional perspectives begin to emerge. Table 8.2 compares the demographics of Charles' class to those of the fundamentals and honors levels at his school. It was in this class that Charles feared there were so many students who were bound to fail. Indeed, only 15 of the 29 students in this class earned a passing grade during the semester of this research, and 10 of those had D's. This is hardly an endorsement of the philosophy that all of the students will be ready for college. On the other hand, his school's honors chemistry classes most likely included the traditionally "college-bound" students. The honors level is where Charles would have wanted a child of his own to be enrolled.

Table 8.2: Demographics of Three Levels of 10th Grade Chemistry at Charles' School

	Fundamentals Chemistry 1-2	**Charles' Class (Chemistry 1-2)**	**Honors Chemistry 1-2**
% Caucasian	16	28	62
% African-Am	25	31	10
% Latino	59	41	27
% Female	23	34	67
Age Spread	5.1 years	4.4 years	2.5 years
% Free/R Lunch	70	79	42
% ELL	58	16	0
% Special Education	44	0	0
% Gifted	0	0	31

Table 8.3 (on the following page) compares the demographics of Diane's class to those of the fundamentals and honors levels at her school. All students are enrolled in physics, but the honors level is where the "smart kids" hang out. The lunch data confirm that the honors level is also where the students of higher socio-economic status are found. Indeed, all three of these tables suggest that even when all students are mandated to

master the same science standards, unbalanced racial groupings still appear. And so, the theme of belonging continues to surface. Charles and Diane both expressed that three levels were not enough to serve the needs of the students. What if there were four levels, or five levels, or even more? Who would really belong in each level? How would the decisions of placement be made?

Table 8.3: Demographics of Three Levels of 11th Grade Physics at Diane's School

	Fundamentals Physics 1-2	**Diane's Class (Physics 1-2)**	**Honors Physics 1-2**
% Caucasian	29	33	73
% African-Am	65	41	16
% Latino	6	22	7
% Female	48	52	50
Age Spread	2.4 years	4.4 years	2.6 years
% Free/R Lunch	77	59	15
% ELL	3	11	4
% Special Education	90	0	1
% Gifted	0	4 (N=1)	54

In this district the honors level has prerequisites that determine whether or not a student qualifies for the class. But when students are scheduled into required science courses without prerequisites, such as the regular level, they are put into a difficult situation where success is limited by the students' lack of preparation. Do they belong there? Sagor (2003, p. 7) explains that the feeling of belonging has two elements: comfort and acceptance. He points out that a person is more inclined to feel a sense of belonging when the environment is comfortable. And the feelings of acceptance are dependent on relationships with others:

> *When people find themselves in a place that suits their sense of self and they are engaged with people they like and who enjoy being with them, they*

experience belonging. Conversely, when people are in an environment that appears strange and foreign, it reinforces their sense of being an outsider.

It is interesting to note that all four teachers in this study experienced a sense of being an outsider to some degree as they were inducted to this large urban school district. Angela said, "I didn't know if *I* felt out of place, but I felt that *other people* felt that I was out of place." Barbara described her early drives to school as "I felt like I was rocketing off to a different planet—this was foreign to me." Charles described his first year as "a big eye-opener, it really was." And even Diane, who thrived as she came to the urban district, expressed the need to adapt as she said with a laugh, "Probably the biggest adjustment was the number of papers to grade."

But what about the students? What kind of sense of belonging could they enjoy in these heterogeneous classes? The data show age differences, a range of prior academic achievement, differing attendance patterns, and even a multitude of neighborhood zip codes. All of these demographic data do not even touch on the unique situations of each student's personal life circumstances. With a group of adolescents who are in different places developmentally, what must a science teacher do to help all of the students feel a sense of belonging?

From the teachers' points of view, some of their students truly *did not belong* in the class. Angela saw her heterogeneous class as inappropriate for one of her "higher-level" students who "lost motivation" and "excitement" as he was "I don't want to say *sinking to the level*, but engaging at the same level that his classmates are engaging at now." At the other end of the spectrum, Barbara felt the pace of her heterogeneous class was "too much" for one of her students, and recommended that she move to the

fundamentals level of biology because "I was starting to lose her, because she was feeling she couldn't do it." Genuine concern for their students led these teachers to believe that some of the students belonged elsewhere. Charles, likewise, was worried for the students who were placed in his chemistry course without enough background to succeed: "You're just throwing a kid that's already struggling or failed into a no-win situation."

Bloom's theory of school learning is based on an underlying assumption that the history of the learner is at the core of school learning (Bloom, 1976, p. 13). He believed that it should be theoretically impossible for students to adequately succeed at a learning task if they lack the necessary prerequisites:

> *If true prerequisites are established, then no amount of effort, persuasion, reward, or quality of instruction will enable the learners without these prerequisites to adequately learn the task under consideration. Thus, the prerequisites, or cognitive entry behaviors (for cognitive learning tasks), constitute a necessary link between the learners and the accomplishment of the learning task—they cannot be ignored or omitted if the student is to adequately learn the task. (Bloom, 1976, p. 33)*

And yet Bloom also points out that empirical verification for prerequisites is rare, saying "the determination of what the learners need at the beginning of an entire course or set of learning tasks (e.g., algebra, geometry, physics, first grade reading, introductory Spanish) is more difficult" (Bloom, 1976, p. 37).

The teachers in this case study were faced with classes that had no prerequisites at all, other than grade level in school. Even so, Bloom's theory suggested that most students could still master high levels of learning if given support in the most optimal

conditions of tutoring (Guskey, 2006, p. 118). In other words, the ideal situation would be for the one-on-one instructor to first diagnose whatever cognitive entry skills were lacking at the beginning of the task, and then skillfully modify the entry characteristics of the learner to prepare him/her for the learning task. If all students are to succeed in biology, chemistry and physics before graduating from high school, however, individual tutoring is not a realistic solution. Bloom suggested that nearly all students can succeed, but his challenge was to find methods of group instruction which can accomplish that goal practically, efficiently, and economically (Guskey, 2006, p. 119).

The school district in this study has taken bold steps to meet that challenge, based on the hope that sufficient resources would be available to serve all of its students equitably. At this time, all students are mandated to succeed in biology, chemistry and physics, under the assumption that three different levels of each subject will offer the proper environment for each student to find a sense of comfort and receive the appropriate instruction to master the science standards. But are three levels enough? Looking at the diversity in the middle group, how many more levels are needed to offer each student "the right place"? Short of individual tutoring, how many kinds of group instruction are needed to bring empowering science knowledge to all students?

Noddings proposes that we are asking the wrong question. Even if it *can* be possible for all students to master the science standards, should it be a necessity that they do so?

> *We want every child to succeed, and this has come to mean that every child should be prepared for college and the sort of work that requires a college education. What of all the children who will become bus and truck drivers,*

> *retail sales clerks, appliance repair people, construction workers, material handlers, heavy equipment operators, railway engineers and conductors, house painters, plumbers, bakers, farm workers, beauticians, postal workers, cooks, waiters, hotel clerks, house and office cleaners, auto mechanics and sales people, dog and horse groomers, telephone/electric line workers, prison guards, hospital attendants, grounds keepers, maintenance workers, managers of laundromats and dry cleaning shops, installers of burglar alarms, carpet layers, window washers, steel workers, fishermen, sailors, caterers, cashiers, chimney sweeps, roofers, makers of china and glassware, decorators, musicians , florists, entertainers, moving men …and what would happen to our society if no one were willing to do this work? Do these people represent failures of schooling, or do we fail them when we lead them to believe that only economic success is success? (Noddings, 2003, p. 35)*

As a matter of social justice, what are we doing to meet the real needs of students? Would *more* true tracking, instead of less, allow more flexibility for caring for students?

Oakes and Lipton do not think so. They believe the professional debate over what content is needed for all students, and how to best organize and present that content, "pales in comparison to the fierce political battles over what American students should learn at school, how they should learn it, and why" (Oakes & Lipton, 1999, p. 96). They say it is not surprising that "Americans with wealth, power, leadership, higher education, and so on would want to transfer to their children these elite privileges" (Oakes & Lipton, 1999, p. 98). Americans insist "that everyone have *opportunities* to get the elite education" (Oakes & Lipton, 1999, p. 98). However, America's schools have developed

a pattern of tracking certain students into the elite education and other students into education for the masses. Even in the schools participating in this case study, the honors level classes appear to be a sanctuary for the elite, while the heterogeneous regular level is available for the masses. In addition to intelligence, Oakes and Lipton say, a multitude of criteria are used to sort students into categories:

> *Schools weave multiple behavioral and social constructs, including achievement, creativity, motivation, ability, leadership aspirations, and self-concept, into a complex categorizing web. Other constructs that are not "officially" legitimate in school, but are present nevertheless, are race, gender, sexual orientation, physical attractiveness, social class, and so on. (Oakes & Lipton, 1999, p. 279)*

Opponents of tracking believe that heterogeneous grouping is the answer to solve the achievement gaps created by all of the subjective sorting and door-closing that has been common in American education.

In the meantime, Noddings (2007, p. 3) is opposed to the idea that all students should be required to take the courses once offered to only a few. She asks whether such a requirement, made in the name of equality, actually guarantees equality or ensures greater inequalities, while "brushing aside profound questions about the aims of education and the different needs of different students" (Noddings, 2007, p. 3). Like the fence-sitter that I quoted at the beginning of this chapter, I find myself unable to take a side on the issue, preferring to climb as high on the fence as possible, in order to look both ways to search for the wisdom to know what is best for our nation's students. Where do they belong? For the teachers in this case study, nevertheless, the correctness

of the school board's decision to place students in heterogeneous science classes without prerequisites is a matter for debate at another place and time. These teachers have a job to do in the classroom, and to their great credit they go about doing that job to the best of their abilities on a daily basis.

The Teacher's Focus: Teaching the Mix

The idea of teaching a heterogeneous group of students is a radical notion in itself, according to Sagor (2003). He points out that "modern school systems are built on the expectation of homogeneity" that features grade levels supported by "curricula that have scope and sequence that presume, for example, that all 3rd graders are ready for 3rd grade work and at the end of 3rd grade they will be equipped to do whatever is expected of a 4th grader" (Sagor, 2003, p. 44). It is no wonder, then, that we find Charles so frustrated with the heterogeneity of the students in a class labeled as "10th grade chemistry." The students are assigned under a false assumption of homogeneity. And it becomes the teacher's job to help the heterogeneous students to develop a sense of belonging.

Darling-Hammond (2006) explains that the new demands are legitimate, since our society now expects more of our schools:

> *In the early 1900's, when our current school system was designed, only 5 percent of jobs required specialized knowledge and skill; today about 70 percent are "knowledge work" jobs that demand the ability to acquire and use specialized information, manage nonroutine tasks, and employ advanced technologies. (Darling-Hammond, 2006, p. 4)*

Students are expected "to master more challenging subject matter content, as well as to think critically, create more sophisticated products, and solve complex problems, rather than merely perform routine tasks" (Darling-Hammond, 2006, p. 4). She adds that teachers are being asked "to achieve these goals for *all* children, not just the 10-20 percent traditionally siphoned off into gifted and talented programs or honors courses" (Darling-Hammond, 2006, p. 4).

That brings us to the four teachers in this study. They are all aware of their need to continue to develop subject-matter expertise, in order to develop knowledge-centered environments (Bransford et al., 1999, p. 183). But teaching the mix also needs a direct focus on the students themselves. That's why Barbara keeps asking her students "What do you need?" She expects them to learn and she understands that "there's always a way to make things happen if you want them to happen." Charles knew how important it was to "learn the material—100%, without a doubt—so that you know it and can explain it a million different ways," but he was deeply frustrated when the students refused to learn what he was teaching. Ladson-Billings (2002) warned that teachers cannot stop at that point—students must not be allowed to feel that the teacher has low expectations for them. Sagor (2003) insists that the students must be assisted to feel comfortable in the classroom. But how can they feel welcome and "in the right place" when they simply don't have the background skills needed for the learning task?

The answer to that question comes from the proponents of differentiated instruction (Silver *et al.*, 2001; Strong *et al.*, 1999; Tomlinson, 2000, 2001, 2003; Tomlinson & Doubet, 2005; Winebrenner, 1996, 2000, 2001), who advocate knowing the students personally, finding out their cognitive entry characteristics, and creating a

welcoming environment with varieties of approaches designed to meet the needs of the students in the class. A framework for planning differentiated lessons was proposed by Tomlinson and Strickland (2005, p. 16-18) as their "Essential Principles of Differentiation."

Principle 1: Good curriculum comes first.

Principle 2: All tasks should be respectful of each learner.

Principle 3: When in doubt, teach up!

Principle 4: Use flexible grouping.

Principle 5: Become an assessment junkie.

Principle 6: Grade for growth.

Faced with the challenges of heterogeneous groupings and the expectations of success for all students, teachers need to plan carefully and work harder to make it happen, because, as Diane exclaimed, "the school doesn't want them to quit, and I don't want them to quit."

Successful Learning: Who are the Winners?

Angela was fearful that the heterogeneous mix in her class was "not the right mix of higher-level and lower-level students." She wanted the students in her class to be successful, but during the semester of this study, she found it necessary to "save" the high-achiever by removing him to another class. "I would love to say that mixed-ability classrooms are the way it should be … this is not one case where it is working."

Barbara did not look at the success of the class as a whole, but rather made extraordinary effort to know each student personally: "I need to figure out to what degree they are successful, and to what degree can I make them *more* successful." When

she discovered that a student's needs might be met in another class, she did what she could to facilitate a schedule change. For Barbara, the welfare of each student was always paramount.

Charles was "not completely on board" for the concept of heterogeneous groupings and the requirement that all students have chemistry for graduations. He believed the "cookie cutter" approach to science education would harm students on both ends of the spectrum, with struggling students being forced into a "no-win" situation, while the more capable students would be cheated out of a more rigorous preparation for college. He felt that the final course marks for the semester corroborated his apprehension. While the intention of the school board was to increase college-readiness for all students, his was one class which may have facilitated the opposite result, decreasing the chances for many of its members to even attain graduation from high school.

Diane worked hard to improve the physics skills of her students, and she expressed the opinion that a heterogeneous mix of students was actually beneficial for them. "I personally think a well-rounded individual makes a more understanding individual," she commented, "And I see nothing wrong with students being put in the classroom so they can see kids of different cultures, see children of different abilities." Even so, she still wanted to advocate more levels of physics so that the members of the class might "all get on the same page if at all possible." She did not believe that all students should study physics to the same depth, noting that students planning to major in physics would need a more rigorous, math-based preparation than a student planning to

attend college as a non-science major. Nevertheless, she felt that the mixed-ability physics classroom gave the students "a more well-rounded view of physics."

Overall, the real winners, the true success stories, are yet to be identified. Successful education, whether developing reading skills or mathematics competence or scientific thinking, is meant to prepare students for success in their adult lives. Time will tell how many of the students in these four cases will experience success influenced by these required science classes. But a warning is sounded by Howard (2008, p. 34), when he proposes that all of the attempts to equalize chances for becoming winners will be outweighed by the advantages of existing privilege. If all of the rigorous requirements and standardized testing produce data to "prove" that the achievement gap was justified all along, who will be the winners?

We seem to be caught up in a dangerous competition for data. In this black-or-white, red-or-blue, polarized society, we cry out for equal opportunity for all students, but fail to see that the rules of the game are already established to designate some as winners and some as losers. If all students leave high school with a transcript that says they earned credit in physics, for example, will those transcripts tell the college admissions office that all students are equally prepared for college—or will they tell the college that those transcripts no longer carry value in determining the strength of high school coursework? This multiple case study was not designed to determine whether or not the board of education of this school district made the correct decision in revising its science graduation requirements. Nor was this study able to pass judgment on the value of tracking or detracking. But what the experiences of these teachers did show us is that the title of a course, or a grade on a report card, does not provide the entire story about what

a student learns in a classroom. There are so many variables and so much diversity. What matters more than titles or groupings is whether or not the student is experiencing quality education. Noddings emphasizes that point:

> *Excellence is defined in context. An academic curriculum replete with physics, chemistry, and higher math may or may not be excellent. A commercial curriculum that prepares students directly for business may or may not be excellent. A vocational curriculum may or may not be excellent. The notion that an excellent curriculum for all must be an academic curriculum that prepares students for traditional college work is not a democratic notion, and it degrades the very idea of excellence. It undermines respect for a multitude of human talents and displays frightening lack of appreciation for the rich diversity of occupational life. (Noddings, 2007, p. 51)*

The teachers in this case study were expected to provide quality for all of their students. Rather than get caught up in the political discussions about which side of the fence to work on, they have a professional responsibility to seek support and do their best to educate every one of their students.

Limitations and Future Research

My intentions in this multiple case study were to find out what happens when teachers are assigned to teach required science courses without prerequisites, facing a heterogeneous mix of students. The teachers in this study spoke loudly and clearly about their experiences, describing their frustrations as well as their accomplishments. During the initial stages of planning this study, I had also wanted to include the voices of

students and parents, but I chose to concentrate on the experiences of the classroom teachers. A very interesting future study would be one designed to focus on the students and their parents. While the professionals are still unable to come to consensus about the merits or shortcomings of tracking, the parents and their children are the ones who have the most to gain—or lose—as they push toward life after high school. Their voices need to be heard.

Implications for Teaching Practices

What lessons can we extract from the experiences of the teachers in this study? The three overarching themes offer a framework for possible recommendations. When a science teacher is assigned to bring a mixed-group of students to common levels of understanding, the task may seem overwhelming at first. From the beginning of the course, the teacher must learn who the students are, as individual people, and also decide who belongs and who does not. Having determined whether everyone is in the right place, the teacher then goes about helping the students to feel that sense of belonging. Would the teacher feel comfortable about the prospects of one's own child being enrolled in that class? If the class is not a "good place" to be, then the teacher must find ways to make it a better place. After all, mandates don't force quality to happen—the teacher has the job of shaping the learning environment for the students.

It is now time for the teacher to practice her/his professional skills, remembering at all times that "it's all about the students." Each individual has unique needs, and those special characteristics will certainly impact the instruction in the classroom. It becomes imperative that the teacher "knows their stuff" and communicate their expectations to the students. The teacher becomes a student of the subject matter in order to bring the

understandings to students. The students need support systems, and so do the teachers. The classroom can evolve into a community of learners in which needs are constantly assessed and support is offered in multiple ways when needed.

The ultimate measure of success will be hidden in many indicators. Certainly the grade will matter for pass-fail purposes, as well as for future education decisions. Likewise, the results from standardized tests encountered throughout the rest of the student's life will benefit from successful learning in each course that student has completed. But the real success will be evident if the teacher was able to "stick with" each student, even as he or she would "stick with" a child of one's own, never giving permission to fail. And even though it will still be necessary to accept the "failures" that inevitably do occur, it should always be the goal of the teacher to care enough that each person leaves the course with new understandings, better skills, and meaningful preparation for the next steps of education.

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APPENDICES

Appendix A

INFORMED CONSENT FORM

Mixed-Ability Secondary Science in One Urban School District: A Multiple Case Study

This is a research project to explore the issues facing teachers when students of mixed abilities are scheduled in the same secondary science class. This study is being conducted during the spring semester of 2005 to complete the researcher's requirements for his doctoral dissertation. The Omaha Public School District is not conducting or sponsoring this research project. You are invited to participate because you are teaching a secondary science class for which students were scheduled by grade level, with no prerequisites for ability or past achievement. You were selected for participation in the study because of opinions you were perceived to hold about this issue. If you agree to participate, you will be one of four individuals who will be included in the study.

Participation in this study will require approximately ten hours of your time over the course of spring semester. There will be four semi-structured interviews consisting of open-ended questions. Each interview will take approximately 45 minutes. The interviews will be audio taped and transcribed. You will be asked to review the transcripts for accuracy, and you will also be asked to review the researcher's report periodically throughout the process to provide feedback regarding his data analysis and interpretations. The study will focus on the issues you identify in one of your classes (you will decide which class). By participant invitation only, the researcher may observe that classroom during one class period. No students will be interviewed or recorded on tape. Sites for your interviews will be determined by mutual agreement between you and the researcher.

This study is dealing with a science education plan that is associated with a history of controversy. For this reason, there is a risk that participants may make statements that might be opposed to the beliefs of certain other educators. In order to minimize the potential for embarrassment, harassment or damage to your professional reputation or employment situation, your identity, and that of your school, will be concealed by pseudonyms in the transcripts of the interviews and in all discussion and writing of the final report.

The information gained from this study may help teachers understand better what really happens in mixed-ability secondary science classrooms. The benefit to you from your participation is the opportunity to insert your voice, your concerns, and your strategies into this project. Your own experiences, along with those of the other participants, will become the rich source of information for exploring this kind of science class.

While it may not be possible to keep your participation confidential, all data obtained during this study will be kept strictly confidential. Audio tapes will be destroyed immediately after your approval of the transcribed text. The principal investigator will be the only person to listen to those tapes before they are destroyed, and during the transcription process pseudonyms for personal and school identities will be inserted. All data and documents will be stored in locked cabinets and/or password-protected computers for three years after the conclusion of the study. The information obtained in the study will be shared with the Omaha Public School District, and may be published in scientific journals or presented at scientific meetings, but the identities of the participants and their schools will not be released.

There will be no compensation for participating in this research. Neither will there be any coercion to elicit your participation. The principal investigator has been your district science supervisor for the past three years, but he is no longer in that position. When he returns to the district next year, he will not be in a supervisory position over the science program or its staff.

You have the right to ask any questions about this research at any time. You have the right to receive answers to your questions before agreeing to participate, and you have the right to have additional questions answered during the study. You may call the investigator at any time at (402) 551-5333. If you have questions concerning your rights as a research participant that have not been answered by the investigator or to report any concerns about the study, you may contact the University of Nebraska-Lincoln Institutional Review Board by telephone at (402) 472-6965.

Participation in this project is voluntary and you have the right to withdraw at any time without adversely affecting your relationship with the investigators, the University of Nebraska, or the Omaha Public Schools. Your decision will not result in any loss of benefits to which you are otherwise entitled.

You are voluntarily making a decision whether or not to participate in this research study. Your signature certifies that you have decided to participate having read and understood the information presented. You will be given a copy of this consent form to keep for your own records.

_____ Initial here if you agree to be audio taped during the interviews.

_____ _____

Signature of Research Participant Date

Frank A. Tworek, MA, Principal Investigator Home: (402) 551-5333
Jim Walter, Ed.D., Secondary Investigator Office: (402) 472-3392

Appendix B

October 26, 2004

Deeann Goeser
Instructional Research Administrator
Research Division
3215 Cuming St.
Omaha, NE 68131-2024

Deeann,

Accompanying this letter is the research proposal packet requesting approval from the Research Review Committee of the Omaha Public School District. I am proposing to conduct this research project in Omaha to complete the requirements for my doctoral dissertation at the University of Nebraska-Lincoln.

The title of the study is "Mixed-Ability Secondary Science in One Urban School District: A Multiple Case Study." I will be the principal investigator. My advisor in the UNL College of Education and Human Sciences, Jim Walter, Ed.D., will be the secondary investigator. Dr. Walter can be contacted at his office in the Department of Teaching, Learning and Teacher Education at (402) 472-3392. His address is 238 Mabel Lee Hall, Lincoln, NE 68588-0234.

The intent of this research project will be to explore the issues facing teachers when secondary science students are scheduled into heterogeneous classes. The district's recently-implemented science graduation requirements apply to the senior class of 2005-2006. This means that all science students up to and including this year's 11th grade class are taking courses to meet these new requirements. It will be to the benefit of the teachers, administrators and students themselves for this study to provide a deeper understanding of what happens in these classes and what strategies and support systems may be recommended.

Please review this research proposal and consider it for approval. If you have any questions, feel free to call or email me. Thank you in advance for your time and consideration.

Sincerely,

Frank A. Tworek
UNL Doctoral Candidate

Appendix C

December ___, 2004

(_____)
(_____) School
(_____)
Omaha, NE (_____)

(To the Principal),

As we discussed in our recent conversation, I am conducting a research study titled "Mixed-Ability Secondary Science in One Urban School District: A Multiple Case Study." I will be the principal investigator. My advisor in the UNL College of Education and Human Sciences, Jim Walter, Ed.D., will be the secondary investigator. Dr. Walter can be contacted at his office in the Department of Teaching, Learning and Teacher Education at (402) 472-3392. His address is 238 Mabel Lee Hall, Lincoln, NE 68588-0234.

This letter is to request your permission for me to ask one of your teachers to volunteer as a participant in the study. The intent of this research project will be to explore the issues facing teachers when secondary science students are scheduled into heterogeneous classes. The district's recently-implemented science graduation requirements apply to the senior class of 2005-2006. This means that all science students up to and including this year's 11th grade class are taking courses to meet these new requirements. It will be to the benefit of the teachers, administrators and students themselves for this study to provide a deeper understanding of what happens in these classes and what strategies and support systems may be recommended.

Please review the attached research proposal. If you have any questions about the potential involvement of one teacher from your building, feel free to call or email me. Thank you in advance for your time and consideration.

Sincerely,

Frank A. Tworek
UNL Doctoral Candidate

Appendix D

Potential Participants:
Numbers of Teachers of Mixed-Ability Secondary Science Classes
By School

School	8th Grade	9th Grade	10th Grade	11th Grade
A				
B	3			
C	3			
D	1			
E	2			
F	2			
G	3			
H	0			
I	3			
J	3			
K	2			
L	3			
M	1			
N		3	3	3
O		4	4	3
P		5	4	4
Q		5	4	5
R		3	5	5
S		8	3	4
T		4	4	2

Appendix E

Interview Guide for First Interview

Participant name _____ Location _____

Date _____ Interview # _____

Greetings and Introduction

Example Questions:

- We will be studying one of your mixed-ability classes, and the issues that have surfaced in that class, but first let's begin by stepping back and looking at what has brought you to this place. Can you tell me about what events, people, circumstances, etc., led you to becoming a science teacher?

- What influenced your decision to teach in an urban, public school district?

- What kinds of things prepared you to teach students coming from diverse backgrounds and cultures?

- What professional development opportunities have given you the most support for teaching heterogeneous classes?

- During the time you have been a teacher in this school, how has your level of comfort with diversity been affected by your experiences?

Appendix F

Interview Guide for Second Interview

Participant name _____ Location _____

Date _____ Interview # _____

Greetings and Introduction

Example Questions:

- We are studying your Period 2 class this semester. In this particular group of students, what kinds of differences are present in the classroom?

- Describe your reactions when you learned that you would be teaching a science class that has no prerequisites.

- What advantages are created when students are scheduled into a mixed-ability course such as this one?

- In what ways do the range of student abilities and the range of student backgrounds affect your work as the teacher of this heterogeneous science class?

- Explain some of the adaptations you have made in your teaching as a response to the special circumstances in this mixed-ability class.

- Describe the kinds of support that are assisting you in teaching this class which includes a range of student abilities.

Appendix G

Interview Guide for Third Interview

Participant name _____ Location _____

Date _____ Interview # _____

Greetings and Introduction

Example Questions:

- In the two previous interviews, we discussed how you came to be teaching in this school district, and the ways that you have adapted to the diverse group of students in one of your classes. As we continue today, I would like to ask specifically about that class. With this particular group of students, what kinds of things have you done to get to know about their individual needs?

- What criteria will you use to judge your own success, as a teacher, with this group of students?

- As you monitor the progress of each individual student, what criteria do you use to decide whether or not that student is "successful"?

- How does the range of backgrounds and abilities in this group affect the opportunities for individual "success"?

- Considering that some of your students in this group received a failing grade during first semester, what can be done to assist these students toward earning a passing grade this semester?

- Considering that some of your students in this group are able to understand the concepts much sooner than the rest of the class, what can be done to maximize the learning opportunities for these students?

- Think about one of your favorite teachers or professors from your own days in school. Imagine that person in your place, teaching this particular group of students. How successful do you think that person would be in this situation?

Appendix H

Interview Guide for Fourth Interview

Participant name: Diane Grade Level: 11

Date: 4-16-05 Time: 9:00 am Location: Coffee Shop

Paperwork and Questions

Final Interview Questions:

- As we try to make sense of the issues in this mixed-ability class, there are certain students who catch my attention on the spreadsheet of data. The five students in Rows 26-30 all failed the first semester of this course. In previous courses and standardized tests, all five of these students have demonstrated varying degrees of academic potential. Can you shed any light on their participation in this class?

- Another student (Row 9) is the only one in this group identified by the school district as "gifted." This student earned a B in this class first semester. Can you describe what it is like to work with this student in this mixed-ability classroom?

- On paper, the student in Row 19 seems to have the ability to be an "average" type of student in science. In this class, however, her first semester grade was a D. Can you describe what makes her performance lower than her apparent abilities?

- Finally, are there any students in this group who, in your opinion, would demonstrate more learning and more success if they were in an ability-grouped classroom instead of this mixed-ability situation? If there are, can you suggest how many different levels of physics should be offered, and what criteria might be used to register students into those ability-grouped classrooms?

Appendix I
Example of Observation Notes

Time	Descriptive Notes	Reflective Notes
8:48 am	The game begins. Ms. T is directing the Jeopardy game at the front of the room, while Mrs. E is working with the five other students at the back of the room. One of the five in the back is working at the keyboard of the computer station.	Multiple activities in the room
8:53 am	As the game continues, Ms. T is interacting with the nine students playing the game.	Highly engaging
8:57 am	The team in the middle has 4000 points, while the team on the right has 400 and the team on the left has -2400. The team with the negative score is enthusiastic and they are raising their voices as they participate. Mrs. E calls from the back of the room to remind them to settle down. All nine participants are leaning closer and closer to the TV screen as the game continues.	Active participation Enthusiastic
8:58 am	The team in last place has broken into positive scoring and now they have a chance for the Daily Double question, which is asking what unit of measurement is used for reporting the diameter of Venus. The team gives the correct answer (kilometers). In the meantime, individual work continues in the back of the room.	Science content
9:04 am	The game moves into the Double Jeopardy phase. The new categories are Hodge Podge, Twins, One Small System, Chem, Rhyme, and Human Body.	Review
9:07 am	Another female student enters the room and goes to the back to talk with Mrs. E, and then sits down to work on the project.	
9:09 am	As the game up front continues, the members of the losing team are all standing, leaning in closer as the competition becomes more intense.	Enthusiastic
9:11 am	The students in the back continue to work. The competition in the front is getting louder. Mrs. E again reminds the students to keep the noise down. In the meantime, the student in the back who is working at the computer keyboard is also using a book to look up information.	Active involvement
9:12 am	One of the students at the back stands up and starts dancing. Mrs. E takes him over to the opposite side of the room and works directly with him. Another student at the back begins picking up her materials and she cleans up from her poster work. She stands up and takes supplies over to the cabinets on the east wall.	Addressing individual needs Students take responsibility

Appendix J

Types of Data Obtained from District Student Records for Students in Each Class

School building
Teacher
Course title
Course section
Class period
Grade level
Ethnicity
Gender
Birth date
Residential zip code
Special Education status
Free/Reduced lunch
English proficiency
Gifted program status
Current enrollment status
Current attendance data
Current Grade Point Average (GPA)
Most recent Reading score in California Achievement Test (CAT)
Most recent Math score in California Achievement Test (CAT)
Most recent score in Test of Cognitive Skills
Work Keys scores
ACT test results
Most recent Reading scores in the district's Criterion Reference Test (CRT)
Most recent Math scores in the district's Criterion Reference Test (CRT)
Most recent Science scores in the district's Criterion Reference Test (CRT)
Course mark in the first semester of this class with this teacher
Final course mark in the second semester of this class with this teacher

Appendix K

Progression of Theme Development

22 Codes	*Etic* Themes (Researcher's Perspective)	*Emic* Themes (Participants' Perspectives)	Over-Arching Themes
Achievement levels	Teacher background	Teacher beliefs	Sense of belonging
Adapt to needs			
Advantages of mix	Observer's view	Teacher's view of students	Teacher's focus
Assessment			
Behavior	Teacher's view of own class		Student learning
Concepts		Concept development	
Frustration			
Gender	Strategies for Success		
Management		Assessment	
Parent contact			
Peer support		Adapting to needs	
Preconceptions			
Pressures		Achievement levels	
Prof support			
Race		Student behavior	
Reading			
Special needs		Teacher frustration	
Student centered			
Student failure			
Teacher beliefs			
Technology			
Time			

Appendix L

Letters from Peer Reviewers, Page 1

March 17th, 2008

To whom it may concern,

My name is Kelly Gatewood. I served as a peer reviewer for Ph.D. Candidate Frank Tworek. An evaluation of the strengths and weaknesses of the dissertation took place as each chapter was completed. I proposed additions, corrections, and deletions to the dissertation on several occasions. Many discussions were held with Frank in order to confirm arguments, aspects and/or data presented in his dissertation. Suggestions for ways in which it could be improved were made with each reading. The documentation that I was provided, as a peer reviewer, was clear and very helpful to me. I tried to support him both intellectually and structurally during his writing process. I witnessed him grow and develop while doing his research.

I am satisfied that the work reported in the dissertation is original. Frank has a full understand of the research that he carried out and he was able to relate his achievements and assertions clearly to his area of science education. His dissertation contained new findings and his contribution to the field of science education has been significant. Additional information can be provided upon request.

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Appendix L (cont.)

Letters from Peer Reviewers, Page 2

March 20, 2008

To Whom It May Concern:

Over the last several years I have worked with Frank Tworek as a peer reviewer as he planned his dissertation work, completed fieldwork and finalized the written product. He demonstrated conscientious and consistent reflection during the process and has completed research that adds to the body of knowledge available to the discipline.

Initially, I served as a sounding board, as Frank thought through the organization of his work. As data were gathered in the field, I continued in this role and additionally critiqued his thinking about the meaning of these data. A portion of the role I played at this time was to assure that Frank remained as objective as possible, since his work was conducted in a setting where he played a critical leadership role for the school district.

As data were analyzed, we spent considerable time discussing the etic and emic themes and ways in which to best present those themes. Additional discussions assured that he fairly represented his informants in the written work.

In addition, I spent time reviewing each chapter in draft and final forms. My reflections on the work were of both a structural and an intellectual nature. Frank and I spent numerous hours discussing the findings and assuring that the written work reflected these findings. We also discussed related research and how it applied to his work. It became quite clear that his work is unique and begins to address an area of great need in science education.

I am available to discuss further any questions or concerns.

Susan B. Koba, Ph.D.
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Omaha Public Schools, Retired
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Appendix M

External Auditor

Attestation
By Kerry E. Williams, Ph.D.

April 6, 2008

I was requested by Mr. Francis (Frank) A. Tworek to conduct an external audit of his qualitative study of Mixed-Ability Secondary Science. The purpose of this audit was to ascertain the extent to which the results of the study are trustworthy.

Materials submitted to the auditor for review

1. The study proposal.
2. Researcher's notebook showing timeline and data analysis strategies.
3. List of data collected for the study.
4. Copy of the interview protocol used.
5. Copies of all transcribed interviews.
6. Copies of all transcribed interviews with color codes.
7. Copies of all transcribed interviews that included member checks.
8. Lists and charts showing coding categories.
9. Copies of all notes taken during interviews.
10. Copies of researcher's observation notes during classroom observations.
11. Copies of all audio-tapes transcribed and analyzed.
12. Copies of emails and correspondence between the researcher and the participants.
13. Copies of demographic information from each participant's school.
14. Copies of participants' curriculum handbooks and classroom expectations.
15. Copies of students' test scores from participants' classrooms.
16. Copies of data coded by a computer program.
17. Copy of the dissertation in draft form.

Procedures of the audit

1. Review of the study's question, data collection and analysis procedures, and steps taken to insure trustworthiness of the data, as described in the proposal for the study.

2. Review of the interview protocols actually used in the study.

3. Comparison of data collection lists with data actually submitted for auditor's review.

4. Comparison of samples of typed transcriptions submitted for review against the audio-tape recorded interviews.

5. Review of the study's question, data collection and analysis procedures, and steps taken to insure trustworthiness of the data, as described in the dissertation draft.

6. Review of the process for generating categories and coding the data and other procedures used to represent the raw qualitative data obtained in the study.

7. Review of the findings and conclusions and comparison of the findings and conclusions to categories used to interpret the data.

Findings of the audit

1. Review of the proposed methods for the study.

In this step, the researcher's original proposal was reviewed to determine overall goals and purposes of the research, specific questions being addressed in the study, the data collection and analysis procedures planned, and steps to insure overall trustworthiness of the data. The design suggested in this proposal adheres to commonly accepted principles of research design for qualitative studies.

The researcher's data collection and analysis procedures are appropriate for the proposed questions of this study. For example, the researcher asked: How do secondary science teachers describe the issues they face while teaching a science course required for graduation when the course has no prerequisites? The data he proposed to collect including interviews of teachers, school documents and catalogs, and student records are suitable to answer this question. Noteworthy is the absence within the proposal of classroom observations as a method of data collection needed in order to answer the proposed question: What strategies do they use to deal with these issues. However, this form of data collection did indeed take place in the actual study.

The proposed analysis of this data including organizing and preparing data, reading through data, coding, providing case descriptions, planning for the narrative, and interpreting the data fit nicely with the questions as well as the data collected.

Steps to insure trustworthiness were described in the proposal and reflect a comprehensive attempt by the researcher to insure the interpretations and conclusions drawn show the perspectives of the subjects in the study. Some of the methods proposed included member checks, peer examination, and clarifying researcher bias, each of which are promoted in qualitative research literature.

2. Review of the interview protocols used for the study.

Protocols were reviewed for the participants in this study. The questions in these protocols were judged to be consistent with the research purposes and questions stated in the study's proposal. For example, one of the proposed questions was: In what ways does the mix of student abilities affect the teacher of a heterogeneous science class? This and the other questions proposed reflect the researcher's intent to insightfully describe issues the participants are facing.

There were some discrepancies noted between the proposed interview questions and the actual questions asked during the interview. For example, during the actual interviews the researcher asked about the participants' past experiences and these questions were not on the interview protocol in the proposal. After reviewing the

researcher's notes, however, it became clear that committee members suggested that he include in-depth descriptions of all participants and these questions would allow him to do so.

3. Review of data collection lists against the data provided.

Each of the data sources were compared against the list of data collected that was provided. All data identified in the list was identified in the actual data sources and there were no data sources unaccounted for on the list. This review raised the question of the classroom observations that were not identified in the initial proposal. The use of observations is discussed in the methods section of the dissertation and the researcher writes of his concern for doing observations because he felt his "presence in the classroom would make it all the more difficult to conceal the identities of the participants in the study." The researcher discusses his plans to alleviate this concern in detail.

4. Review of typed transcripts against the audio-tape recordings provided

Segments of the audio-tapes from the interviews were arbitrarily selected. The first page of each new tape was used and as anchor and then segments well into the tape were selected. Record was kept of all errors in transcriptions by penciling in what was heard but not on the recording or by crossing out what was on the transcription but was not heard on the tape. The results of this review are reported by data source.

4.1 Interviews with participant "Angela"

Four interviews were reviewed, for a total of 24 pages of transcription. The average number of errors observed per page was 5.6 with a low of 2 and a high of 11.

4.2 Interviews with participant "Barbara"

Four interviews were reviewed, for a total of 24 pages of transcription. The average number of errors observed per page was 4.3 with a low of 2 and a high of 9.

4.3 Interviews with participant "Charles"

Four interviews were reviewed, for a total of 24 pages of transcription. The average number of errors observed per page was 3.5 with a low of 0 and a high of 9.

4.4 Interviews with participant "Diane"

Four interviews were reviewed, for a total of 24 pages of transcription. The average number of errors observed per page was 2.2 with a low of 0 and a high of 7.

The vast majority of the errors observed in the transcribed data were simple deletions of one or two words. In addition, the transcriptions had some errors already noted. Therefore, an effect of these errors on the actual data analysis and findings is probably non-existent.

5. Review of the study's question, data collection and analysis procedures, and steps taken to insure trustworthiness of the data, as described in the dissertation draft.

The study's questions and purposes within the proposal were verbatim to those in the dissertation draft and seem appropriate for a multiple case study. The data collection, analysis procedures, and steps taken to insure trustworthiness described on pages 15-19, 19-21 and 21-23 respectively, also reflect appropriate methodology for a multiple case study.

The description of data collection procedures were compared to the researcher's notes and logs kept during this portion of the study. There were no discrepancies found. In addition, the data within dissertation draft were the same as provided in the materials submitted for this review. The only minor discrepancy found between the actual raw data and the data in the draft came when the researcher described the classrooms as a part of the classroom observation notes. For example, in his notes about "Charles'" classroom he described it as, "sterile" and that, "it does not appear to be functional for chemistry laboratory experiments." Within the dissertation, however, the researcher describes "Charles'" classroom as, "clean and orderly."

The description of data analysis procedures were compared to the researcher's notes and logs kept during this portion of the study. There were no discrepancies found. The researcher analyzed the data several times including once after each individual interview and then taking each participant's whole set of data and analyzing it. The researcher also analyzed the data across cases. Although there were no discrepancies, it is unclear in the dissertation draft how each of these procedures fit together. How were the codes from the individual interviews used during the whole case analysis? Did the researcher use both sets of codes or just the latter? How did he use the codes to create themes?

The descriptions of procedures used to insure trustworthiness within the dissertation draft are consistent with recommended procedures recommended in qualitative research. The materials submitted by the researcher including emails from participants, written transcriptions with peer examiner codes, and notes in his observation notebook provide evidence that these procedures actually took place.

6. Review of the process for generating categories and coding the data

The process for generating categories and codes for the data were reviewed by comparing codes to raw data, comparing codes to categories and themes created, and comparing those to the dissertation draft. The codes and categories created seem to be supported by the raw data and the process for creating those codes reflects the nature of qualitative research. However, it would have been helpful to know more about how the codes and categories were inter-related as perceived by the researcher. For example, in the case of "Angela" there are twenty codes including such words as assessment, advantages, gender, and pressures and the raw data from her interviews seem to fit under those codes. The next step of categorizing the data is unclear, however, as no evidence of how the researcher took the codes and created categories and themes was submitted. The researcher was asked about this via email and he stated: I had the ATLAS.TI program count how many passages there were attached to each code for each participant. I then studied the most frequent codes on the list for that person, and transformed them into themes that seemed to fit their case. This may need to be added to the methodology section of the dissertation.

7. **Review of the findings and conclusions and comparison of the findings and conclusions to categories used to interpret the data.**

The findings were reviewed by reading sections of the dissertation containing the use of data. These findings were reviewed to ascertain their appropriateness and consistency of the interpretation with the analytic categories used. Specifically, the chapter headings were compared to the list of themes, categories and code words supplied by the researcher. In addition, content was reviewed to determine the extent to which it reflected the overall topic or theme indicated in the chapter headings. Sections of the various chapters presenting findings were arbitrarily selected for this review and no attempt was made to be exhaustive or representative. The researcher's findings are organized and presented over five chapters. The first four chapters of findings focus on individual cases and the fifth on a cross case analysis of all cases.

The researcher describes the subject of each case in great detail abiding to the dissertation's purpose of describing a mixed-ability science classroom. Each heading provides a different perspective of the classroom including the teachers' perceptions and the researcher's perspective as well. In addition, the researcher provides sections in each case about teachers' strategies for success answering his second research question, "What strategies do they use to deal with these issues?" The themes provided in each case are supported by the raw data. However, the theme names do not seem to describe the theme and the codes within them very well. In other words, some of them are quite broad and do not describe the content of the theme. For example, in each case "teacher beliefs" is a theme, but it is left to the reader to figure out what those beliefs are. Perhaps some sub-themes would have been useful utilizing some of the many codes that weren't represented directly in the dissertation draft but were apparent in the analysis.

The conclusions flow from and give insight into the researcher's interpretation of all of the data as well as the literature that surrounds this multiple case study. The data that is pulled into the conclusions illustrates specific points being made and helps highlight how specific conclusions were inferred from the data.

8. **Summary**

The results of this audit demonstrated an excellent audit trail maintained by the researcher. Implementation of data collection procedures were consistent with what was proposed and are reflective of accepted principles of qualitative research. Transcribed data were verified with the audio-tape recordings from which they were transcribed. The findings, as presented in a draft of the dissertation, were found to be consistent with the raw data submitted for this audit. Other than a few minor discrepancies, this research has been found to be trustworthy.

Attested to by

Kerry E. Williams, Ph.D.