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Developmental/Remedial Sciences at Community Colleges in Five States in the Central Part of the United States

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DEVELOPMENTAL/REMEDIAL SCIENCES AT COMMUNITY COLLEGES IN FIVE STATES IN THE CENTRAL PART OF THE UNITED STATES

by

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DEVELOPMENTAL/REMEDIAL SCIENCES AT COMMUNITY COLLEGES IN FIVE STATES IN THE CENTRAL PART OF THE UNITED STATES

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Phipps (1998) emphasized interinstitutional collaboration among colleges to share and replicate best practices and ideas as a strategy to improve the effectiveness of developmental/remedial education, but Johnson (2001) noted a lack of communication between science educators and developmental educators.

The purposes of this mixed methods study were (a) to identify and examine the characteristics of developmental/remedial sciences as it existed in the 2006-2007 academic year in terms of organization, structure, instructional practices, and curriculum as offered at community colleges in five states in the central part of the United States; and (b) to develop a set of guidelines for community college faculty and administrators to use in making decisions about whether or not to offer developmental/remedial sciences and identify the general steps to follow in implementation.

The study was conducted in four phases which involved two surveys, subsequent interviews with leaders at three institutions selected for case study, and guideline development.

Developmental/remedial sciences were offered at few institutions. At those institutions where they were offered, however, nearly half offered courses and multiple

support services, but did not define their offerings as a program. Some developmental education best practices were adopted (such as integrating study skills with science content in courses and using a variety of instructional strategies), but many, including goals and assessment, were omitted. Interviewees indicated the need for developmental/remedial sciences would continue in the future.

Guidelines to use in determining whether to offer developmental/remedial sciences included the following:

1. adopt an attitude of quality improvement;
2. look to faculty as a #1 resource;
3. assess what is currently offered in the sciences and ask if it works;
4. know what you are remediating;
5. start a conversation between the academic department and support services staff to create a truly integrated program;
6. consider placement and advising;
7. consider assessment;
8. consider training and experience of faculty;
9. plan for the appropriate physical space and staff; and
10. do your homework.

Acknowledgements

The past four and a half years have been some journey! I started this doctoral program when my daughter, Faith, was barely one year old and my son, Payton, was barely two. Now Payton is finishing kindergarten and Faith is preparing to enter. My goal was to finish before they were both in school – I barely made it!

Those who know me know that I am crying while I write this because I am so thankful for the support I received from many people during this time.

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And finally, I have to offer up my praise to God. He is GOOD! What an incredible journey this has been – one that, at times, would have been fairly easy to give up. But He sustained me.

So what have I learned on my journey? I have learned I am capable of more than I thought possible. I have learned that support means everything. And I have learned that it is a good thing to step outside one's comfort zone–to stretch, and to do so *on purpose*. I see this work not so much as a destination, but as one stop along the way.

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CHAPTER ONE

INTRODUCTION

Statement of the Problem

In 2006, there is a general concern in the United States that the nation is lagging behind the rest of the world in scientific literacy (NCES, 2006). This is true for citizens of all ages (McDonald & Dominguez, 2005, NCES, 2004). Moreover, the pool of citizens who are scientists is shrinking. Yet, our society has an insatiable appetite for the modern day conveniences which are products of science and new technology. A society dependent upon technology necessitates that the average citizen feel comfortable with science or, at the least, does not fear it (Hsu, Jensen, Moore, & Hatch, 2005; McDonald & Dominguez, 2005).

Adding to the issue is that by the time students reach the college level, a prior negative experience with science or a science course is not uncommon (DiMuro, 2006). As such, some may feel excluded from the sciences (Moore, 2002b), have an apathetic perception of science (Marx, Honeycutt, Rahmati Clayton, & Moreno, 2006), or may be intimidated by the idea of just taking a science class, much less majoring in a science or science-related field (Biermann & Sarinsky, 1993). As a consequence, many students enter college underprepared (Bastedo & Gumport, 2003; Biermann & Sarinsky, 1993; Moore, 2002a; Roach, 2000) for the content and rigors of college level study in the various science fields.

Institutions of higher education have used a number of approaches with underprepared students. From basic study skills courses and preparatory courses in specific disciplines to remedial courses and academic support services for students, institutions have offered opportunities to underprepared students in general, as well as to underprepared students studying in the disciplines of math, reading, writing, and the sciences (Congos & Mack, 2005; Fowler, 1988; Halloun & Hestenes, 1985; Hsu et al., 2005; Jensen, 1996; Jensen & Rush, 2000; Johnson, 2001; Kull, 1999). Developmental/remedial education may make science more appealing to students such that they see science as something they could learn–to see an understanding of science as an attainable goal (Hsu et al., 2005). Further, sciences taught in a developmental/remedial education context can also support the reading, writing, and math components of developmental/remedial education programs by providing a disciplinary context for students to apply and practice those skills and a rich environment for developing best practices in classroom instruction (Hsu et al., 2005; Johnson, 2001).

Community colleges are open-door institutions accustomed to serving underprepared students requiring developmental/remedial education. Such institutions also help to equalize educational opportunities for groups of students traditionally underserved by higher education, including women, ethnic minorities, and students of lower economic status (Cohen & Brawer, 2003; Jenkins & Boswell, 2002; Moore, 2001, 2002a, 2002b). And, as higher education enrollments increase and as more and more four-year institutions of higher education phase out developmental/remedial education, community colleges are becoming responsible for an increasing number of developmental/remedial programs and students (Bastedo & Gumport, 2003; Jenkins & Boswell, 2002; Kozeracki, 2002; Lewis & Farris, 1996; Phipps, 1998; Trombley, 1998).

There is a clear indication that four-year institutions, as a whole, have reduced developmental/remedial education offerings for their students (Bastedo & Gumport, 2003; Jenkins & Boswell, 2002; Kozeracki, 2002; Phipps, 1998; Trombley, 1998). For instance, in 1996 the Massachusetts Board of Higher Education set into motion policies to simultaneously increase university admissions standards and reduce what was termed remedial education at the universities in the state. In 1995, 24% of entering freshmen at the state's comprehensive colleges and 22% at the University of Massachusetts required remediation. By fall 1997, only 10% of first-time freshmen were allowed to enroll in remedial courses at four-year institutions, and by fall 1998 that number had been reduced further to 5%.

> Community colleges were identified in the . . . mission statement as the site of remedial education in Massachusetts, and the four-year colleges were encouraged to create partnerships with local community colleges to eliminate remedial education at the four-year campuses altogether. (Bastedo & Gumport, 2003, p. 349)

Similar action was taken in 1998 by the City University of New York (CUNY) Board of Trustees when it voted to phase out all remedial education from its 11 four-year senior colleges, placing full responsibility for developmental/remedial education upon its numerous community colleges (Bastedo & Gumport, 2003; Phipps, 1998; Trombley, 1998).

Other states, including Colorado, Missouri, Florida, and South Carolina, were among a growing list of states considering the same policy (Jenkins & Boswell, 2002; Kozeracki, 2002). A 2003 National Center for Education Statistics (NCES) report on remedial education at postsecondary institutions in the United States in the fall 2000 semester revealed that 98% of public two-year colleges offered at least one remedial course in reading, writing, or mathematics (Parsad & Lewis, 2003), and public two-year colleges offered a greater number of different remedial courses than did four-year institutions. Further, 42% of entering college freshmen enrolled in at least one remedial reading, writing, or mathematics course at a public two-year college versus 20% at public four-year institutions. Boylan, Bonham, and White (1999) pointed out that

> community colleges serve as a pathway to a baccalaureate degree for many students whose family, financial, or social circumstances prevent them from attending a four-year institution. They also provide education and training for those who have no intention of seeking a baccalaureate degree but still seek the benefits of postsecondary education. Both of these groups are likely to require substantial amounts of developmental education, including remediation. Community colleges are currently the primary provider of developmental education and the need for them to do so will continue. (p. 97)

The centrality of community colleges to developmental/remedial education is clear (Bastedo & Gumport, 2003; Boylan et al., 1999; Cohen & Brawer, 2003; Lewis & Farris, 1996; NCES, 1996; Parsad & Lewis, 2003). If developmental/remedial students fail at the community college, they may not have access to other academic institutions; thus, effective developmental/remedial education at community colleges is crucial to the future academic success of developmental/remedial students (Southard & Clay, 2004). Community colleges are the institutions where students may find opportunity and innovation in developmental/remedial services, classrooms, and offerings, including those in the sciences.

Purpose Statement

The purposes of this mixed methods study were (a) to identify and examine the characteristics of developmental/remedial sciences as it existed in the 2006-2007 academic year in terms of organization, structure, instructional practices, and curriculum as offered at community colleges in five states in the central part of the United States; and (b) to develop a set of guidelines for community college faculty and administrators to use in making decisions about whether or not to offer developmental/remedial sciences and identify the general steps to follow in implementation.

Research Questions

1. To what degree were developmental/remedial sciences offered by selected community colleges in five states located in the central part of the United States?
2. What were the descriptive characteristics of developmental/remedial sciences where offered by the selected community colleges? Descriptive characteristics included the following:
   a. What were the factors that contributed to identifying the need for developmental/remedial sciences?
   b. Were developmental/remedial sciences at the selected community colleges offered in the form of a course or an entire program?
      i. If a course, what kind of academic credit did it carry?
      ii. What topics were covered?
      iii. Was a lab associated with the course?
   c. How were developmental/remedial sciences organized and delivered? Within academic departments? In a developmental/remedial education department/division? Interdepartmental? Through a learning center?

d. What were the goals of developmental/remedial sciences?

e. What were the instructional practices that supported those goals?

f. What advising and support services were available to students in developmental/remedial sciences?

    i. How were students placed?

    ii. Was tutoring available?

    iii. Was Supplemental Instruction available?

    iv. What individuals were involved with advising/counseling developmental/remedial science students?

g. How was student progress assessed in the developmental/remedial sciences so that students could move on?

h. How was the effectiveness of developmental/remedial sciences assessed?

3. Was there commonality among developmental/remedial sciences to develop a set of guidelines for community college administrators and instructors to use in determining if they should implement developmental/remedial sciences? What were the stages and process for implementing a developmental/remedial sciences program?

Overview of Study

This study occurred in four phases. The first phase involved the distribution of a survey to the Chief Academic Officers (CAOs) at the main campuses of the community colleges in five states in the central U.S. All institutions were member institutions listed in the *AACC Membership Directory 2005*. This survey identified those that offered developmental/remedial sciences and identified the individual who had administrative/leadership responsibilities for developmental/remedial sciences courses or programs. CAOs were also asked to identify additional campuses of their institutions where developmental/remedial sciences were offered following different policies and procedures than those in place at the main campus, along with contact information for the CAOs at those campuses so that surveys could be administered to them.

The second phase was an in-depth survey, which was sent to individuals identified by the CAOs as having administrative/leadership responsibilities for developmental/remedial sciences. This survey was used to determine the characteristics [listed as “a-h” of Research Question 2] of the developmental/remedial sciences offered.

In the third phase of the study, the researcher interviewed the identified individuals with administrative/leadership responsibilities for developmental/remedial sciences at three institutions selected for in-depth case studies based on responses from Survey 2. Case study sites were selected from among institutions where comprehensive programs of developmental/remedial sciences were offered. More specific selection criteria included (a) type of course(s) offered (biology, chemistry, physical science, earth science, or a combination of these); (b) success rates of students in developmental/remedial science course(s); and (c) success rates of students in the subsequent science course, in order to better reflect the variety of developmental/remedial sciences offerings in the sample and to reflect those that were more successful as measured by student success.

Based on the data collected through the surveys and interviews, the fourth and final phase of the study involved the development of a set of guidelines that may be of use to community college administrators and instructors in determining if they should offer developmental/remedial sciences and provided stages to follow for those who choose to do so. The detailed method of the four phases of this study is described in Chapter Three.

Definition of Terms

Key terms for this study included the following:

Chief Academic Officer (CAO) – Different community colleges may use different titles for the individual who administers the academic component of the institution. For this study, the American Association of Community Colleges' (AACC) definition was used: the CAO is the officer responsible for academic programming (AACC, 2005).

Community college – A community college is "any institution regionally accredited to award the associate in arts or the associate in science as its highest degree" (Cohen & Brawer, 2003, p. 5), including the comprehensive two-year college and technical institutes, many of which are now accredited under the same body as the comprehensive institutions to award associates degrees. For this study, the term referred only to public two-year community colleges in five states in the central part of the U.S. that were member institutions of the American Association of Community Colleges (AACC) in 2005-06.

Course – As used in this study, a science course was offered within the biological, chemical, physical, or earth sciences disciplines.

Developmental education goals – The NADE goals for developmental education were to make educational opportunity a possibility for all postsecondary learners; develop the skills and attitudes necessary for learners to attain their academic, career, and life goals; ensure proper placement by assessing the level of preparedness for college coursework for all learners; maintain academic standards by enabling learners to acquire the competencies needed to succeed in mainstream college courses; and to enhance student retention (NADE, 2001b).

Developmental/remedial education – For this study, no distinctions are made between developmental education and remedial education. Remedial education is generally considered to include preparatory courses that are precollege level (Fowler, 1988; Lewis & Farris, 1996), which reteach skills students should have learned in earlier education (Boylan et al., 1999; Roueche & Roueche, 1999; Shaw, 1997). However, the term has a negative connotation indicating that some aspect of the person is deficient and needs to be remedied or fixed, so is being phased out in lieu of the term "developmental education," which more adequately describes the types of courses being taught and assistance services offered (Roueche & Roueche, 1993).

Developmental education was defined by the National Association for Developmental Education (NADE) as "a comprehensive process that focuses on the intellectual, social, and emotional growth and development of all students. Developmental education includes, but is not limited to, tutoring, personal/career counseling, academic advisement, and coursework" (NADE, 2005). "Developmental education programs and services commonly address academic preparedness, diagnostic assessment and placement, development of general and discipline-specific learning strategies, and affective barriers to learning" (NADE, 2001a, n.p.). Developmental education involves a wide range of "learner-centered" (NADE, 2001b, n.p.) programs, courses, and activities aimed at "enhancing students' chances for reaching their postsecondary education goals" (Weinstein, 1994, p. 375). For the purposes of this study, no distinctions were made between the terms remedial and developmental education. Both terms were used because higher education personnel may be familiar with one term but not the other.

Developmental/remedial sciences – Developmental/remedial sciences were biological, chemical, physical, or earth sciences that followed the definition of developmental/remedial education as defined above and, as used in this study, included a course or a program.

Instructional practices – In this study, instructional practices were teaching methods and strategies used by instructors of developmental/remedial courses. In other words, how curriculum was implemented (Jensen, 1996). These practices included, but were not limited to the following: problems, assignments, readings, activities for students, small group work, cooperative learning (Johnson, Johnson, & Smith, 1998; Roschelle, 1992; Watts, 1994); constructivist approaches (Fensham, Gunstone, & White, 1994; Jensen, 1996; Jensen & Rush, 2000; Moore, 2001); discovery-based learning/inquiry-based approach (Johnson, 2001; NRC, 1996); laboratories, lecture (Hsu et al., 2005; Jensen & Rush, 2000); computer use (Jensen & Rush, 2000); discussion groups, individualized instruction (Waycaster, 2001); stress of higher order thinking skills (Bloom, 1956; Hsu et al., 2005; Jensen & Rush, 2000; Johnson, 2001); integration of skills with academic content (Hsu, et al., 2005; Johnson, 2001); isolation of skills separate from academic content, change of the traditional order of topics covered in a course (Johnson, 2001); and regular and constructive feedback (Hsu et al., 2005; Johnson, 2001; Levin & Levin, 1991).

Program – This study referred to a program as one in which a developmental/remedial science course(s) was offered in one or more disciplines alongside supplemental services such as placement, tutoring, Supplemental Instruction, academic advising, and/or counseling.

Science – This term was used in this study to refer to a single science area, such as biological, chemical, physical, or earth science.

Sciences – For the purposes of this study, the term “sciences” meant programs in which at least two of the following were included: biological, chemical, physical, or earth sciences.

Scientific literacy – For the purposes of this study, scientific literacy referred to the ability to understand scientific knowledge and apply that knowledge in everyday life. As defined by the Organisation for Economic Co-Operation and Development (OECD) (2004), scientific literacy was “the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity” (p. 286). The American Association for the Advancement of Science (2006, p. 1) agreed that to be science literate is to be “able to make sense of how the world works, to think critically and independently, and to lead interesting, responsible, and productive lives in a culture increasingly shaped by science and technology."

Support services – For the purpose of this study, support services included tutoring, Supplemental Instruction (Congos & Mack, 2005), advising/counseling, and placement of students.

Assumptions of the Study

Developmental/remedial sciences in higher education are not common (Hsu et al., 2005; Johnson, 2001). In fact, meetings and publications of NADE may not even make mention of them, perhaps because of a "view that students must have a firm grounding in reading, writing, and mathematics skills before they can succeed in a science course" (Hsu et al., 2005, p. 30). However, science courses can be important in developmental/remedial education when structured to help students develop the skills and mind-set necessary for success in higher education (Hsu et al., 2005). For the purposes of this study, the assumption was made that there was a need for community colleges to offer developmental/remedial sciences.

Another assumption was that there were some community colleges in the five states selected for this study that offered something in the way of developmental/remedial sciences, and it was further assumed that they would be willing to participate in this study by sharing their practices and experiences with developmental/remedial sciences.

An additional assumption was that respondents would have a similar understanding of the survey questions and that the interview questions were clear and did not make the interviewees feel as if they were being led to a particular response. A final assumption was that the responses received were an accurate and honest reflection of what was offered in the way of developmental/remedial sciences.

Delimitations and Limitations

Delimitations are factors that prevent a researcher from claiming that research findings “are true for all people in all times and places” (Bryant, 2004, p. 57). The underlying purposes of this study were to identify developmental/remedial sciences characteristics and practices and to describe those practices such that guidelines could be developed for institutions to consider in implementing developmental/remedial sciences on their campuses. Because this study focused only on community colleges in five states in the central part of the U.S., identified characteristics and practices in developmental/remedial sciences were not generalizable to other types of postsecondary institutions or to community colleges in other states due to state-specific or regional mandates.

This study relied upon data collected through self-reporting on surveys and in interviews (Creswell, 1998; Dillman, 2000). Hence, the data are only as accurate as they were reported. This was a limitation to the study. Further, the data collected reflected the situation as it existed in developmental/remedial sciences in the 2006-2007 academic year.

The case study component of this research was qualitative in nature. Consequently, the researcher’s impact on study design, data collection, analysis, and interpretation were limitations. Further, the fact that the selected institutions analyzed in the case studies were bounded systems limited the generalizability of their practices in general (Creswell, 1998) and to institutions in other states.

Significance of the Study

Phipps (1998) emphasized interinstitutional collaboration among colleges to share and replicate best practices and ideas as a strategy to improve the effectiveness of developmental/remedial education. Johnson (2001) noted

> as I examine science teaching journals, much of the emphasis is content-centered, not student-centered. On the other hand, the developmental education journals are more student-centered, but they usually do not address the teaching of . . . science. The ideal is to get both groups talking to each other (p. 154).

In this study, the identification of community college developmental/remedial science education practices helped to introduce to the developmental/remedial education and science education communities instructional practices and strategies in developmental/remedial sciences in the community colleges. By describing these practices, other institutions may be encouraged to implement developmental/remedial sciences. Additionally, the guidelines that resulted from this study may be helpful for such institutions.

The results of this study may be of benefit to developmental/remedial education program directors and instructors, postsecondary science educators, the fields of developmental/remedial education and postsecondary science education, and community college leaders and decision makers. Developmental/remedial education program directors can learn about developmental/remedial science program structures and goals, and instructors can learn about instructional practices and curriculum utilized in developmental/remedial sciences (Hsu et al., 2005). College science educators may learn more about how students learn science from institutions practicing developmental/remedial sciences.

Given little research related to developmental/remedial sciences, the field of developmental/remedial education stands to gain from this study of developmental/remedial science practices at community colleges. The postsecondary science education field may learn how to encourage students to enter the various fields of the sciences such that the United States can begin recruiting and training the next generation of American scientists.

Community college leaders and decision makers may gain a better understanding of the importance of developmental/remedial sciences, and developmental/remedial education in general, to inform their policy and decision making in instruction and instructional services.

Summary

In this chapter, the background for the study, the purpose and research questions, an overview of the method, terms, assumptions, delimitations and limitations, and significance were outlined. In Chapter Two, background information from the literature is provided for the reader to set the stage in the following areas: developmental/remedial education in higher education, the science education crisis in the United States, developmental/remedial sciences, and effective instructional practices in the developmental/remedial sciences.

The detailed methodology used in this study is provided in Chapter Three. The results are presented in Chapter Four. An analysis of the results, as well as guidelines for developmental/remedial science programs based on study results, and conclusions and recommendations for future study are offered in Chapter Five.

CHAPTER TWO

LITERATURE REVIEW

The purposes of this chapter are (a) to address some common questions associated with developmental/remedial education and describe the active debate regarding the appropriateness of developmental/remedial education in postsecondary education; (b) to introduce to the reader the science education "crisis" in the United States; (c) to discuss developmental/remedial sciences; and (d) to summarize existing studies of effective developmental/remedial sciences instructional practices.

Developmental/Remedial Education in Higher Education

Developmental/remedial education at the postsecondary level is an emotionally charged subject, with controversy swirling around the questions of: is it remedial, developmental, or does the process address elements of both? Attendant questions include the following: Why has developmental/remedial education suddenly become an issue? Who requires developmental/remedial services, why, and are they used effectively? Where should the responsibility rest for ensuring such services are available and accountable? Are there indices of successful postsecondary developmental/remedial education programs?

Remedial or Developmental Education?

In much of the literature, the terms remedial and developmental education are used interchangeably. But the term *remedial* has a "curative connotation" (Clowes, 1980, p. 8), inferring something was broken and needed to be fixed or remedied. That posture promoted a lack of self-efficacy in the students requiring educational intervention (Astin, 1998; Casazza, 1999). Furthermore, such a model implied one aspect of a person represented the whole; a low test score indicated an inability to be academically successful. Boylan et al. (1999) provided a more comprehensive definition of both terms:

> The term *remedial* refers exclusively to courses generally considered to be precollege level. Developmental courses are usually considered to be college level but with a focus on academic development such as study strategies, critical thinking . . . rather than a particular content area. Exceptions are sometimes found in mathematics and college writing, where the course content is clearly beyond high school but the course is considered developmental because it is designed to fill the gaps between high school preparation and college expectations. (p. 88)

Those authors wrote "developmental education, on the other hand, refers to a continuum of services ranging from remedial courses at the low end to tutoring or learning assistance centers at the high end" (Boylan et al., 1999, p. 88). Further, Casazza (1999) noted developmental education was a *process* involving the intellectual, social, and emotional growth and development of all learners. Using Casazza's definition, developmental education was an umbrella under which a variety of interventions can be placed (Cross, 1976; Oudenhoven, 2002), with the most visible and common being the developmental course. Kozeracki (2002) noted the concepts of remedial and developmental education have been differentiated, but it was unclear whether the differences were understood or accepted by students and instructors.

A New Problem?

No matter the definition, the need for developmental/remedial education is nothing new; ". . . remediation in colleges and universities . . . represents a core function that has been a silent but persistent part of higher education for hundreds of years" (Phipps, 1998, p. 20). As early as the 17th century, Latin and Greek tutors were provided for underprepared students at Harvard University. The 18th century saw the establishment of land-grant colleges to teach courses demanded by an increasingly industrialized economy. The Higher Education Act ushered in open admissions policies and became the hallmark of the 19th century (Payne & Lyman, 1996).

American colleges have more recently experienced an increasing enrollment of academically underprepared students (Johnson, 2001). A 1999 study by Sax, Astin, Korn, and Mahoney surveyed college freshmen regarding their use of tutoring and remedial work in high school and their expected need for similar services in college. Of the surveyed students, 13% reported that they had received tutoring or had remedial work in math while they were in high school; 5% had received comparable help in the sciences. When these same students were asked if they expected to need such tutoring or remediation in college, the percentages doubled from 13% to 26% for math, and from 5% to 10% for science.

Astin, Parrott, Korn, and Sax (1997) reported that students associate going to college with getting a better paying job because that is what they are taught and told by authority figures. However, as more students enter higher education, more enter with lower high school rank and lower standardized test scores as a result of gaps in prior learning. Increased academic disengagement among high school students was reported by Sax et al. (1999) as a contributing factor to gaps in knowledge, hence the increased need for college level remediation.

College Remediation: What It Is, What It Costs, What's at Stake reported

> the need to help underprepared students . . . has been embedded in the very fabric of the nation's higher education system for well over three centuries. . . . As higher education continues to educate an ever-growing proportion of the population, there is every reason to conclude that remediation will continue to be a core function of colleges and universities. (Phipps, 1998, p. 6)

To Remediate or Not to Remediate? – The Debate

Two schools of thought exist on developmental/remedial education at the postsecondary level: one supports developmental/remedial education and one is adamantly against it. Opponents have been so vocal in their arguments that policy debates have used these arguments as presumptions–presumptions not fully substantiated. There are three general arguments against developmental/remedial education:

1. *It was too expensive*. The money could be applied in other academic programs (Phipps, 1998).
2. *It was double billing*. Availability of developmental/remedial education in higher education provides no incentive for students to do well in high school. Taxpayers resent paying twice for students to learn the same thing (Phipps, 1998; Roach, 2000).
3. *Developmental/remedial education was an inappropriate college function*. Admitting underprepared students and providing developmental/remedial services threatens an institution's reputation and sense of academic excellence (Astin, 1998, 2000; Moore, 2004). If postsecondary remedial services are to be offered, four-year institutions should not be involved, placing the sole responsibility on community colleges (Phipps, 1998).

Proponents of developmental/remedial education responded to the criticisms:

1. *Developmental/remedial education was too expensive*. Developmental/ remedial education absorbed less than 1% annually from a $115 billion federal higher education budget (Breneman & Haarlow, 1998). Students who successfully completed remediation were more likely to persist (Friedlander, 1981; Perin, 2002; Tinto, 2003; Waycaster, 2001), and the tuition paid helped to partially offset the costs of such services (Friedlander, 1981). Astin (1998) argued “effective ‘remedial’ education would do more to alleviate our most serious social and economic problems than almost any other action we could take” (p. 12). An investment in developmental/remedial education was more cost-effective than the alternatives: low-paying jobs, welfare, incarceration, etc. Phipps (1998) added that attending college yielded great benefits to society, including increased tax revenues, greater productivity, decreased crime rates, and the like. Consequently students who benefited from developmental/remedial instruction contributed to the public good. “Abandoning remedial education . . . would be unwise public policy” (Phipps, 1998).
2. *It was double billing*. The National Center for Education Statistics (NCES) report *Remedial Education at Higher Education Institutions in the Fall 1995* indicated that in many instances, the public did not pay even once. Analyzed data led to the belief that just over half of high school graduates in 1994 completed a college-preparatory curriculum, meaning just *under* half did *not*

complete the curriculum (Lewis & Farris, 1996). In addition, many students who required remediation were returning adult students who likely attended high school when participation in college-preparatory courses was lower than current rates (Boylan, 1999). When juxtaposing this fact against the realization that all high school graduates do not intend to attend college, it becomes evident that the issue of double billing is a claim more spurious than fact.

3. *Developmental/remedial education was an inappropriate college function*. This argument failed to consider the wide range of adults served by developmental/remedial education. Kozeracki (2002) cited a Nevada study by Woodhams (1998) in which only 19.6% of developmental education students were recent high school graduates, and more than 30% were over the age of 30. Students who participated in such courses may be strong in some areas but weak in others. Oftentimes they were good students who needed refreshers because of having been out of school for some time (The Institute for Higher Education Policy and The Education Resources Institute, 1996).

   Casazza (1999) noted

   > There has always been a tension between those who would provide access and those who fear it will lower standards. There have always been and there will always be students who are very capable of succeeding but simply need additional assistance. (p. 5)

   Developmental/remedial programs give many students the opportunity to be successful (Boylan, 1999) and enable the maintenance of high academic standards by better preparing underprepared students for subsequent coursework (Friedlander, 1981).

As for a decline in institutional reputation, perceived loss of prestige is considered by some to be an elitist posture:

> Just as our preoccupation with materialism, individualism and competitiveness makes it difficult for us to be responsible citizens who work cooperatively for the collective good of all citizens (especially the least advantaged ones), so does higher education's preoccupation at the institutional level with . . . reputational enhancement make it difficult to appreciate the critical importance of effectively educating all students, and especially those who are underprepared. . . . We forget that our institution's mission is to develop students' intellectual capacities, not merely to select and certify those students whose intellectual talents are already well developed by the time they reach us. (Astin, 1998, p. 12)

Developmental/Remedial Education – Whose Responsibility?

In 1996, the Massachusetts Board of Higher Education set into motion policies to simultaneously increase university admissions standards and reduce remedial education at the universities in the state. In 1995, 24% of entering freshmen at the state's comprehensive colleges and 22% at the University of Massachusetts required remediation. By fall 1997, only 10% of first-time freshmen were allowed to enroll in remedial courses at four-year institutions, and by fall 1998 that number had been reduced further to 5%.

> Community colleges were identified in the . . . mission statement as the site of remedial education in Massachusetts, and the four-year colleges were encouraged to create partnerships with local community colleges to eliminate remedial education at the four-year campuses altogether. (Bastedo & Gumport, 2003, p. 349)

Similar action was taken in 1998 by the City University of New York (CUNY) Board of Trustees when it voted to phase out all remedial education from its 11 four-year senior colleges, placing full responsibility for developmental/remedial education upon its numerous community colleges (Bastedo & Gumport, 2003; Phipps, 1998; Trombley, 1998).

Other states, including Colorado, Missouri, Florida, and South Carolina, are among a growing list of states considering the same policy (Jenkins & Boswell, 2002; Kozeracki, 2002). An NCES national survey of remedial education in higher education institutions in the United States in fall 2000 found that 98% of public two-year colleges offered at least one remedial course with 96% offering remedial courses in each of the three subject areas of reading, writing, and mathematics. Public two-year colleges offered a greater number of different remedial courses than did four-year institutions. Further, 42% of entering college freshmen enrolled in at least one remedial reading, writing, or mathematics course at a public two-year college versus 20% at public four-year institutions (Parsad & Lewis, 2003). Boylan et al. (1999) pointed out

> community colleges serve as a pathway to a baccalaureate degree for many students whose family, financial, or social circumstances prevent them from attending a four-year institution. They also provide education and training for those who have no intention of seeking a baccalaureate degree but still seek the benefits of postsecondary education. Both of these groups are likely to require substantial amounts of developmental education, including remediation. Community colleges are currently the primary provider of developmental education and the need for them to do so will continue. (p. 97)

Advocates of developmental/remedial education agree that serving underprepared students is an important part of the community college mission, but fear that making community colleges solely responsible will create further separation and stratification between two-year and four-year institutions (Bastedo & Gumport, 2003) and exacerbate the already limited resources of community colleges (Oudenhoven, 2002). The fact remains that community colleges are being expected to assume an even greater responsibility for developmental/remedial education.

Whereas some research has shown that students who begin higher education at community colleges are 13% less likely to attain a baccalaureate degree than students who begin at four-year institutions (Whitaker & Pascarella, 1994), it is worth mentioning that analysis of more recent research has revealed a substantial proportion of community college students did not have degree completion as their main motivation for attending college (Horn & Nevill, 2006). Based on data from the *National Postsecondary Student Aid Study 2003-04* (NCES, 2004b), Horn and Nevill (2006) noted these students more often cited personal interest (46%) and job skills (42%) rather than transfer to a four-year college (36.5%) (Horn & Nevill, 2006, p. 23), hence lesser intent to complete a baccalaureate, as reasons for attending. Further, the same study revealed that community college students who were considered “more committed” because of their college attendance intensity (full-time enrollment status) and self-reported intentions to either transfer to a four-year institution or complete an associates degree or certificate program at a community college participated in developmental/remedial education overall more often (20%) than students in a “less committed” (based on part-time or less-than-part-time enrollment status) group (12%), as well as in specific disciplines such as math and English. These results further substantiate the important role of community colleges in developmental/remedial education.

The centrality of community colleges to developmental/remedial education is clear (Boylan et al., 1999; Cohen & Brawer, 2003; Horn & Nevill, 2006; Lewis & Farris, 1996; NCES, 1996; Parsad & Lewis, 2003; Southard & Clay, 2004). If developmental/remedial students fail at the community college, they may not have access to other academic institutions; thus, effective developmental/remedial education at community colleges is crucial to the future academic success of developmental/remedial students (Southard & Clay, 2004).

While resolving responsibility for such instruction is one issue, determining if the instruction adds value is another critical issue.

Successful Developmental/Remedial Education

Casazza (1999) claimed successful developmental/remedial education programs emphasized (a) a process involving more than a better grade in a class; (b) a holistic approach to learning encompassing the intellectual, social, and emotional development of learners; (c) identification of weaknesses and strengths of students; and (d) was not limited to learners at any particular level. To crystallize her observations, Casazza said, “We are all developmental learners depending on the context in which we find ourselves” (p. 6).

Others agreed that a comprehensive approach to developmental/remedial education was good educational policy and added that the best developmental/remedial practices

1. Offered credit for developmental/remedial courses (Hsu et al., 2005; Kozeracki, 2002).
2. Provided training and professional development for faculty involved in teaching developmental/remedial courses (Spann, 2000).

3. Established faculty-to-student ratios appropriate for effective and efficient developmental/remedial education. Spann (2000) noted educators want the intervention to work the first time in order to enhance student self-efficacy.
4. Employed regular and systematic program evaluation (Boylan et al., 1999). Phipps (1998) called attention to the reality that not all developmental/remedial education was delivered effectively or efficiently, nor did institutions consistently assess the effectiveness of developmental/remedial education (Roueche & Roueche, 1999). Spann (2000) suggested institutions should determine the extent to which students receiving such education benefit and use the information in a formative manner. Hsu et al. (2005) provided a model of continuous evaluation of courses, curriculum, and instructional practices.
5. Enforced exit standards for developmental/remedial courses (Phipps, 1998) in order to match developmental/remedial exit standards to regular college course entry expectations such that students who completed remedial courses would have the level of skills and knowledge needed to enter college level courses (Moore, 2002a).

While much discussion has centered around developmental/remedial education in general, there has been relatively little conversation regarding the teaching of sciences in a developmental/remedial education context.

The Crisis in Science Education in the United States

The U.S. is Lagging Behind

The lagging numbers of science and engineering college graduates in the United States are of major concern (Fullilove & Triesman, 1990; McDonald & Dominguez, 2005; NCES, 2004a). From 1985 to 2002, a 4.6% decrease in bachelor's degrees and a 0.5% decrease in graduate degrees awarded in science, math, and engineering in the United States has occurred (NCES, 2004a; OECD, 2004). Not only has the percentage of these degrees within the U.S. declined, but the country has lagged behind 18 of the 25 listed countries in undergraduate degrees and 20 of the 25 listed countries in graduate degrees in these fields (NCES, 2004a; OECD, 2004).

Paldy (2005) noted concerns from the Pentagon regarding the declining number of U.S. citizens choosing careers in science and engineering, so much so that the American Film Institute's Catalyst Workshop was created to address "one of the most significant issues facing our nation: the need to engage society (especially young people) in the activity of science" (AFI, 2006). Through the workshops, science-literate writers (read: scientists) were recruited to create motion pictures with better science in an effort to attract young people to science fields.

Science Education Reform

The United States has struggled with science education reform for nearly a century. Reform efforts following WWI were aimed at helping students better and more effectively participate in democracy, emphasizing the connection between science and society, yet they excluded women, students from disadvantaged circumstances, and ethnic minorities. In an attempt to increase U.S. competitiveness in the space race following the Soviet's 1957 launch of Sputnik, American government placed millions of dollars in the hands of scientists to reform science education through training and advanced degrees for science teachers and curriculum development by scientists in order to arm teachers with the most current scientific information. Science became increasingly popular and competitive, and teachers singled out the best and brightest students (Bybee & Fuchs, 2006; Moore, 2001, 2002b). However, little attention was then given to individual student needs and the social constraints of science such that women, disadvantaged students, and minorities were still denied access to science (Anderson, 1983; Moore, 2001, 2002b).

The 1980s were marked by poor standardized test scores (Moore, 2002b) and led to a new wave of science education reform which focused on teacher preparation and educational standards (Hurd, 1983). These standards emphasized science literacy for all high school graduates. As described by Project 2061 of the American Association for the Advancement of Science in *Science for All Americans* (Rutherford & Ahlgren, 1990), standards included the nature, benefits, limitations, and interconnectedness of science, math, and technology; an understanding of life and the natural world; and the impact of human interaction with the natural environment. However, this continued to exclude women, minorities, and the disadvantaged, the populations most often needing developmental/remedial education.

In the 1990s, schools continued to cope with the social change of "having to provide science as a meaningful study for all students, rather than the small minority who might become the next generation of professional scientists" (Fensham et al., 1994, p. 1). As such, general science education reform emphasized science teaching and learning standards (Fuhrman & Malen, 1991), but the "crisis" still had not been addressed. Leonard (2000, p. 386) stated "the vast majority of college students are not . . . learning science" because college science courses were notorious for poor teaching. So even though science may have attracted the best and brightest students, the environment was still "hostile" to those who most often take advantage of developmental/remedial education, namely women, disadvantaged students, and minorities (Moore, 2001).

Based on larger numbers of economic competitors, complex skills needed by today's and tomorrow's students, and an undefined timeline for improving science and technology education, Bybee and Fuchs (2006) wrote of concerns that the U.S. is in danger of losing its competitive edge in the global economy if real action in science education reform does not occur. These authors synthesized 12 major reports from the interconnected fields of business, industry, and government and noted key recommendations for K-12 science and technology education, including preparation of the 21st century workforce as measured by higher achievement by larger numbers of students on such tests as the National Assessment of Educational Progress and Third International Mathematics and Science Study (described below), and policies and programs addressing workforce competencies and career awareness, equity issues, and science and technology. The need for high quality teachers, rigorous content, and appropriate assessments aligned with goals were common across all reports. Each report mentioned the crucial role of science and technology in the increasingly global economy but failed to directly address science education (Bybee & Fuchs, 2006).

While literacy and mathematics were cited frequently as leading disciplines, for global competitiveness to be maintained, science education must be seen as central to realizing desired workforce competencies, including critical thinking, complex communication skills, and problem solving, all skills and abilities promoted by scientific inquiry. Further, it was noted that research-based educational approaches informing the above recommendations were scarce. Bybee and Fuchs (2006) argued that there is a compelling need for research studies that would inform science educators and policy makers. Indeed, enduring educational reform is not easily achieved (Rutherford & Ahlgren, 1990), and the United States cannot afford to wait for a 21st century version of Sputnik to force real action in science education reform (Bybee & Fuchs, 2006).

Students are Underprepared in the Sciences

The 1995 Third International Mathematics and Science Study (TIMSS) assessed fourth and eighth grade student performance across a range of nearly 50 countries and revealed American student performance in math and science to be lower than most other countries, especially in the eighth grade (NSF, 2005). Overall, of the 14 countries that participated at the fourth grade level during both 1995 and 2003, U.S. students outperformed students in fewer countries in 2003 than in 1995, indicating that "U.S. 4th-graders are not keeping pace with their international peers in science" (NCES, 2006, n.p.).

U.S. eighth graders, however, performed above the international average and had higher science scores in 2003 than international peers in 32 of the 44 participating countries. Further, of countries participating in both 1995 and 2003, U.S. eighth graders performed better than their peers in 11 countries in 2003 versus 5 countries in 1995. In sum, TIMSS results from 1995 to 2003 indicated American fourth graders showed no measurable gains in science performance on average, with eighth graders showing some improvement (NCES, 2006).

The 2005 National Assessment of Educational Progress (NAEP), used to compare the performance of U.S. students to other U.S. students, also indicated that the United States is falling behind in science. This national test of fourth, eighth, and twelfth graders indicated that

> at grade 4, the average science score was higher in 2005 than in previous assessment years. At grade 8, the average science score in 2005 showed no significant change compared to results in 1996 and 2000. At grade 12, the average science score was lower than in 1996, and showed no significant change from 2000. (NCES, 2005, n.p.)

The test reports student performance on three levels: *Basic*, *Proficient*, and *Advanced*. The percentage of fourth grade students performing at or above *Basic* level increased from 63% in 1996 and 2000 to 68% in 2005; there was no significant difference in *Proficient* level performance over the three assessment years, and the percentage of *Advanced* performing fourth graders decreased only fractionally from 1996 to 2005. Eighth grade students’ performance percentages did not change significantly between 1996 and 2005 for the *Basic* and *Proficient* categories, but the percentage of students with *Advanced* performance was lower in 2005 than in 2000. The percentages for twelfth grade students in all performance categories were lower in 2005 than in 1996 (NCES, 2005).

Overall, for fourth graders across participating states in 2005, a range of 17-50% performed below *Basic*, 33-47% at *Basic* level, 12-35% at the *Proficient* level, and 1-5% performed at the *Advanced* level. For eighth graders overall, 24-60% performed below *Basic* level, 26-37% at the *Basic* level, 13-38% at the *Proficient* level, and 1-6% at the *Advanced* level.

In the fourth grade group, a significantly larger number of Blacks, Hispanics, and students eligible for free school lunch (indicating challenged economic status) performed below *Basic* level achievement than did White students and students who did not qualify for free school lunch. The below *Basic* achievement levels were above 20% for all but three participating states, with an overall average of 34%. For eighth grade test takers, females, Blacks, Hispanics, and students eligible for free school lunches performed far below males, White students, and those who did not qualify for free lunches. The below *Basic* achievement levels were above 20% for all participating states, with an overall average of 43% (NCES, 2005).

Demographic data for twelfth grade students was not available, but a trend based on how many science courses were taken indicated twelfth graders who took biology, chemistry, and physics performed better than students who took biology and chemistry or just one science course in high school.

So, while data may be encouraging for younger students, twelfth grade figures are discouraging; instead of making progress as they move through the school system, students are falling short. These data taken as a whole indicated students are not coming out of high school prepared for secondary sciences much less college level sciences. Further, females, ethnic minorities, and students from disadvantaged circumstances are less likely to be prepared in the sciences compared to white students.

Rutherford and Ahlgren's (1990, n.p.) comments were consistent with these findings:

> U.S. schools have yet to act decisively enough in preparing young people—especially minority children, on whom the future of America is coming to depend—for a world shaped by science and technology. Sweeping changes in the entire educational system from kindergarten through twelfth grade will have to be made if the United States is to become a nation of scientifically literate citizens.

Still others agreed with the fact that students lack the skills needed to conduct scientific inquiry even at the simplest level (Wilke & Straits, 2005).

In a discussion of what he called the "urban achievement gap," Moore (2002a) noted students from urban environments had lower than average scores on national achievement tests and standardized tests in all subject areas in all grades, and that lower numbers of ethnic minority students took college preparatory courses compared to White students. These disparities were especially pronounced in the sciences. Nationally, over 40% of all community college freshmen required remediation (Ignash, 1997), with even higher numbers in some states (Hoyt & Sorensen, 2001).

Moore (2002a) recommended, based on his research and on findings by Adelman (1999), that "science for all" programs to increase science literacy, hence economic access, can occur by "offering more rigorous and relevant courses, integrating students into content-rich courses, ensuring that all students have an equitable opportunity to learn, and requiring all students to learn before they can graduate" (Moore, 2002a, p. 9).

Inadequate preparation of students in the sciences is a critical issue (Bastedo & Gumport, 2003; Biermann & Sarinsky, 1993; Moore, 2002a; Roach, 2000). It is obvious that many students entering community colleges are poorly prepared for the introductory science courses they encounter for a number of reasons, which could include that they had weak math and verbal skills that led them to avoid sciences in high school, hence they were never exposed to science or the abstract logic associated with understanding science concepts; they took science courses in high school, but have been out of school for some time, so that they have forgotten what they learned; or perhaps they are from a foreign country. Science preparation for many students is poor, thus they tend to avoid choosing majors in a science or science-related field (Biermann & Sarinsky, 1993). However, higher education is not in a political position to make rapid changes in what occurs in the high schools.

Roach (2000) wrote of the Collaborative Academic Preparation Initiative, which placed California State University system faculty, administrators, and students in California high schools to help implement curricular changes in an effort to reduce the number of students requiring developmental/remedial education in the state's higher education system. However, while such collaborative relationships between colleges and high schools may show some promise, the need for community colleges to offer developmental/remedial sciences still exists. If the gap between high school graduation and adequate college preparation could be filled, such collaboration would be much more widespread than it is today. The gap would already be filled.

Developmental/Remedial Sciences

Instead of pointing fingers, community colleges must then focus on what is within their control–meeting the students coming out of the high schools and working with them in order to "foster the intellectual skills of underprepared students and expose them to experiences that will provide them with the means to function in courses taken by the general college population . . . [and] promote the necessary self-confidence to succeed" (Biermann & Sarinsky, 1993, p. 53). This requires developmental/remedial education, as many students are not ready to step into college level science classes for the purpose of accruing general education credits or as science majors.

Hsu et al. (2005) stated the goals of developmental/remedial science courses are to "help students learn the concepts of a particular field of science as well as the methods of inquiry and ways of knowing used in science" with the addition of course design that helps students "acquire the attitudes and learning skills necessary to be successful in their future college courses, both science and nonscience" (Hsu et al., 2005, p. 32).

Developmental/remedial sciences are a way to help underprepared students increase their readiness for college level sciences. Yet Hsu et al. (2005) wrote

> through our professional associations, we are not aware of a single developmental education program in the United States that includes a science course as part of its curriculum. . . . Presumably the absence of science courses from developmental education comes from the view that students must have a firm grounding in reading, writing, and math skills before they can succeed in a science course. . . . In our view, science courses can be an important component of a developmental education program when they are structured in such a way as to help students

> develop the skills and attitudes necessary for success in postsecondary education, including skills in reading, writing, and mathematics. (p. 30)

Provide Inclusiveness/Access to Science

By the time students reach the college level, a prior negative experience with science or a science course is not uncommon (DiMuro, 2006). As such, some may be intimidated by the idea of just taking a science class, much less majoring in a science or science-related field (Biermann & Sarinsky, 1993). Developmental/remedial sciences at the college level help students to see science as something they could learn–to see an understanding of science as an attainable goal (Hsu et al., 2005).

Moore (2002b) noted the "hostile" environment of science education for developmental/remedial education students, promoted by the large number of scientists and educators who believe science is "beyond the grasp" of these students, and explained "this is why virtually all universities include only reading, writing, and math–and not science–in their developmental education programs" (p. 83).

The objectivist penchant of most science teaching was described by Moore (2001) as a contributor to the hostile environment. The objectivist approach, described as one in which instructors "open the student's head, pour in knowledge, close the student's head and then have the student take a test" (Leonard, 2000, p. 386) is at odds with how science is actually done. Moore (2001) observed that such an approach "often discriminates against students, especially those in developmental education, who have alternate ways of learning" (p. 144). Science is problematic for developmental/remedial education students when it is taught out of context and as if there is only one way to teach and learn (Moore, 2001; Waycaster, 2001).

"Conventional methods of covering the subject matter and presenting only the scientists' view of scientific phenomena clearly do not effectively teach science to all students" (Wittrock, 1994, p. 30). Adding to the problem is that as more students who effectively compete under the traditional objectivist model go into the sciences, the traditional approach is perpetuated such that few new groups of students benefit (Atwater & Brown, 1999, as cited in Moore, 2001). This model may create in developmental education students, primarily women, ethnic minorities, and financially disadvantaged students, an apathetic perception of science (Marx et al., 2006) or may intimidate these students to avoid the sciences altogether in college.

Moore (2002b) defined developmental/remedial education students as women, ethnic minorities, and poor students who have issues beyond academic underpreparedness and noted that if academic preparation or intelligence was the main issue, remediation would be a "simple solution" (p. 87). However, these students have many variables beyond underpreparedness that figure into the equation. Factors such as self-confidence, self-control and discipline, attitude about education, social justice, and the ability to seek help (Boylan & Saxon, 1998, cited by Moore, 2002b; Ryan, Pintrich, & Midgley, 2001) all influence a student's ability to be academically successful, yet have nothing to do with academic skills or intellectual ability. By considering how science education programs can embrace teaching science to *all* students, developmental/remedial science students may achieve better access to the sciences.

Moore (2002b) outlined five phases through which institutions progress before they are inclusive of *all* students, including developmental/remedial students, in the sciences. He then offered suggestions for moving beyond a particular phase toward a more accessible/less hostile environment. The five phases and Moore's suggestions follow:

1. *Ignoring the problem.* In this phase

   > faculty, administrators, and students do not know or care that developmental education students . . . are excluded from science programs. In these programs, no one asks or cares about how their courses, pedagogical techniques, student services, or attitudes contribute to the retention and success of students. (Moore, 2002b, p. 85)

   The general consensus is that developmental/remedial students hinder a quality science program.

   To move forward, Moore wrote that developmental/remedial education students must resist developing self-fulfilling prophecies of failure because of an institutionalized attitude that they are incapable of being successful in a science course or program.

2. *Noticing the problem but implementing ineffective changes*. At this phase, institutions tend to emphasize student deficiencies as opposed to identifying obstacles and possible discriminatory practices of the science education they offer. And at this phase, "courses remain a 'filter' that excludes students from science rather than a 'pump' that helps ensure students' access to and success in science" (Moore, 2002b, p. 86).

   Typically developmental/remedial education students are placed into 'remedial' or 'skills' courses rather than content courses, blocking their participation in mainstream science courses. But the feasibility of such an action has been questioned, as isolated skills courses can be a "dead end" for most students (Richardson, Fisk, & Oken, 1983, as cited by Moore, 2002b) and grouping students by ability into remedial courses can perpetuate ethnic and socioeconomic segregation of educational programs (Atwater, 1994). Moore (2002b) wrote "it is difficult to see how placing students into remedial courses can be a better alternative to the opportunity to succeed in a content course" (p. 86).

To move forward, faculty and administrators must move toward removing barriers that block students' access to science.

3. *Identifying and removing barriers*. The educational experiences of developmental/remedial education students tend to be impacted by many factors beyond academic ability, including but not limited to self-confidence, attitude toward education, and ability to seek help.

   To move forward, educators should be encouraged to help students connect with what they study, see science in a broad social context, and understand that science can be compatible, not competitive, with other personal goals the student may have. Furthermore, educators should design engaging courses using a variety of pedagogical techniques in a more intimate environment.

4. *Students learn the contributions of women, minority, and disabled scientists*. Because many developmental/remedial students see themselves as outsiders to science, especially when most role models are White males, emphasis can be

placed on the important contributions of women, minorities, and disabled scientists to break the stereotype.

5. *Redefining and restructuring science to include all students*. Achieving the goal of science access for all students involves embracing the following recommendations: Good science teaching involves teaching science to all students; involves multiple ways of knowing and doing science to illustrate that science is not isolated; insures social justice; immerses learners in the construction of meaningful knowledge; and integrates skills with content (Rosser, 1995, cited by Moore, 2002b).

Moore (2001) argued that for science education to be truly inclusive, reform efforts must be shifted from deficiencies of developmental/remedial education students to the biases and deficiencies of *science and science education*. He called for reform toward a constructivist approach in which knowledge is constructed by learners instead of imparted by teachers and books as the authority figures of knowledge (Moore, 2001; Roth, 1994).

Constructivism

The fundamental principle of the constructivist view of learning is that individuals construct their own meanings for experiences. "The constructed meaning depends on the person's existing knowledge, and since it is inevitable that people have had different experiences and have heard or read different things, all have different (though often similar) meanings for any concept" (Fensham et al., 1994, p. 5).

While construction occurs with each individual, it can be guided by the instructor with selected instructional approaches. Students may come to class with some prior knowledge, which may or may not be accurate. “Instruction, then, must account for students’ prior knowledge in order for them to gain a more accurate understanding” (Jensen & Rush, 2000), for a “conceptual change” to occur. Fensham et al. (1994) considered the example of sucking liquid through a straw:

> When learners come to understand the notion of pressure difference, they do not drop the work “suck,” though their conceptions of sucking change. Knowledge about pressure has been added, but old knowledge is revised rather than abandoned. A conceptual [change] has occurred. (p. 7)

Clement (1982) noted students’ preconceived misunderstanding of the relationship between force and acceleration, hence “learning becomes a process in which new concepts must displace or be remolded from stable concepts that the student has constructed over many years” (p. 66). In another example, Jensen, Wilcox, Hatch, and Somdahl (1996) noted that students often had flawed conceptions of the various forms of membrane transport (diffusion, osmosis, etc.) so that, before newer accurate conceptions could be constructed, the old, flawed conceptions had to be addressed. Such is the nature of conceptual change (Jensen & Rush, 2000).

Wittrock (1994) argued that science teaching not only focuses on presenting the subject matter of science and the scientists’ views, but

> also involves understanding the students’ views of science concepts. Teaching involves more than showing students the incorrectness of their beliefs that work quite well for them everyday in realistic contexts. It involves more than setting up dissonances between students’ models and teacher controlled demonstrations. It involves leading students to test and develop their models and thought processes in familiar contexts, which they believe are real, representative of everyday

> experience, and under their control rather than subject to manipulation by powerful people who cause clever but false things to happen. (pp. 32-33)

Further, constructivist approaches

> stimulate learning by *all* students because they immerse students in science, show students how relationships and knowledge are situated within the discourses of scientific knowledge and authority, and demonstrate to students the cultural, social, and historical aspects of science, in the classroom as well as in society. (Moore, 2001, p. 146)

Discovery- (or Inquiry-) Based Learning

Another approach is discovery-based learning, intended to better align the study of science with the practice of science (NRC, 1996). Contrary to the more common cookbook approach to science education involving little critical thinking or elements of creativity or discovery (Moore, 2001; Sundberg, Armstrong, Dini, & Wischusen, 2000), the discovery-based approach, especially when combined with supplemental activities such as tutoring and cooperative learning, increases student self-confidence and motivation to learn by immersing the students in their work so that they gain a better understanding of the purpose of their work and learn more (Morrow, 1999), even though they find the activities more challenging and work-intensive than traditional activities (Moore, 2001).

Piaget (1970) noted that students who utilized concrete reasoning benefited from hands-on activities because, through the experiences of such sensory activities, students constructed their own knowledge, leading to enhanced cognitive development and achievement in the sciences (Koballa, 1986). The expense of hands-on activities, however, has been an obstacle for schools, such that students were not challenged to develop reasoning skills beyond the concrete. This created barriers for students in learning scientific concepts that required abstract reasoning abilities.

A study by Biermann and Sarinsky (1993) compared a preparatory college biology course taught using two different instructional methodologies, a laboratory hands-on approach and a remediation-based course, to determine which approach was the better preparation for follow-up courses. The courses were initially developed to improve student performance in anatomy and physiology, the first of a two-semester sequence for students going into allied health majors, and general biology, the first in a two-semester sequence for science and pre-physical therapy majors.

Both approaches incorporated discussion with demonstrations, hands-on lab experiences, and remediation skills, but the curriculum involved using the instructional approaches at different levels. In the course using the hands-on approach, students performed basic scientific skills (proper use of lab equipment, use of scientific methodology, designing experiments, collecting, organizing, and drawing conclusions from data) for 27 hours, and spent 19 hours on discussion with demonstrations, and one hour of class time and one hour of discussion time on remediation. The remediation-based course spent 15 hours on basic scientific skills, 9 hours on discussion with demonstrations, 10 hours on remediation during discussion time, and 14 hours of class time practicing the skills they learned. Remediation skills included vocabulary enhancement, reading comprehension, and library and math techniques.

Two years of data were collected for (a) students who placed into the preparatory course based on below standard grades on the freshman skills assessment test for reading and math, and (b) students who enrolled directly in general biology or anatomy and physiology courses without having to take the preparatory course (control group). Grades earned in the preparatory course using both approaches, grades earned the first time through general biology and anatomy and physiology (the follow-up courses), and grades earned in the *best* follow-up (best grade earned if the student took the follow-up course multiple times) were collected.

From a hands-on group of 406 students and a remediation-based group of 323 students, a one-way ANOVA demonstrated that the two groups were not statistically different in grades in the preparatory course, but the hands-on group performed significantly better ($p < .05$) in the initial and best follow-up grades. The control group of 68 students was not statistically different from the remediation-based group in any of the comparison categories. However, the hands-on group significantly ($p < .05$) outperformed the control group in initial follow-up grades. Overall, analyses of variance confirmed the hands-on group performed significantly better, based on course grades, than both the control group and the remediation-based group (Biermann & Sarinsky, 1993).

The team concluded that "students in the hands-on group may have performed better in subsequent biology classes because the techniques used . . . fostered the intellectual and practical skills necessary to succeed" (Biermann & Sarinsky, 1993, p. 58). They strongly encouraged the development of laboratories using a hands-on inquiry-based approach to better facilitate science learning.

An inquiry-based approach allows a focus on student understanding; for example, buying into the role of math in physical science. Commonly, math classes focus only on simplifying abstract expressions rather than on applications. In the physical science course described by Johnson (2001), being able to *apply* math is essential. “It is necessary for students to have the hands-on experience of the observation and analysis processes in order for them to realize what graphs, equations, and inequalities are all about” (Johnson, 2001, p. 159).

Integrating Skills with Course Content

Hsu et al. (2005) noted that learning is highly context-dependent and that knowledge and skills learned in an abstract way or in only one specific context may be applied incorrectly or not at all to new situations. Additionally, before being able to transfer a skill to a new context, learners must have the opportunity to practice the new skills in a number of different contexts (Perkins & Solomon, 1989). Consider that in a typical science course, students must be able to read a textbook and extract information from it, perform laboratory investigations and summarize their work in lab reports, and use math to analyze quantitative data they collect during the course of an experiment. Without question, science courses “provide a concrete context in which students can practice . . . basic skills in the service of learning disciplinary context” (Hsu et al., 2005).

Because higher education must serve a greater diversity of students with a greater diversity of academic needs (many requiring help with study skills and basic content knowledge), Johnson (2001) noted the strong need for “bridging the teaching of physical science with the teaching of developmental strategies” (p. 154). Most developmental support is separate from content courses where the students could be learning study skills easier and faster by practicing and applying their newly learned skills to the content areas. This isolated type of structure increases time to degree and costs to attend, and uses up student financial aid (Johnson, 2001).

Student achievement and motivation to learn and ask for help are greater when skills are embedded in degree credit-bearing content courses where the student recognizes the purpose of the skills while applying them to more easily learn content (Francisco, Trautmann, & Nicoll, 1998; Gebelt, Parilis, Kramer, & Wilson, 1996; Levin & Levin, 1991).

A science faculty member in the former General College at the University of Minnesota, Johnson (2001) outlined the strategies used when integrating study skills into his physical science course. The course had a typical enrollment of 40-60 students, all diverse in their background knowledge of basic science concepts, math aptitude, maturity, attitude toward the course, confidence in their ability to do well in the course, and willingness to get involved in the course. The course itself had developmental support running simultaneously with the content such that study skills and basic knowledge of science and math were integrated, allowing students to also learn the concepts and terminology associated with the discipline. Various developmental strategies were employed to help “motivate students to buy into the educational opportunities that lie before them so that they take ownership in their own educational endeavors” (Johnson, 2001, p. 156), including frequent testing and a repetitive routine, changing the order of the curriculum to better suit the needs of developmental students, and gradually working toward higher order thinking skills.

Changing the Curricular Order

Learning science within the context of what is familiar to students "can lead to the application and understanding of new concepts, principles, and terminology from physics, chemistry and biology" (Johnson, 2001, p. 158). Consequently, the order of topics in a typical class may need to be changed in order to make the content more understandable for students. For example, Johnson's (2001) Weather and Climate class would typically use a small scale to planetary perspective, but the order was changed because it was easier for students to understand the reverse perspective. While there may be barriers to changing the order of topics (traditionally organized texts, faculty colleagues with traditional training, etc.), it may be easier for students to see the whole before the parts in order to better understand the parts (Zoller, 2000).

Higher Order Thinking Processes

Higher Order Thinking Skills

Bloom's *Taxonomy* (1956) arranged cognitive skills in "a hierarchy of ascending complexity and abstractness beginning with knowledge (i.e., retention of information), which is followed by five kinds of intellectual skills and abilities: comprehension, application, analysis, synthesis, and evaluation" (Jensen & Rush, 2000, p. 49). Through this hierarchy, Bloom (1956) emphasized that while gaining knowledge is important, even more important is the application of that knowledge, allowing students to do something with what they have learned. The physical science course described by

Johnson (2001) placed heavy emphasis on application (i.e., given data, students are asked to draw conclusions) to help students see they could do science and to help them view the field as professionals do. That is, because professionals have to take information/data and make sense of it to draw conclusions, so must students be asked to analyze data to draw conclusions (Johnson, 2001).

Hsu et al. (2005) agreed that science classes offer ideal opportunities for students to practice higher-order thinking skills through the synthesis/application/evaluation process (Bloom, 1956): synthesis of experimental results, development of theories and application of those theories to new contexts, and finally evaluating results to determine if the theory they had developed was useful.

Jensen and Rush (2000) described a human biology course emphasizing human anatomy and physiology, which was taught in a developmental education context at General College, University of Minnesota. The initial emphasis of the course was on mastery of anatomy, but as the course progressed, a greater emphasis was placed on physiology. The idea was to help students advance through Bloom’s (1956) taxonomic stages, from the lower level cognitive skills needed to master anatomy, to the higher level skills required to understand physiology. Course exams were made up of both anatomy and physiology questions, but the emphasis on each changed along with the course emphasis as the course progressed. That is, physiology questions made up a larger percentage of the exams as the course went along; the final exam was almost entirely physiology based.

For the anatomy component of the course, students were expected to master (answer quiz and exam questions without mistakes) terminology, the names of bones, muscles, etc. The goal of anatomy mastery was not only to help students learn basic anatomy at the "knowledge" level of learning, but also to provide "a small domain of information that the students can master" (Jensen & Rush, 2000, p. 50) in order to improve developmental/remedial students' self-confidence that they can be successful in a science course and that they can be successful college learners.

More complex physiological events were taught to help students question and analyze their prior knowledge, which may have been erroneous. Such approaches allowed the use of higher order thinking skills and promoted conceptual change (Jensen & Rush, 2000).

Cooperative Learning Approaches

Roschelle (1992) noted the intersection of cognitive and social outcomes when students worked collaboratively: the cognitive outcome was that a conceptual change occurred; the social outcome was that members of the group in which that change occurred then shared the new conceptual structure. Additionally, effective problem solving involved cooperative learning and social collaboration (Watts, 1994).

> Cooperative learning has been suggested as a solution for an astonishing array of educational problems: it is often cited as a means of emphasizing thinking skills and increasing higher order learning; as an alternative to ability grouping, remediation, or special education; as a means of improving race relations and acceptance of mainstreamed students; and as a way to prepare students for an increasingly collaborative work force. (Slavin, 1991, p. 71)

Students forming and working in cooperative groups are not new concepts in the sciences (Jensen, 1996). While some instructors may be reluctant to use cooperative learning as a teaching tool because of the extra planning involved and the perceived time taken away from delivering content (Jensen, Moore, & Hatch, 2002), the lab component of many science courses naturally encourages relationship-building and cooperation, skills named as critical for student success (Fullilove & Triesman, 1990) and for increased learning and college persistence (Johnson & Johnson, 1999; Slavin, 1991).

However, students must be given parameters for cooperative interaction to work; simply telling a class of students to work cooperatively in groups is not enough (Jensen et al., 2002; Slavin, 1991). Certain conditions must exist within the learning environment in order for the learning to be truly cooperative (Johnson et al., 1998), including positive interdependence between the students; face-to-face positive and supportive interaction among students; the proper use of interpersonal and small group skills; group processing to discuss the actions and dynamics of the group in order to determine what worked and what did not, and possibly disband the group for work on future projects; and the accountability of individual students for their own learning.

Jensen (1996) described the use of cooperative quizzes, administered at the end of weekly anatomy and physiology labs, in which the questions were matched to learning objectives communicated to the students at the start of each lab. Students worked in small cooperative groups of two to three students, and all students in the group received the same grade. Both on regular course exams and in terms of knowledge gained in anatomy (as measured by a pre-test/post-test design), students in lab sections that took cooperative quizzes performed better than students in the lab sections that took individual quizzes. On course evaluations, students in both the cooperative and individual quiz groups reported that the “use of daily quizzes was an effective preparation device for exams” (Jensen, 1996, p. S52). Further, 83% of students in the cooperative sections indicated that the cooperative quizzes should be continued versus the report by 58% of students in individual sections that individualized quizzes should be continued. The cooperative quiz approach led to positive interdependence (students had a vested interest in the performance of the other members of their group) and individual accountability, two aspects of effective cooperative learning.

Jensen et al. (2002) explained that cooperative quizzes can be a versatile learning tool for use in lectures and labs, but should not be considered reliable testing tools as they do not accurately measure the knowledge of an individual student. These authors provided examples, based on their experiences, of how cooperative quizzes can be used in a lecture setting, a computer lab, and a dissection lab of an anatomy and physiology course.

Noting that instructors may have questions about individual accountability of students, these authors mentioned two built-in forms of accountability: (a) the questions at the beginning of the cooperative quizzes are for individuals; only the second half of each quiz involves the group; and (b) exams are taken by individuals. In the anatomy and physiology course, while a student can improve his overall course grade by maximizing group points, the student cannot pass the course by maximizing group points but failing individual exams (Jensen et al., 2002).

In response to a possible concern that cooperative quizzes bring about the potential for grade inflation, Jensen et al. (2002) wrote

> we have found that the combination of small cooperative quizzes, and larger individual exams produces an academic environment that is rigorous and which contains many of the positive outcomes of a cooperative classroom (e.g., increased student-student interactions, increased student-teacher interactions, etc.). (pp. 33-34)

Additional Strategies

Additional strategies used in developmental/remedial sciences include lecture (Hsu et al., 2005; Jensen & Rush, 2000); peer instruction, cognitive rehearsing, and road maps to help students better learn from lecture courses (Hsu et al., 2005; Jensen & Rush, 2000; Mazur, 1997); smaller classes helping students to think like scientists (Hsu et al., 2005); use of computers to help students experience computers and prepare for what they will encounter in the workplace (Jensen & Rush, 2000); frequent testing for repeated use of study skills and better understanding of content (Johnson, 2001); repetitive course routine to help students know what to expect (Johnson, 2001); Supplemental Instruction to help students learn transferable study skills within the context of a particular course (Congos & Mack, 2005; Jensen & Rush, 2000); instructor feedback to help students improve their knowledge and understanding (Hsu et al., 2005; Johnson, 2001); and encouraging students to seek help through course centers (Hsu et al., 2005).

Lecture

A large course using a lecture format can be intimidating for developmental/ remedial education students, but Hsu et al. (2005) used the experience of the large lecture course as a learning opportunity for students so that they learned how to function in such an environment, an environment that will be common when students progress beyond developmental/remedial science courses. Jensen and Rush (2000) also used the large lecture approach, supplemented with computer simulations for visual learners in the developmental/remedial education setting. “Cognitive rehearsing” (p. 51) in the lecture environment promoted the active processing of material the students were learning and introduced a variety of study techniques and skills that could also be applied to other courses.

Peer Instruction

A fly on the wall of the typical large lecture course may observe many disengaged students (Tobias, 1992) mindlessly copying the instructor’s notes into notebooks full of doodles and tic-tac-toe diversions. Peer instruction (Mazur, 1997) was described as a way to engage students by breaking up a long lecture, allowing students time to synthesize, check their understanding of the topic being presented, and interact with classmates. An added benefit of this approach was that weaker students felt less pressure, and stronger students were able to solidify their knowledge as they explained the answer to their classmates. As an example, an instructor might lecture over a topic for 15 minutes and then pose a question to the class. Students may be asked to come up with an answer on their own and be given time to do so. Then students are allowed to interact with classmates and make revisions to their answers before the instructor draws the class together to discuss the answer to the question posed (Hsu et al., 2005).

A variation on peer instruction was what Jensen and Rush (2000) called “cognitive rehearsing.” This approach involved “repeatedly expanding on previously learned information” (p. 51). The example provided involved the teaching of muscle cell anatomy: the instructor drew a muscle cell on the board, referenced a related figure in the textbook, and then presented internet images of muscle cells which covered the same concepts but at greater complexity. In latter parts of the lecture, the students were asked to draw a muscle cell from memory. Then, the following lecture session would open with an activity that grouped students in pairs to draw a muscle cell and explain to each other, using the drawing, the steps of muscle contraction.

Road Maps

Alternatives to peer instruction are lecture “guides” called road maps (Hsu et al., 2005), which outline the important concepts of the lecture and useful readings, and provide structured spaces for note taking, guided questions for students to answer, and in-class activities. These maps further help students glean relevant information from a textbook when doing before-class assignments. The authors described these handouts as used in a biology course studying cell cycles and cell division. Such a road map

> begins with a short list of important concepts, lists the relevant pages in the text along with two web sites for further information, then lists eight guiding questions such as “How do mitosis and cytokinesis differ between a plant cell and an animal cell?” These questions are broken into smaller parts or supporting activities to help students answer them . . . . One activity is for students to fill out a table as a before-class homework assignment in which they list features of mitosis and Cytokinesis in both plant and animal cells. Students later revise their table after discussing the question with peers during a short in-class activity. (p. 32)

On an end-of-course survey, students rated road maps as useful study tools and guides in helping them to focus on the most important concepts in the course (Hsu et al., 2005).

Smaller Classes Using Nontraditional Methods

Given the intimidation factor that can accompany large lecture courses, especially for developmental/remedial students, it is not uncommon for developmental/remedial courses to be kept small and to use less traditional formats for teaching to help students overcome science anxiety. For instance, a physical science course offered at the University of Minnesota's General College was kept to a maximum enrollment of 45 students and used a Physics by Inquiry curriculum with very little lecturing. Students spent most of their class time working in small stable groups to "perform short experiments, make observations, develop their own theories as to how things work, and use those theories to try to predict the outcome of further experiments" (Hsu et al., 2005, p. 34). This course, then, helped students to learn the process of science and how to think like scientists in a supportive environment. On surveys completed by students at the end of the term, over half reported that their attitude toward physics had improved and used the language they were "scared" initially because of "horror stories" they had heard, but were "less afraid" at the end of the term.

Computers

It is not uncommon for developmental/remedial education students to be lacking in computer skills, skills that will be important for students as they move to advanced college courses and when they enter the workplace (Jensen & Rush, 2000). Through a computer lab requirement in developmental/remedial science courses, students can learn, among other things, the content of the course using interactive tutorials such as WebAnatomy (Jensen, 2006), how to copy and paste text and navigate the internet using search engines (Jensen et al., 2002), and how to create a web page (Jensen & Rush, 2000). Jensen and Rush (2000) noted the benefits of allowing students the option of working in groups on computer projects to help "promote group skills and to ease anxieties related to the use of computers" (p. 52). Further, a course web page can be an excellent communication mechanism for course schedule information and instructor feedback to students, including the all-important updated grade reports (Jensen & Rush, 2000).

Frequent Testing

Tests in a physical science course described by Johnson (2001) were given as frequently as nine per quarter or seven per semester to allow for repetitive use of study skills and to encourage understanding as opposed to memorization. Tests were increasingly demanding over the term as the level of knowledge application grew. Students got a faster start and were immersed in the class earlier on, and the greater frequency of exams aided learning as it better allowed students to "get their heads around the knowledge and processes that will be used. It also allows for more in-depth testing of the topics compared to what can be accomplished in a one-hour exam covering several weeks of work" (Johnson, 2001, p. 157).

Repetitive Routine

Johnson's (2001) physical science course also used a highly repetitive weekly routine which helped students know what to expect each week, and helped them overcome difficulties with test taking, test anxiety, note taking, time management, and attention span.

Supplemental Instruction (SI)

The SI program used at institutions of higher education across the United States today began as an academic assistance and retention program at the University of

Missouri at Kansas City Medical School in 1973 (Blanc, DeBuhr, & Martin, 1983; Center for Academic Development, 2006) and was designated an Exemplary Educational Program by the U.S. Department of Education in 1981 as it was proven to increase retention and academic performance for student participants (National Center for Supplemental Instruction, 1997).

The SI model focuses on historically-difficult courses, those in which one-third or more of the enrolled students typically earn grades of D or F or withdraw, as opposed to high-risk students in courses (Arendale, 2002; Center for Academic Development, 2006; Texas Higher Education Coordinating Board, 2007).

> The emphasis in SI is on helping students acquire and refine the college level learning skills indispensable to mastering college level course content. SI sessions are led by peers called SI leaders, who are especially trained to help students refine how to learn the course content, understand course content, and become independent learners. (Congos & Mack, 2005, p. 1).

A typical SI leader is an undergraduate student with a minimum 3.0 GPA who earned a grade of A in the historically-difficult course targeted for SI support, as a grade of A suggests the student has not only mastered the course content, but also has mastered the college level study skills needed to learn the content.

The National Center for Supplemental Instruction (1997), with evidence validated by the U.S. Department of Education, claimed that students who participated in SI earned higher mean final course grade averages than nonparticipating students, even when differences in prior academic achievement and ethnicity were considered; withdrew less and earned fewer D and F course grades than nonparticipants; and persisted, reenrolled, and graduated at higher rates than nonparticipants.

Jensen and Rush (2000) described SI for their developmental anatomy and physiology course as a graded one-credit class, which met three times per week for one hour each session, in addition to the core course lectures. While the course was originally intended for TRIO students (students from disadvantaged backgrounds) who were even less prepared than other students in General College, “voluntary attendance by non-TRIO students is generally quite high” (p. 52). Students learned basic study skills, such as notetaking, lecture content review, time management, analysis of test questions, practice tests, and preparation for a final exam all within the context of anatomy and physiology. Group work was encouraged to foster interactive learning.

VerBeek and Louters (1991) noted that many students entered college with underdeveloped problem solving skills, making chemistry courses–which require competency in mathematics, theory application, conceptualization, problem solving, and comprehension of chemical language–even more challenging. This issue is amplified by the fact that the chosen majors of many students necessitated that they take at least one chemistry course. If instructors did not take the time to help develop and remediate these students in basic chemistry fundamentals, a larger number of students earned grades of D and F. “Many entering college students need access to a resource that helps them build college level learning skills, refine problem solving skills, acquire a more solid basis or fundamental chemistry knowledge, and enhance thinking skills” (Congos & Mack, 2005, p. 3).

Congos and Mack (2005) described the SI program for a non-chemistry majors chemistry course and a chemistry majors chemistry course at the University of Central

Florida (UCF). While many of the students who entered UCF had chemistry in high school, they still did poorly in introductory college chemistry classes due to inadequate knowledge of basic chemistry and underdeveloped skills for learning college level chemistry. They did not know how to take organized lecture notes or comprehend chemistry texts; their problem solving skills were lacking, and they did not know how to appropriately manage their time to meet the demands of college level chemistry courses.

Chemistry SI sessions at UCF focused on five "modes of operation":

1. *Building complete and accurate lecture and text notes*. When a question was posed by a student, the SI leader pooled the collective resources of the SI attendees to build a complete and accurate answer to the question.
2. *Formulating potential exam questions and answers*. The SI leader had SI attendees list all main ideas and types of problems that could potentially appear on an upcoming exam to develop a guide for studying for the test. SI attendees then worked to develop complete and accurate answers and solutions to each question and problem. Skills for learning and remembering potential test information were then exchanged.
3. *Building complete and accurate steps in solutions to problems*. Using a four-part board model (Figure 1), SI leaders divided a chalkboard into four equal sections.

   The problem was recorded in Section 2. In Section 1 was written any background/prerequisite information for solving the problem; the textbook, class notes, etc., was used by attendees for this step. In Section 2, the group

Chalkboard Model

PREREQUISITES	STEPS IN THE SOLUTION	RULES	SIMILAR PROBLEM
This first step includes relevant *equations, formulas, charts,* and *general rules* for solving this type of problem, along with the source. For example: $\% \text{ yield} = \frac{\text{actual}}{\text{theoretical}}$	$\frac{XXXX}{XXX}$ $\frac{XXXXX}{XXX} =$ The SI leader or the student(s) model the solution step-by-step with *what is done in each step of a solution and why it is done.* 1. 2. 3. 4. 5.	Here, a narrative description of what is done in each step of a solution is written down. 1. 2. 3. 4. 5.	$\frac{XXXX}{XXX}$ $\frac{XXXXXX}{XX} =$ Here, students check their understanding using prerequisites, steps in solutions and rules as learning aides. 1. 2. 3. 4. 5. Answer and a source for the verification of the answer.

Source: Center for Academic Development, 2006, p. 68

Figure 1. Four-part board model.

named the type of problem and attempted to solve it, listing the steps of the solution (including why the steps were performed). If the group was stuck, the SI leader would provide input based on his/her previous experience with the course and/or related problems. In Section 3, an SI attendee or SI leader wrote the words for the step-by-step problem solution, describing the “rules” for solving that type of chemistry problem in the future. A similar problem was placed in Section 4 of the board for attendees to practice. If they got stuck, they had the background information, a model and rules for the solution, and they could collaborate with one another and the SI leader to build their understanding. This approach appealed to verbal and quantitative learners and provided “opportunities for students to learn through examples, models of solutions, step-by-step explanations, written narratives, opportunities to ask questions, and chances to practice understanding" (Congos & Mack, 2005, p. 5).

4. *Sample testing*. Possible test questions and problems were compiled into a sample test, which students could work on individually or in small groups to better collaborate and help one another. Solutions were then written on the board for the benefit of the whole group.
5. *Post-test review*. Students identified their incorrect answers on an exam and linked those errors with ineffective study techniques so that they could develop more effective study strategies when preparing for future assessments.

Congos and Mack (2005) found the DFW (grade of D or F or withdrawal from course) percentage for the non-chemistry majors chemistry course decreased from 32% before SI was implemented to 9% after SI implementation. Also, students who attended SI had a higher final course grade (more grades of A, B or C) than students who did not attend, even though the incoming SAT scores for attendees and non-attendees were about the same. For the chemistry majors course, the DFW percentage dropped from 45% before SI to 33% after SI was implemented, and the final course grades were higher for SI attendees in seven of the eight semesters in the study (in one semester there was no statistical difference for attendees and non-attendees).

Use of Feedback

The constructive use of feedback from the instructor has been shown to be an effective learning tool for students in multiple disciplines (Davidson, House, & Boyd, 1984; Hsu et al., 2005; Johnson, 2001; Juhler, Rech, From, & Brogan, 1998; Murray, 1990). For instance, frequent testing (as described by Johnson, 2001) is an opportunity for instructors to provide and students to receive frequent feedback. For students who perform poorly, instructors can initiate dialogue, diagnose what went wrong, and discuss corrective strategies (Levin & Levin, 1991). Johnson (2001) found that students who adopted more effective strategies saw improvement of their scores over the term. Another example is the expectation that students will use feedback from instructors to revise and improve their work.

Hsu et al. (2005) described that developmental/remedial science students had the opportunity to regain points on exams by reworking problems they missed or by summarizing information relevant to what they missed on a test. Further, they were encouraged to seek help from the instructor during the process. Of 50 student respondents to a survey administered at the end of the semester, 38 students reported they took advantage of the opportunity at least one time because they felt it helped them better learn the information (25 respondents) or thought it would boost their grade (12 respondents). Of the remaining respondents, 8 did not use the opportunity because they were satisfied with their grades; 3 students did not have time to use the opportunity to rework and regain missed test points.

Improve Help-seeking

"When students do not ask for help when they need it, they run the risk of undermining their learning and achievement" (Ryan et al., 2001, p. 110). Often the students who need the most help are those who avoid seeking it. Hsu et al. (2005) tried what they called a “course center,” an alternative to office hours; instead of instructors holding office hours in their offices, they were available in a different location. The rationale for this strategy was that students may see instructors who are in their offices as busy doing other important things hence would avoid disturbing the instructor. Additionally, a more spacious location for course centers can allow for multiple students to meet with the instructor at the same time and allow room for students to “spread out” and study together in a low pressure environment. In some cases, course centers were staffed by undergraduate teaching assistants who had recently completed the courses for which students were requesting help. Around 40% of surveyed physical science students ranked the course center as their first choice for getting help, and 80% noted that “just having a course center option available made them more likely to get help in the class” (Hsu et al., 2005, p. 34) because it was set up just for them to get help.

Summary

A crisis exists in the United States. The nation’s schools are not preparing students for college level study in the sciences, and the nation is not producing the next generation of scientists. One possible solution may be developmental/remedial sciences at the college level.

Developmental/remedial sciences at the college level using constructivist, collaborative learning, and various other approaches help students to see science as something they could learn–to see an understanding of science as an attainable goal. Actively involving students and their personal experiences can help guide students in their construction of knowledge by helping them to see themselves as a part of science.

Further, the reading, writing, and math components of developmental education programs can be supported by developmental/remedial sciences by providing a disciplinary context for students to apply and practice those skills and a rich environment for developing best practices in classroom instruction (Hsu et al., 2005).

The detailed method that will be used to identify developmental/remedial sciences practices at community colleges in five states in the central part of the United States in an effort to add to the sparse literature linking practices in the science education and developmental/remedial education disciplines is presented in Chapter Three.

CHAPTER THREE

METHODOLOGY

Chapter Overview

This chapter includes the study's purpose and research questions and a detail of the methodology for the four phases of the study. In Phases One and Two are described the procedures used for the survey components of the study; details of the method for the qualitative portion are provided in Phase Three, and the process for developing a set of guidelines for developmental/remedial sciences is identified in Phase Four.

Purpose of the Study

The purposes of this mixed methods study were (a) to identify and examine the characteristics of developmental/remedial sciences as it existed in the 2006-2007 academic year in terms of organization, structure, instructional practices, and curriculum as offered at community colleges in five states in the central part of the United States; and (b) to develop a set of guidelines for community college faculty and administrators to use in making decisions about whether or not to offer developmental/remedial sciences and identify the general steps to follow in implementation.

Research Questions

1. To what degree were developmental/remedial sciences offered by selected community colleges in five states located in the central part of the United States?

2. What were the descriptive characteristics of developmental/remedial sciences where offered by the selected community colleges? Descriptive characteristics included the following:
   a. What were the factors that contributed to identifying the need for developmental/remedial sciences?
   b. Were developmental/remedial sciences at the selected community colleges offered in the form of a course or an entire program?
      i. If a course, what kind of academic credit did it carry?
      ii. What topics were covered?
      iii. Was a lab associated with the course?
   c. How were developmental/remedial sciences organized and delivered? Within academic departments? In a developmental/remedial education department/division? Interdepartmental? Through a learning center?
   d. What were the goals of developmental/remedial sciences?
   e. What were the instructional practices that supported those goals?
   f. What advising and support services were available to students in developmental/remedial sciences?
      i. How were students placed?
      ii. Was tutoring available?
      iii. Was Supplemental Instruction available?
      iv. What individuals were involved with advising/counseling developmental/remedial science students?

g. How was student progress assessed in the developmental/remedial sciences so that students could move on?

h. How was the effectiveness of developmental/remedial sciences assessed?

3. Was there commonality among developmental/remedial sciences to develop a set of guidelines for community college administrators and instructors to use in determining if they should implement developmental/remedial sciences? What were the stages and process for implementing a developmental/remedial sciences program?

Phases One and Two – Quantitative Methodology

Overview of Phases One and Two

The first phase involved the distribution of a general survey to the Chief Academic Officers of all 2005 American Association of Community Colleges (AACC) member institutions in five states in the central United States in order to identify community colleges that offered developmental/remedial sciences and individuals with administrative/leadership responsibilities for developmental/remedial sciences at those institutions. In Phase Two, an in-depth survey was sent to the identified individuals in order to determine the characteristics [listed as “a-h” of Research Question 2] of the developmental/remedial sciences offered.

Participants

All community college main campuses in five states in the central part of the U.S. that were registered member institutions of the AACC in 2005 were included in the sample. A total of 72 main campuses composed the sample, including 19 community colleges in state A, 14 in state B, 5 in state C, 20 in state D, and 14 in state E. State names were kept confidential for privacy. The researcher's home state was in the center of the five states. As such, these states were selected because of close proximity for contacts later in the study. AACC member institutions were selected, as contact information was readily available through the *AACC Membership Directory 2005* (AACC, 2005).

The Phase One survey initially went to Chief Academic Officers (CAOs) at main campuses only and asked if the institutions had additional campuses where developmental/remedial sciences were offered following policies and procedures different from the main campus. Where developmental/remedial sciences were offered and followed different policies at the additional campuses of an institution, CAOs were asked to provide the name(s) of additional campuses and contact information for the CAOs on those campuses. CAOs of institutions where developmental/remedial sciences were offered indicated that where additional campuses existed, none followed policies different from the main campuses, so it was not necessary to send surveys to additional campuses.

Respondents were Chief Academic Officers (CAOs) and individuals with administrative/leadership responsibilities for developmental/remedial sciences as identified by the CAO at each institution. In some cases, CAOs forwarded the Phase One survey to other campus leaders who had a more thorough knowledge of the course offerings and support services about which the survey questions inquired.

Description of the Instruments

This study incorporated Social Exchange Theory as addressed by Dillman's (2000) research-based Tailored Design Method in an effort to maximize response rates.

Survey 1 (Appendix B) was developed by the researcher to identify the campuses that offered courses or support services in the developmental/remedial sciences. The survey was composed of ten questions: eight questions asked CAOs if courses or support services were offered in developmental/remedial sciences on their campuses (and/or other campuses of their institutions); two questions requested contact information for individuals with administrative/leadership responsibility for developmental/remedial sciences at the campus(es).

Questions in Survey 2 (Appendix C) were patterned in part after a similar study of developmental/remedial chemistry by Fowler (1988), a study of developmental mathematics by Kull (1999), and some survey content was adapted from a chemistry survey by Kotnik (1974). Some questions were based on the researcher's own experiences with community college science education and developmental/remedial sciences. The survey was composed of 35 total questions: 8 Yes/No questions, 2 checklist/rank order questions, 1 Likert scale question, 6 multiple choice questions, 9 open-ended questions, and 9 demographic questions about the respondent. Respondents were also asked to attach artifacts such as syllabi, date action was taken by the governing boards or dates programs/courses were approved, goals statements, marketing brochures/pamphlets for developmental/remedial science courses and/or support services, course placement criteria, and assessment procedures.

A table showing the relationship of survey items to the research questions for this study may be found in Appendix D.

Validity

Instruments are designed to gather descriptive information about what exists. Typically it is appropriate to have a knowledgeable panel review a survey and do a pilot study to ensure the survey measures what it is intended to measure (Bryant, 2004). Therefore, content validity for both surveys was determined by a panel of experts. A pilot study was conducted for Survey 2. Further, an independent auditor reviewed the study for validity (Appendix J).

Panel of Experts

The panel of experts (Appendix G) was selected to include three individuals who had knowledge of science, science education, developmental/remedial education, developmental/remedial sciences or any combination of these and shared similar characteristics with the sample used in the study.

Members of the panel of experts were contacted via phone in advance of the study for their consent to participate as a member of the panel. Panel members were provided copies of the study's purpose statement, research questions, a brief summary of the methodology, Surveys 1 and 2, and the interview protocol. Each was then sent an email message outlining the researcher's request: "Based upon your experiences, knowledge, and expertise, do you think the survey questions and interview questions are appropriate to answer the research questions of the study? Are there questions you would add? Remove? Change?"

Comments from the panel of experts follow:

- Two members of the panel commented that Survey 2 would require some time to complete. One of these members further noted the appropriateness of the questions and that reducing the number of questions in order to make the survey shorter would likely take "away from the content" of the survey. The length of the survey was not altered.
- One member of the committee recommended "asking each school if they track the percentages of their students who eventually graduate from 4-year schools. This may enable you to find the most successful programs." This recommendation was considered but rejected, as other panel members did not see the same perspective, instead noting that "not all community college students who take science courses, and, likely, developmental/remedial sciences, have as their goal graduating from a four-year institution." Horn and Nevill (2006) supported this statement when they found many community college students did not have degree completion as a main motivation for attending college.
- One panel member recommended adding "Environmental Science" to the Earth Sciences category of Survey 1. Other panel members thought the "Other" option on the survey was appropriate. This component of the survey was not changed.

Pilot Study for Validity

A pilot study was performed to determine content validity by administering Survey 2 to three individuals. These individuals were selected because they shared characteristics with the individuals who responded to the surveys. Each participant was asked to complete the surveys under conditions that resembled actual conditions of study participants.

Pilot study participants did not participate in the actual study. Initially, three individuals participated in the pilot study. However, one participant was recommended to participate in the second phase of the study by the CAO of their institution. As a consequence, this person's pilot study comments were not used in the study. The comments of two pilot study participants were incorporated into the study.

Each was sent a packet, which included a letter for the pilot study participant (Appendix A) and an envelope containing information identical to what actual study participants were to receive later in the study: the cover letter, Survey 2, and a stamped return envelope. Pilot participants were asked to make comments and recommendations so that stumbling points could be identified and remedied by the researcher prior to administration of the survey to the sample. The time required for taking the survey was determined. Participants were asked to make notes directly on the survey instrument if a question was not clear or if the question was ambiguous and asked to comment on how an unclear question should be changed or improved. Additionally, participants in the pilot study were asked to answer the following questions regarding face validity after completing the survey:

- *Appearance of the packaging/envelope*. If you received this envelope at work, would you open it or toss it away without even opening it? Why?
- *Clarity and legitimacy of cover letter*. Do you understand why you have been contacted to participate in this study? Do you understand the purpose of the study? Do you feel the purpose of the study is worthwhile? That is, do you feel the study will produce results that will be helpful to developmental/remedial science educators?
- *Appearance of the survey*. Did the survey look appealing? Was there anything about it that was exceptionally positive or negative?
- *Clarity of questions*. Did the questions make sense to you? Did the questions flow logically from one to the next? Was the language appropriate? Could you answer all of the questions? If not, were the skip patterns clear and easy to follow? Did any questions seem repetitive or inappropriate? If so, which ones? Knowing the purpose of the study, what additional questions would you recommend?
- *Overall assessment*. If you were to receive this package (cover letter, survey, return envelope) in the mail at work, would you respond to it? Why?

Comments made by pilot study participants included the following:

- The average time to complete the survey was 30 minutes.
- One individual remarked there may not be enough space for a respondent to list topics covered in a developmental/remedial science course, but also indicated that the option provided to attach a syllabus ("Syllabus Attached")

would take care of any problem the respondent may have with available space to answer this question.

- One individual wrote next to Question 11: “What if different strategies are used in different courses?”
- Two suggestions were offered that the results should be made available to those completing the survey if the respondent was interested.

Pilot study comments concerning face validity included:

- *Appearance of the packaging/envelope*: Pilot study participants indicated that they would open the envelope if they received it in the mail at work. One individual specifically indicated s/he would open it because the mailing address was directly typewritten/printed onto the envelope, not on a label.
- *Clarity and legitimacy of cover letter*: Participants indicated that they understood the purpose of the study, why they had been contacted to participate in the study, and that “absolutely” they felt the study was worthwhile and would be helpful to developmental/remedial science educators “and administrators” based on the information provided to them in the cover letter.
- *Appearance of the survey*: Both participants indicated that the survey looked appealing. One person noted they liked the boxes which were provided for explanations. Another pointed out the print was quite small. The font size of the survey questions was increased in response to this comment.

- *Clarity of questions*: Pilot participants agreed the questions made sense to them, flowed logically from one to the next, and used language appropriate for the positions and education of the respondents. Both also responded that they felt study participants would have the knowledge and data available to them to answer the questions and, where an answer was not appropriate, they could follow the skip patterns. Further, both indicated the appropriateness of the questions. Only one additional question was recommended: "How are developmental science courses and support services funded?" This question was rejected as it did not fall within the focus of the research questions.

Survey Procedures

The following procedures were implemented:

1. Development of Survey 1 (Appendix B) and Survey 2 (Appendix C), cover letter and follow-up letters for Survey 1 (Appendix E), cover letter and follow-up letters for Survey 2 (Appendix F), and interview protocol (Appendix H) for the study.
2. Sent cover letters, copies of surveys and follow-up letters, and interview protocol (for the qualitative component of the study) to the University of Nebraska-Lincoln (UNL) Institutional Review Board (IRB) for approval.
3. Gained IRB conditional approval for the study (Appendix N). Full approval to conduct subsequent phases of the study was sought from the IRB via change in protocol as letters of commitment were received from each institution.
4. Completed the pilot study for the second survey.

5. Utilizing the five points of contact of the Tailored Design Method (Dillman, 2000), addressed and mailed prenotice letters (first contact) on November 13, 2006, to all identified community college CAOs in the sample.
6. Assembled, addressed, and mailed survey packets (including a cover letter, Survey 1, a stamped return envelope, and copies of Survey 2, interview protocol, a sample letter of commitment, and a description of the study) to all identified community college CAOs in the sample two days following the prenotice letter (second contact) on November 15, 2006. Each institution was given a two letter code which was written on each survey to identify when the survey had been returned and who to contact in the event of no response. To gain permission and institutional commitment to the subsequent phases of the study, the first survey asked the CAO to write a letter of commitment to the study. A sample letter of commitment was sent in the survey packet to the CAOs, asking them to write a similar letter in which they indicated commitment to participate in the study (Albert, 2004). The CAOs mailed or emailed the letters to the researcher. Each institution was asked to use its own process to review and approve participation of faculty and administrators in the survey and interview components of the study. There were no institutions with multiple campuses following developmental/remedial sciences policies and procedures different from the main campus (as indicated by CAOs on the main campus). As such, additional survey packets were not required.

7. Followed up with a thank you/reminder postcard (third contact) to all participants on November 27, 2006, two weeks following the date when the prenotice letter was mailed. This served as sincere thanks for those who had already responded and as a more casual reminder/appeal to participants who had not responded to please do so as their response was important to the study.
8. On December 4, 2006, three weeks after the prenotice letters were mailed, followed up with nonrespondents by mailing a more insistent cover letter (fourth contact) with a replacement survey, stamped return envelope, copy of Survey 2 and interview protocol, the sample letter of commitment, and description of the study. The intent of the letter was to “personally” communicate with the individual in order to further encourage their response.
9. The researcher attempted to contact any remaining nonrespondents via phone from December 11-18, 2006, four weeks following the initial mail contact. This was the fifth and final contact for nonrespondents. A script was used to remind the participant about the survey, ask if they had questions about the survey or the study, and ask if they would like another copy of the survey. Each was encouraged to complete the survey over the phone (which took 5-10 minutes) and return a letter of commitment to the researcher by mail or email. The researcher attempted to contact via phone a total of 44 CAOs who had not responded to previous contacts; 31 were successfully contacted and completed the survey over the phone. One CAO returned the completed survey in the

mail in response to the researcher's voice mail message. The remaining 12 individuals did not respond to voice mail messages and/or messages left with secretaries.

10. All completed surveys were opened by the researcher and scrutinized upon receipt so that appropriate comments and/or clarifications could be made in the fourth contact. There were no questions from participants during the implementation process, making further clarification unnecessary.
11. Twelve letters of commitment were scanned and sent via email to the IRB for approval as the letters were received. A change in protocol form was submitted with the letters to "add a site."
12. Upon IRB approval (Appendix N), Survey 2 was sent to the individuals identified by the CAOs in Survey 1 as individuals with administrative/leadership responsibility for developmental/remedial sciences on their campuses.
13. A procedure similar to that used for Survey 1 was followed for Survey 2, but with four points of contact over a five-week period. The four points of contact included: (a) cover letter, survey, and stamped return envelope sent on December 18, 2006; (b) thank you/reminder postcard on January 1, 2007, to all participants in the second survey; (c) more insistent cover letter, replacement survey, and stamped return envelope to nonrespondents only sent on January 5, 2007; and (d) final phone contact for nonrespondents only during the week of January 15-19, 2007. Four nonrespondents were contacted

via phone. Two returned the survey through the mail, and one faxed the completed survey to the researcher within one week. One participant responded within one week that they had given the survey to another individual on their campus; the completed survey was returned three weeks later.

All survey data were recorded by the researcher in an Excel spreadsheet and analyzed for the selection criteria such that three institutions were selected for qualitative case studies in Phase Three. Selection criteria for case studies are outlined in the following section.

Phase Three – Qualitative Methodology

Overview of Phase Three

In the third phase of the study, the researcher conducted interviews with individuals at three institutions selected for in-depth case studies based on responses to Survey 2. Case study sites were selected from among institutions where comprehensive programs of developmental/remedial sciences were offered. More specific selection criteria included (a) type of course(s) offered (biology, chemistry, physical science, earth science, or combination of these); (b) success rates of students in developmental/remedial science course(s); and (c) success rates of students in the subsequent science course, in order to better reflect the variety of developmental/remedial sciences offerings in the sample and to reflect those that were more successful as measured by student success.

Participants

Institution I was a multicampus institution serving a five county region. The institution operated at 6 locations, 3 suburban and 3 rural, in addition to a virtual campus. Developmental/remedial science courses had been offered at most of the campus locations for over 10 years.

Institution II had 3 rural campuses, which served a 3 county area. A virtual campus also existed. Developmental/remedial science courses had been offered at the three campuses for 4-6 years.

Institution III had 3 campus locations, 1 urban and 2 rural, and served 15 counties. Developmental/remedial sciences had been offered at one of the rural campuses for over 20 years.

Description of the Instruments

The interview protocol (Appendix H) consisted of 24 questions and was administered in a semi-structured interview in the case study component of this study. Some questions sought clarification or built upon survey questions previously answered by the interviewee. Artifacts were requested before the interview, including the following: written documents describing the developmental/remedial education program and/or developmental/remedial sciences, written goals, placement criteria, evaluations/assessments of the program, and course syllabi. During the interviews with individuals from two institutions, additional information was requested including assessment surveys and an advising flow chart.

Panel of Experts

The panel of experts mentioned in the earlier phases of the study was also asked to comment on the interview protocol. The panel suggested the following:

- A panel member recommended the researcher add a question about training for developmental/remedial staff, with the rationale that qualified personnel should be "in charge" of new developmental/remedial programs, and "not just left over or weak faculty or outsiders." Such a question was added to the interview protocol via a change in protocol request to the IRB. The question read: "Are the instructors teaching developmental/remedial sciences trained to teach such classes? If so, how? In developmental/remedial? In sciences only? In both?"
- One panel member suggested interviewing several students from each case study institution. The researcher decided against this suggestion as the focus of the study was from an administrative/leadership perspective, as opposed to student perspectives.

Pilot Study for Validity

The interview protocol was pilot tested with two individuals to determine if the interview questions were ambiguous or leading, the best order of questions, the types of probing questions that would be helpful for interviewees, and a helpful script to open the interview. Changes made to the protocol based on experiences in the pilot study included the addition of two questions to conclude the interview:

- “What do you see as the best thing about your current program?”
- “What do you see in the future of your program? Growth/expansion? Lesser need?”

Interview Procedures

Upon approval of the change in protocol from the IRB, the following procedure was implemented for the qualitative component of the study:

1. The Chief Academic Officers (CAOs) at the three community colleges identified for case studies were contacted by phone to notify them that their institutions were chosen for the case study based on the aforementioned criteria. Two CAOs were not able to be contacted directly by phone, so the researcher left voice mail messages and followed up with an email for clarification and documentation.
2. Commitment was verbally reaffirmed with each CAO (within two days) as each had already committed to the case study component in the letter of commitment from Phase One.
3. Individuals to be interviewed were contacted by phone to remind them of the study, their CAO’s institutional commitment to the study, and how their further input would be beneficial to the results of the study. They were then asked if they would be willing to participate in an interview that would take no longer than one hour. Verbal commitment was gained via phone.
4. Each individual verbally committed. The researcher then mailed each person a copy of the Informed Consent Form (Appendix M) and asked each of them to

sign and return the form to the researcher in the enclosed stamped return envelope.

5. Upon receipt of signed Informed Consent Forms, the researcher again contacted interviewees via phone to set up a date and time for a phone interview.
6. All interviewees were emailed a copy of the interview protocol in advance to allow them time to ponder the questions and gather materials they felt would be helpful to the study.
7. Semi-structured interviews took place on February 2, 2007. Interviews ranged in time from 60 minutes to 79 minutes. All interviews were audio tape recorded for accuracy, and all interviewees were assured of the confidentiality of their responses in the final write up of the research. The researcher took notes on the interview protocol during the interview.
8. Interview audio tapes were transcribed by the researcher.
9. Transcriptions were emailed to the interviewees for member checking, a process whereby study participants check the transcription for accuracy to ensure the intent of their responses is clear. Interviewees were also given the option of adding information to their responses. None chose to do so.
10. The researcher coded the transcripts (Appendix I) to get inside the data and identify relevant themes.
11. An independent auditor checked the interview data for validity of the qualitative component of this study (Appendix J).

Coding and Themes

Creswell (1998) presented coding as an approach to reducing data into codes or categories. Ultimately, the goal of coding is "getting from unstructured and messy data to ideas about what is going on in the data" (Morse & Richards, 2002). A researcher collects data, prepares the data for analysis (through transcription of interview tapes and notes, for instance), reads through the data repeatedly, bracketing and making notes in the margins to make sense of it, then codes the data by grouping text segments into categories and labeling them with codes. Once a group of 20-25 codes has been identified, data can be used to develop themes to be used in the final report (Creswell, 2002). A theme is a "common thread that runs through the data. Just as a theme melody in an opera emerges, recurring at different points, themes in data keep emerging, although their forms may not always be identical" (Morse & Richards, 2002, p. 113). Creswell (1998) recommended reducing the data to five or six themes.

In this study, the researcher personally transcribed the interviews as they were completed, read and reread the transcripts and formed topic files to develop codes, and looked for emerging themes. This study utilized open coding (Creswell, 1998; Morse & Richards, 2002) aimed at "opening up the data" (Morse & Richards, 2002, p. 121).

Validity and Reliability

Creswell and Miller (2000; citing Schwandt, 1997) defined validity in qualitative studies as "how accurately the account represents participants' realities of the social phenomena and is credible to them" (p. 2). These authors suggested that the choice of validity procedures in qualitative research is governed by the lens researchers use to validate studies.

The three lenses for qualitative study are established by the people who conduct, participate, or read/review a study and include (a) the lens of the researcher, in which the researcher constantly returns to the data to see "if the constructs, categories, explanations, and interpretations make sense" (Patton, 1980); (b) the lens of study participants, suggesting the "importance of checking how accurately participants' realities have been represented in the final account" (Creswell & Miller, 2000, p. 2); and (c) the lens of individuals external to the study, involving reviewers not associated with the study in helping to establish validity.

For this multiple case study, four validation strategies were utilized: researcher reflexivity, member checking, peer debriefing, and external audit. This represents at least one validation strategy from each perspective.

Researcher reflexivity or clarifying researcher bias occurs when researchers self-disclose their assumptions, beliefs, and biases (Creswell & Miller, 2000), such that bracketing or suspension of those biases may occur. The researcher in this study explained her involvement with developmental/remedial education and her belief systems regarding developmental/remedial sciences from the outset.

The researcher currently teaches a developmental/remedial science course and is employed at a community college that supports developmental/remedial education. Although the researcher's institution provides a developmental/remedial science course and support services, delivery of such programs is unique to each institution (advising, guidance of students to tutoring services, courses, etc.). The researcher believes that developmental/remedial education should be viewed as an opportunity for students who would not be successful in higher education without support. Furthermore, developmental/remedial education should be prioritized as part of the community college mission. Developmental/remedial education classes are not just for the ill-prepared freshmen who come to college straight from high school. They are also for students who never completed high school or who decided to attend college years after leaving high school. Developmental/remedial sciences are a way for students lacking in science background, academic skills, self-confidence, and, perhaps, interest in science to be successful in college, build scientific literacy, and gain confidence and interest in the various fields of science.

With this background in mind, interview questions were constructed in such a way as to minimize the potential for "leading" participants answers and thus swaying the results of the study.

Member checking is a validation procedure in which the data is taken back to the participants in the study so that they can confirm the credibility of the information and ensure it reflects their experience (Creswell, 1998, 2002; Creswell & Miller, 2000). After the interviews for this study were transcribed, the researcher asked the participants to review and approve their interview transcript prior to analysis by the researcher.

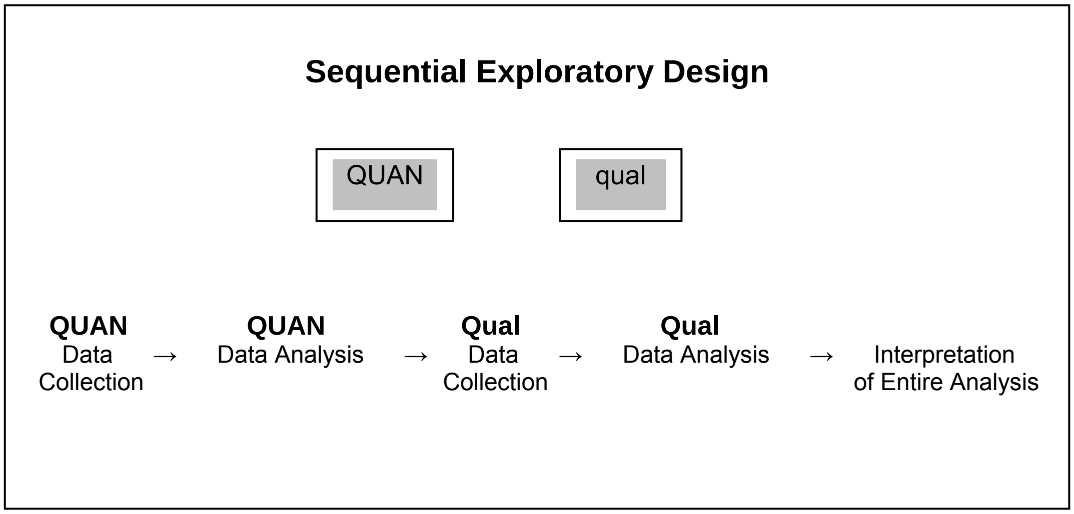
Peer debriefing is the review of the data and research process by someone who is familiar with the researcher or the focus of the study. A peer reviewer provides support, plays devil's advocate, keeps the researcher honest, asks hard questions about the methods, meanings, and interpretations, and challenges the researcher's assumptions (Creswell, 1998, 2002; Creswell & Miller, 2000). During this study, peers at the researcher's institution and the researcher's supervising advisor and committee members reviewed the research questions, the intended participants, the proposed procedures including the questions to be asked, and the suggested method of analysis.

An external auditor was used to "examine both the process and product of the inquiry, and determine the trustworthiness of the findings" (Creswell & Miller, 2000, p. 5). The auditor scrutinized the documentation provided by the researcher and wrote an analysis, which is included in the study in Appendix J. Ultimately, the auditor assessed whether the findings were grounded in the data, if category/code/theme structure was appropriate, and the degree of researcher bias.

By completing the four aforementioned verification strategies, the researcher is confident that the results of the study are valid. Further, depth in qualitative research is enhanced by the number and types of data collection points within the inquiry. Including 72 community college main campuses from a five state area helped to validate this research.

Reporting of Quantitative and Qualitative Data

In a qualitative study of faculty perceptions of underprepared students, Albert (2004) utilized Creswell's (2003) "Sequential Exploratory Design" method of collecting and analyzing data. This design is characterized by "the collection and analysis of quantitative data followed by the collection of qualitative data, and the two methods are integrated during the interpretation phase of the study" (p. 215). Such a design was appropriate for this study. Visual representation of the design is in Figure 2.



Source: Creswell, 2003, p. 213, as cited in Albert, 2004, p. 85

Figure 2. Creswell's sequential exploratory design.

Phase Four – Developmental/Remedial Sciences Guidelines

Overview of Phase Four

Finally, in the fourth phase of the study, the author used the collected data from the Phase One and Two surveys and Phase Three interviews to develop a set of guidelines that may be of use to community college administrators and faculty considering the implementation of a developmental/remedial science program. The researcher looked for shared characteristics and unique features among the identified community college developmental/remedial sciences to develop these guidelines.

Summary

This mixed methods study used both quantitative and qualitative approaches to answer three research questions. An initial general survey was administered to CAOs at all community college main campuses in five states in the central part of the U.S. to determine if developmental/remedial sciences were offered at the institutions. To respondents that did offer developmental/remedial sciences, an in-depth survey was administered to gather greater detail about the characteristics of developmental/remedial sciences at those institutions. Survey responses were analyzed to select three institutions for in-depth case studies. Individuals from case study institutions were interviewed and data were analyzed for emerging themes. Methods were checked for validity and reliability.

The results of this study are presented in Chapter Four.

CHAPTER FOUR

RESULTS

Chapter Overview

In Chapter Four the data from the survey instruments and interviews are presented and analyzed. The chapter is organized around the two surveys and the research questions of the study and is divided into four major sections:

- In Section 1, the return rate and results of Survey 1 from the CAOs are presented.
- In Section 2, the demographic information from respondents to Survey 2 and results of Survey 2 are presented.
- In Section 3, case study data for the three selected institutions are presented.

Purpose of the Study

The purposes of this mixed methods study were (a) to identify and examine the characteristics of developmental/remedial sciences as it existed in the 2006-2007 academic year in terms of organization, structure, instructional practices, and curriculum as offered at community colleges in five states in the central part of the United States; and (b) to develop a set of guidelines for community college faculty and administrators to use in making decisions about whether or not to offer developmental/remedial sciences and identify the general steps to follow in implementation.

Research Questions

1. To what degree were developmental/remedial sciences offered by selected community colleges in five states located in the central part of the United States?
2. What were the descriptive characteristics of developmental/remedial sciences where offered by the selected community colleges? Descriptive characteristics included the following:
    a. What were the factors that contributed to identifying the need for developmental/remedial sciences?
    b. Were developmental/remedial sciences at the selected community colleges offered in the form of a course or an entire program?
        i. If a course, what kind of academic credit did it carry?
        ii. What topics were covered?
        iii. Was a lab associated with the course?
    c. How were developmental/remedial sciences organized and delivered? Within academic departments? In a developmental/remedial education department/division? Interdepartmental? Through a learning center?
    d. What were the goals of developmental/remedial sciences?
    e. What were the instructional practices that supported those goals?
    f. What advising and support services were available to students in developmental/remedial sciences?
        i. How were students placed?

ii. Was tutoring available?

iii. Was Supplemental Instruction available?

iv. What individuals were involved with advising/counseling developmental/remedial science students?

g. How was student progress assessed in the developmental/remedial sciences so that students could move on?

h. How was the effectiveness of developmental/remedial sciences assessed?

3. Was there commonality among developmental/remedial sciences to develop a set of guidelines for community college administrators and instructors to use in determining if they should implement developmental/remedial sciences? What were the stages and process for implementing a developmental/remedial sciences program?

Section 1: Survey 1

Section 1 contains the results of Survey 1 from the CAOs. This section will be presented in the following format:

1. Survey return rate
2. Statement of the research question
3. Statement of survey questions addressing the research question
4. Quantitative data analysis

Percentages have been rounded up in the tables, which in some cases totals over 100%.

Survey 1 Return Rate

Survey 1 did not contain demographic questions and was sent only to Chief Academic Officers at 72 community colleges in 5 states in the central part of the United States. A total of 60 responses was received for a return rate of 83%.

Research Question 1

Research Question 1: To what degree were developmental/remedial sciences offered by selected community colleges in five states located in the central part of the United States?

Responses to Questions 1, 6, 7, 8, and 9 on Survey 1 were used to answer this research question. A discussion of the data follows each table.

Survey 1, Question 1

As of November 2006, do you offer developmental/remedial science courses or support services for students on the campus where you are located? Check "No" or "Yes" for each of the following:

- My institution offers developmental/remedial science courses and/or programs.
- My institution uses criteria to identify developmental/remedial students and uses that information to place students into developmental/remedial science courses/programs.
- My institution offers tutoring for developmental/remedial science students.
- My institution offers academic advising for developmental/remedial science students.
- My institution offers counseling for developmental/remedial science students.
- My institution offers Supplemental Instruction (SI) for developmental/remedial science students.
- My institution offers other developmental/remedial science services not listed here.

Data: Survey 1, Question 1. Responses are found in Table 1.

Table 1

Degree of Developmental/Remedial Sciences Offerings

Are developmental/remedial sciences offered at your campus?	#	%
No	40	67
Yes	20	33
Total	60	100

A total of 40 out of 60 (67%) respondents answered "no" to all components of Survey 1, Question 1, which indicated developmental/remedial sciences were not offered at their campuses. However, comments were written by 13 of these respondents and were grouped into 2 categories, which are reported in Table 2.

Table 2

No Developmental/Remedial Sciences Offered – Additional Comments

Comment Category	#	%
Unprepared science students took courses in developmental math, English, and writing	2	5
Support services were offered for *all* students, not specifically for one group	11	28
Total	13	33

- *Unprepared science students took courses in developmental math, English, and writing*. The following comments were made by one or more respondents: "Developmental science deficiencies are removed by completing the math deficiency." "Anyone not prepared for sciences would go to the Developmental Ed department for English, writing, math, ESL. . . ." These comments were consistent with commentary by Hsu et al. (2005):

"Presumably the absence of science courses from developmental education comes from the view that students must have a firm grounding in reading, writing, and math skills before they can succeed in a science course" (p. 30).

- *Support services were offered for all students, not specifically for one group*. Regarding support services, such as tutoring and advising, at least one respondent indicated the availability of "tutoring and advising for all students in most disciplines, but not special developmental tutoring in sciences." Others comments included "tutoring for all students, not targeted," and that advising was offered at their institutions but "not especially for developmental science students."

Table 1 also shows that a total of 20 out of 60 (33%) respondents reported developmental/remedial sciences *were* offered at their campuses. Data in response to the components of Survey 1, Question 1 may be found in Tables 3, 4, 5, 6, 7, 8, and 9.

Developmental/remedial science courses and/or programs. Data for this component are presented in Table 3.

Table 3

Developmental/Remedial Science Courses and/or Programs Offered

Developmental/remedial science courses and/or programs offered	#	%
No	6	30
Yes	12	60
No Response	2	10
Total	20	100

In response to the offering of courses and/or programs in developmental/remedial sciences, 12 (60%) CAOs indicated that courses and/or programs were offered; 6 (30%) institutions did not offer courses or programs, and 2 (10%) did not respond.

Placement of developmental/remedial science students. These data are shown in Table 4.

Table 4

Criteria Used to Identify Developmental/Remedial Science Students and Used for Placement

Criteria used to identify developmental/remedial science students and used for placement	#	%
No	8	40
Yes	8	40
No Response	4	20
Total	20	100

CAOs from 8 (40%) institutions indicated criteria were used to identify students for placement into developmental/remedial sciences, 8 (40%) did not use criteria for placement, and 4 (20%) did not respond.

Tutoring for developmental/remedial science students. Respondent data are presented in Table 5.

CAOs from 14 (70%) community colleges reported offering tutoring for developmental/remedial science students. Tutoring was not offered at 1 (5%) institution and 5 (25%) did not respond.

Table 5

Tutoring for Developmental/Remedial Science Students

Tutoring for developmental/remedial science students	#	%	Area/Discipline of Tutoring
No	1	5	
Yes	14	70	Biology Chemistry Physical Science Science All disciplines
No Response	5	25	
Total	20	100	

Academic advising for developmental/remedial science students. These data are shown in Table 6.

Table 6

Academic Advising for Developmental/Remedial Science Students

Academic advising for developmental/remedial science students	#	%
No	7	35
Yes	9	45
No Response	4	20
Total	20	100

Academic advising was provided for developmental/remedial science students at 9 institutions (45%) whereas advising services were not offered at 7 (35%) institutions; 4 (20%) did not respond to this question.

Counseling services for developmental/remedial science students. CAO responses are presented in Table 7.

Table 7

Counseling for Developmental/Remedial Science Students

Counseling for developmental/remedial science students	#	%
No	8	40
Yes	8	40
No Response	4	20
Total	20	100

Counseling for developmental/remedial science students was reportedly offered at 8 (40%) institutions. Another 8 (40%) CAOs indicated no such service and 4 (20%) did not respond.

Supplemental Instruction (SI) for developmental/remedial science students. Data are presented in Table 8.

Table 8

Supplemental Instruction (SI) for Developmental/Remedial Science Students

SI for developmental/remedial science students	#	%	Area/Discipline of SI
No	10	50	
Yes	5	25	Biology A&P Chemistry Science
No Response	5	25	
Total	20	100	

Supplemental Instruction (SI) for developmental/remedial sciences was provided at 5 (25%) community colleges; 10 (50%) CAOs indicated no SI and 5 (25%) did not respond.

Other developmental/remedial science services not listed on the survey. These data are presented in Table 9.

Table 9

Other Developmental/Remedial Science Services

Other developmental/remedial science services	#	%	Other Services
No	10	50	
Yes	2	10	Small study groups with tutor Basic Learning Center
No Response	8	40	
Total	20	100	

Only 2 (10%) CAOs added comments in the “other services offered” category indicating that small study groups with a tutor and a Basic Learning Center are utilized at their institutions.

Summary: Survey 1, Question 1. Of the 60 respondents to Survey 1, 40 (67%) CAOs indicated no developmental/remedial sciences were offered at their campuses. However, some of those indicated students underprepared for the sciences took courses in developmental math, English, and writing to “remove” developmental science “deficiencies.” Others wrote that support services were offered not just for specific groups of students, but for *all* students.

The remaining 20 (33%) CAOs indicated developmental/remedial sciences were offered at their campuses and further elaborated on the types of services that were offered. Courses and/or programs were offered at 12 of the 20 (60%) institutions. Criteria were used to identify and place developmental/remedial science students into developmental/remedial science courses and programs at 8 (40%) institutions. At a majority (14 of 20, or 70%) of institutions, tutoring services were offered, 9 (45%) offered academic advising, and 8 (40%) offered counseling for these students. Supplemental Instruction (SI) was offered for developmental/remedial sciences at 5 (25%) institutions and 2 (10%) respondents indicated offering the additional services of either small study groups with tutoring or a Basic Learning Center.

Survey 1, Question 6

As of November 2006, do you have plans to offer developmental/remedial science courses or programs at your campus in the future?

Data: Survey 1, Question 6. Data are presented in Table 10.

Table 10

Plans to Offer Developmental/Remedial Sciences in Future

Plans to offer developmental/remedial sciences in future	#	%	Comments
No	29	49	
Yes	17	28	
No Response	11	18	
Write In	3	5	Unsure Considering it Probably look into going forward
Total	60	100	

Nearly half (29 of 60, or 49%) of respondents to Survey 1 indicated no plans to offer developmental/remedial sciences at their institutions in the future; 17 of 60 (28%) reported they did have plans to offer developmental/remedial sciences in the future. These findings are not consistent with the literature, which suggests there is “every reason to conclude that remediation will continue to be a core function of colleges and universities" (Phipps, 1998, p. 6). Further, Boylan et al. (1999) wrote "community colleges are currently the primary provider of developmental education and the need for them to do so will continue" (p. 97). Another 11 (18%) did not respond, and 3 (5%) wrote in that they were either "unsure" or "considering it." The third write in respondent noted developmental/remedial sciences "is something [institutional leaders] will probably look into going forward with," and she appreciated the researcher's interest "in a topic that should be considered academically in a two year college."

Survey 1, Question 7

Does your institution have multiple campuses?

Survey 1, Question 8

Are developmental/remedial science courses or support services offered on any other campuses of your institution?

Survey 1, Question 9

Are the developmental/remedial science policies and practices the same at all campuses of your institution?

Data: Survey 1, Questions 7, 8, and 9. Data for Questions 7, 8, and 9 are presented together in Table 11.

Of the 60 respondents to Survey 1, the majority (39 or 65%) indicated their institutions had multiple campuses, 10 (17%) had only one campus, and 11 (18%) did not respond.

Table 11

Multiple Campuses and Developmental/Remedial Science Offerings

Survey 1, Questions 7-9	No		Yes		No Response		Total	
	#	%	#	%	#	%	#	%
Institution has multiple campuses	10	17	39	65	11	18	60	100
Dev/Rem science courses or support services offered on other campuses	32	54	8	13	20	33	60	100
Dev/Rem science policies and practices the same at all campuses	0	0	7	12	53	88	60	100

CAOs from 8 (13%) institutions indicated developmental/remedial science courses or support services were offered at other campuses of their institutions while 32 (54%) CAOs noted such courses and services were not available at their other campuses; 20 (33%) did not respond to this question.

CAOs from 7 (12%) institutions indicated that developmental/remedial science policies and practices were the same at all campuses of their institutions. Given that developmental/remedial sciences were not offered at most institutions (40 of 60, or 67%), this question did not apply for the majority of CAOs.

Summary: Survey 1, Questions 7, 8, and 9. The majority (39 of 60, or 65%) of institutions had multiple campuses, and at 8 (13%) of those institutions with multiple campus sites, developmental/remedial sciences were offered, the majority of which followed the same policies and practices as the main campus.

Research Question 2b

Were developmental/remedial sciences at the selected community colleges offered in the form of a course or an entire program?

Responses to questions 1 and 2 on Survey 1 were used to answer this research question.

Survey 1, Question 1

The responses to this survey question were addressed in detail for Research Question 1. Responses are summarized here.

At a majority (12 of 20, or 60%) of the institutions where developmental/remedial sciences were offered, courses and/or programs existed. Criteria were used to identify and place developmental/remedial science students into developmental/remedial science courses and programs at 8 (40%) institutions, and at a majority (14 of 20, or 70%) of institutions tutoring services were offered. Advising was available for these students at 9 (45%) institutions, counseling at 8 (40%) institutions, and Supplemental Instruction (SI) was offered for developmental/remedial sciences at 5 (25%) institutions.

Survey 1, Question 2

In which areas are developmental/remedial sciences offered at your campus? Mark all that apply with an X.

- Biological Sciences
  - → Biology courses for non-science majors
  - → Biology courses for science majors
  - → Human Anatomy and Physiology
  - → Microbiology
  - → Other

- Chemistry
  - → Chemistry courses for non-science majors
  - → Inorganic Chemistry
  - → Organic Chemistry
  - → Other
- Physical Science/Physics
  - → Physical Science
  - → Physics courses for science majors
  - → Other
- Earth Sciences
  - → Geology
  - → Weather and Climate
  - → Other

Data: Survey 1, Question 2. Responses are presented in Table 12.

Of the 20 respondents to Survey 1 who indicated developmental/remedial sciences were offered at their campuses, 17 individuals responded to this question. Developmental/remedial sciences were offered most often in the areas of "Chemistry courses for non-science majors" (11 responses, or 55%) and "Biology courses for non-science majors" (10 responses, or 50%). "Physical Science" received 6 (30%) responses and "Human Anatomy & Physiology" received 4 (20%) responses. Receiving 3 (15%) responses each were "Biology courses for science majors" and "Microbiology." "Physics courses for science majors" and "Geology" each received 1 (5%) response, along with four write in areas, including Environmental Science, Fundamentals of Technology, Transitional Science, and Basic Science.

Summary: Survey 1, Question 2. At least half of respondents to this question indicated developmental/remedial sciences in the areas of "Chemistry courses for non-science majors" and "Biology courses for non-science majors" were offered at their institutions. The "Physical Science" category received half as many responses. Other areas in biological sciences, physical science, and earth science received at least one response as presented in Table 12.

Table 12

Areas of Developmental/Remedial Science Offerings

Areas of developmental/remedial science offerings	#	%	"Other" Category
Biological Sciences			
Biology courses for non-science majors	10	50	
Biology courses for science majors	3	15	
Human Anatomy & Physiology	4	20	
Microbiology	3	15	
Other	1	5	Environmental Science
Chemistry			
Chemistry courses for non-science majors	11	55	
Inorganic Chemistry	0	0	
Organic Chemistry	0	0	
Other	0	0	
Physical Science/Physics			
Physical Science	6	30	
Physics courses for science majors	1	5	
Other	1	5	Fundamentals of Technology
Earth Sciences			
Geology	1	5	
Weather & Climate	0	0	
Other	0	0	
General Science			
Other	2	10	Transitional Science Basic Science

Research Question 2e

Research Question 2e: What were the instructional practices that supported those goals?

Responses to Question 3 on Survey 1 were used to answer this research question.

Survey 1, Question 3

How are developmental/remedial sciences offered on your campus? Mark your response with an X.

- Developmental/remedial education is integrated into the content of regular science courses.
- Developmental/remedial education is offered as separate study skills courses.
- Both of the above.
- Other. Please explain.

Data: Survey 1, Question 3. Responses for this survey question may be found in Table 13.

Table 13

Content and Developmental Education Study Skills Integrated or Separated?

Content and developmental education study skills integrated with or separated from science courses?	#	%
Developmental/remedial education is integrated into the content of regular science courses.	1	2
Developmental/remedial education is offered as separate study skills courses.	10	16
Both of the above	1	2
Other	3	5
No Response	45	75
Total	60	100

A total of 15 of 60 (25%) participants in Survey 1 responded to this question. Most of those who responded to this question (10 of the 15) answered that developmental/remedial education was offered in the form of separate study skills courses as opposed to being integrated into the regular science courses taught at that institution. A single respondent indicated that developmental/remedial education was integrated into the content of regular science courses. Both approaches were used at one institution, depending on the course. CAOs at three other institutions indicated other approaches were used, which included offering tutoring services as needed, offering a separate developmental biology course, and, similarly, integrating developmental/remedial study skills into developmental/remedial science courses offered.

Summary: Survey 1, Question 3. The majority of the respondents to this question on Survey 1 indicated developmental/remedial education was offered as study skills courses separate from regular (nondevelopmental/nonremedial) science courses. At one institution where developmental/remedial sciences were not offered, developmental/remedial education and science content were integrated into regular science courses. At another institution both approaches were incorporated, depending upon the course. CAOs from three other institutions responded that either tutoring was offered as needed or developmental/remedial study skills were integrated specifically into developmental/remedial science courses as opposed to integrating skills into the regular, nondevelopmental/nonremedial science courses offered at their institutions.

The fact that most surveyed institutions separated developmental/remedial education from the content courses is consistent with the findings of Johnson (2001), who noted that most developmental support is separate from content courses where the students could be learning skills easier and faster by practicing and applying their newly learned skills in the content area. Moore (2002a) argued that scientific literacy can occur by "integrating students into content-rich courses" (p. 9), not a practice employed by most respondents to this question on Survey 1.

Research Question 2f

Research Question 2f: What advising and support services were available to students in developmental/remedial sciences?

Responses to Question 1 on Survey 1 were used to answer this research question.

Survey 1, Question 1

Responses to this survey question were addressed in detail for Research Question 1, but are summarized here. The components of Survey 1, Question 1, which speak to this research question, deal only with support services, such as the use of criteria for identifying and placing students, tutoring, academic advising, counseling, and Supplemental Instruction (SI). The most common (14 of the 20, or 70%) support service offered was tutoring. Academic advising was available at 9 (45%) institutions. Counseling was available and criteria were used to identify and place students into developmental/remedial science courses and/or programs at 8 (40%) institutions each. SI was offered at 5 (25%) schools.

Results from Survey 1 were presented in Section 1. In Section 2, the demographic data and survey responses for Survey 2 are presented.

Section 2: Survey 2

Section 2 contains the demographic information for respondents to Survey 2 and results of Survey 2. This section will be presented in the following format:

1. Survey return rate
2. Demographic data and summary from Survey 2 respondents
3. Statement of the research question
4. Statement of survey questions addressing the research question
5. Quantitative data analysis
6. Summary of data for each research question

Survey 2 Return Rate

Survey 1 was sent to Chief Academic Officers at 72 community colleges in 5 states in the central part of the United States. A total of 60 responses was received; 20 of those 60 (33%) indicated developmental/remedial sciences were offered in some form at their institutions. Only 12 of those 20 committed to participate in Survey 2, so Survey 2 was sent to individuals at those 12 institutions. All individuals who received Survey 2 returned the survey to the researcher, but only 8 were able to answer the in-depth questions about developmental/remedial sciences offered at their institutions. Thus, only 8 institutions were used for the data analysis.

Demographic Data for Survey 2 Respondents

The respondents to Survey 2 were individuals who had been identified by the CAOs who responded to Survey 1 that developmental/remedial sciences were offered at their campuses and who had also agreed to participate in subsequent phases of the study by providing a letter of commitment as reported in Chapter 3.

Survey 2 contained nine demographic questions asking for information about the person completing the survey, including the following: job position/title, employment status, highest academic credential, gender, current instructor status, years of teaching experience, experience teaching developmental/remedial courses and science courses, and the type of educator respondents considered themselves. Data are found in Tables 14-22 and are discussed following the tables.

Position/Job Title

Data about respondent position and job title are in Table 14.

Table 14

Position/Job Title

Position/Job Title	#	%
Science Department Chair	2	25
Dean	2	25
Executive Director of Academic Support	1	13
Help/Testing Center Coordinator and Instructor	1	13
Instructor	2	25
Total	8	100

The majority (6 of 8, or 75%) of the respondents to Survey 2 held an administrative title at their institutions, including 2 science department chairs, 2 Deans, 1 Executive Director of Academic Support, and 1 Help Center Coordinator/instructor. Another 2 respondents indicated they held instructor positions at their institutions.

Employment Status

Data about the employment status of respondents are in Table 15.

Table 15

Employment Status

Employment Status	#	%
Full Time	8	100
Part Time	0	0
Total	8	100

All respondents to Survey 2 were in full time positions at their institutions.

Highest Academic Credential

The highest academic credential of respondents is shown in Table 16.

Table 16

Highest Academic Credential

Highest Academic Credential	#	%
BA/BS	1	13
Masters	5	63
EdD/PhD	2	25
Total	8	100

Only 1 (13%) respondent to Survey 2 held a Bachelor's degree as his/her highest academic credential, but the majority (7 of 8, or 88%) held higher degrees; 5 (63%) held Master's degrees and 2 (25%) held the doctorate.

Gender

Gender data for Survey 2 respondents is found in Table 17.

Table 17

Gender

Gender	#	%
Male	4	50
Female	4	50
Total	8	100

An equal number of males and females (4 each) completed and returned Survey 2.

Current Instructor Status

The current instructor status of Survey 2 respondents is shown in Table 18.

Table 18

Current Instructor Status

Are you currently an instructor?	#	%
No	3	38
Yes	5	63
Total	8	100

The majority (5 of 8, or 63%) of respondents was teaching during the fall 2006 semester, even though 7 of the 8 held administrative positions; three (38%) respondents indicated they were not teaching at the time.

Years of Teaching Experience

Data on the number of years of teaching experience for respondents is found in Table 19.

Table 19

Years of Teaching Experience

Number of Years Teaching Experience	#	%
Less than 5 years	1	13
6-10 years	0	0
11-15 years	1	13
16-20 years	1	13
21-25 years	1	13
26+ years	4	50
Total	8	100

Only 1 respondent (13%) indicated she had been a teacher for less than 5 years, 1 (13%) indicated 11-15 years, and 1 (13%) other indicated 16-20 years. The remaining 5 respondents (63%), however, were veteran teachers with at least 21 years experience each.

Developmental/Remedial Teaching Experience and Science Teaching Experience

Respondents to Survey 2 were asked to indicate if they had ever taught a developmental/remedial course, and, if so, to indicate the course(s) they had taught. They were also asked to indicate if they had experience teaching science courses and to indicate which courses they had taught. Data are presented in Table 20.

Table 20

Experience Teaching Developmental/Remedial Courses and Science Courses

Demographic Questions	No #	No %	Yes #	Yes %	Total #	Total %	Courses Taught
Have you ever taught a developmental/remedial education course in any field?	1	12	7	88	8	100	Basic Arithmetic Fundamentals of Algebra Math Reading Study Strategies College Learning Methods Introduction to Science Fundamentals of Zoology
Have you ever taught courses in the sciences?	3	37	5	63	8	100	Biology A&P Cell Physiology Chemistry Physics Basic Science

All but 1 (88%) respondent had taught developmental/remedial courses during their careers; 5 (63%) had taught science courses. Only 2 (25%) had experience teaching developmental/remedial sciences.

Type of Educator

The final demographic question asked the respondents to indicate whether they considered themselves to be developmental/remedial educators, science educators, or if they affiliated themselves with both areas or with some other area. Data are presented in Table 21.

A total of 3 respondents (38%) indicated they considered themselves to be developmental/remedial educators and 4 (50%) marked "science educator." Only one (13%) individual marked administration as his/her role. None of the respondents indicated they were both developmental/remedial educators and science educators. These

Table 21

Type of Educator

Do you consider yourself a developmental/remedial educator or a science educator?	#	%	Other
Developmental/remedial educator	3	38	
Science educator	4	50	
Both	0	0	
Other	1	13	Administrator
Total	8	100	

data were interesting, given the finding presented earlier that 7 of the 8 held administrative titles at their institutions, but were consistent with the majority of respondents having teaching responsibilities along with those administrative roles.

Summary of Demographic Data for Survey 2 Respondents

All respondents held an administrative position except two, all were employed full time, and all but one held a Master's or higher level degree. An equal number of males and females completed the survey. Most (63%) respondents were teaching at the time of the surveys, and most (63%) were veteran teachers with at least 21 years teaching experience. All but one respondent had taught developmental/remedial classes in some field (2 in developmental/remedial sciences) and most (63%) had taught courses in the sciences. Half of the respondents considered themselves science educators, 38% indicated they were developmental/remedial educators, and one (13%) indicated s/he was an administrator.

Research Question 2a

Research Question 2a: What were the descriptive characteristics of developmental/remedial sciences where offered by the selected community colleges? Descriptive characteristics included the following: What were the factors that contributed to identifying the need for developmental/remedial sciences?

Responses to Questions 1, 2, 4, and 24 on Survey 2 were used to answer this research question. A discussion of the data follows each table.

Survey 2, Question 1

Based on the experience at your campus, are students prepared for the science courses they take?

Data: Survey 2, Question 1. A response of "not applicable" or no response was interpreted to mean the courses about which the question inquired were not offered at a respondent's institution. Results are presented in Table 22.

- Biological Sciences
  - → *Biology courses for non-science majors*: In the area of biological sciences, 6 (75%) respondents indicated students were not prepared for biology courses for non-science majors, and 2 (25%) responded that students were prepared for such courses at their campuses.
  - → *Biology courses for science majors:* In this category, 3 (38%) respondents indicated students who were science majors were prepared for the majors level biology courses they would take, an equal number (3 of 8, or 38%)

reported students were *not* prepared for these courses, and 2 (25%) either did not respond or wrote "not applicable" for this question.

→ *Human Anatomy and Physiology:* Half of the respondents noted that students were not prepared for anatomy and physiology courses; another 3 (38%) indicated students were prepared, and one (13%) did not respond.

→ *Microbiology:* A majority of respondents (5 of 8, or 63%) indicated students were not prepared for microbiology courses; 2 (25%) indicated students were prepared for microbiology, and 1 (13%) did not respond.

→ *Other*

- Chemistry

→ *Chemistry courses for non-science majors:* A majority (5 of 8, or 63%) indicated a lack of student preparation for chemistry courses for non-science majors; 2 (25%) indicated students were prepared, and 1 (13%) indicated "not applicable."

→ *Inorganic Chemistry:* The poor preparation of students for inorganic chemistry was reported by 3 (38%) individuals, while 1 (13%) reported students were prepared, and 4 (50%) wrote "not applicable" or did not respond to this category of chemistry courses.

→ *Organic Chemistry:* Responses to student preparation for organic chemistry were markedly different as only 1 respondent (13%) indicated students were not prepared for the courses, while 3 (38%) indicated

Table 22

Are Students Prepared for Science Courses?

Are students prepared for the science courses they take?	No		Yes		No Response/ Not applicable		Total	
	#	%	#	%	#	%	#	%
Biological Sciences								
Biology courses for non-science majors	6	75	2	25	0	0	8	100
Biology courses for science majors	3	38	3	38	2	25	8	100
Human Anatomy & Physiology	4	50	3	38	1	13	8	100
Microbiology	5	63	2	25	1	13	8	100
Chemistry								
Chemistry courses for non-science majors	5	63	2	25	1	13	8	100
Inorganic Chemistry	3	38	1	13	4	50	8	100
Organic Chemistry	1	13	3	38	4	50	8	100
Physical Science/Physics								
Physical Science	4	50	3	38	1	13	8	100
Physics courses for science majors	3	38	3	38	2	25	8	100
Earth Sciences								
Geology	4	50	3	38	1	13	8	100
Weather & Climate	0	0	2	25	6	75	8	100

students were prepared, and half of the respondents wrote “not applicable” or left this blank.

→ *Other*

- Physical Science/Physics

→ *Physical Science:* Half of the respondents indicated that students were not prepared for physical science; 3 (38%) indicated students were prepared, and 1 (13%) did not respond.

→ *Physics courses for science majors:* Students were not prepared for physics courses taken by science majors, according to 3 of 8 respondents (38%); an equal number (3 of 8, or 38%) indicated students were prepared, and 2 (25%) either did not respond or wrote “not applicable.”

→ *Other*

- Earth Sciences

→ *Geology:* Half of the respondents indicated students were not prepared for courses in geology; 3 (38%) indicated students were prepared for geology courses, and 1 (13%) did not respond.

→ *Weather and Climate:* Only 2 (25%) respondents indicated students were prepared for this course, and 6 (75%) either wrote “not applicable” or did not respond.

→ *Other*

Summary: Survey 2, Question 1. For 6 of the 11 course categories, at least half of respondents indicated students at their campuses were not prepared for the science courses they take. For two of the categories ("Biology courses for science majors" and "Physics courses for science majors"), equal numbers of respondents indicated that students either were or were *not* prepared for these courses. Organic Chemistry and Weather and Climate were the only courses for which respondents indicated more often that students were prepared than not prepared.

These findings are consistent with TIMSS (NCES, 2006) and NAEP (NCES, 2005) data, which indicated students were not prepared for math and science. Taken as a whole, TIMSS and NAEP data indicated students are not coming out of high school prepared for secondary sciences, much less college level sciences. These data are further supported by the findings of Bastedo and Gumport (2003), Biermann and Sarinsky (1993), Moore (2002a), Roach (2000), Rutherford and Ahlgren (1990), and Wilke and Straits (2005), which indicated many students entering community college are poorly prepared for introductory sciences. Friedlander (1981) made the case for developmental/remedial work as it better prepares underprepared students for subsequent coursework.

Survey 2, Question 2

Please identify the apparent sources of weaknesses for students who are underprepared for science courses they will take at your campus. Mark all that apply with an X. Then, of the weaknesses you marked, indicate the top 3 sources of student weaknesses with 1 being the greatest weakness and 3 being the lesser weakness.

- Inadequate math background
- Inadequate biology background
- Inadequate chemistry background
- Poor reading ability

- Poor writing ability
- Overall lack of ability
- Lack of confidence
- A general fear of science courses
- Lack of motivation
- Poor study habits
- Poor time management
- Poor attitude toward the course
- Other

Data: Survey 2, Question 2. Responses for this question are presented in Table 23.

Table 23

Student Weaknesses

Apparent sources of weaknesses for students who are underprepared for science courses	Total responses		Responses as a top 3 weakness	
	#	%	#	%
Inadequate math background	8	100	7	88
Inadequate biology background	4	50	1	13
Inadequate chemistry background	5	63	1	13
Poor reading ability	7	88	5	63
Poor writing ability	4	50	1	13
Overall lack of ability	3	38	2	25
Lack of confidence	7	88	2	25
General fear of science courses	6	75	1	13
Lack of motivation	5	63	4	50
Poor study habits	8	100	5	63
Poor time management	7	88	3	38
Poor attitude toward the course	2	25	1	13

The importance of math background was obvious in the data, given that all respondents reported it as a weakness, and 7 of 8 (88%) reported it as a top 3 weakness in students who are underprepared for science courses.

Among the other weaknesses that stand out as important are poor study habits and poor reading ability. Poor study habits were indicated by all respondents as a weakness and by 5 (63%) as a top 3 weakness. Poor reading ability was reported by 7 (88%) respondents as a weakness, and by 5 (63%) as a top 3 weakness.

Lack of confidence and poor time management were each indicated by 7 (88%) respondents as weaknesses, but less than half of respondents indicated these as a top 3 weakness. This was interpreted to mean these weaknesses were noticeable, but not as important as inadequate math background, poor study habits, and poor reading ability for students who take science courses.

Summary: Survey 2, Question 2. Each of the 11 categories of student weaknesses listed on the survey was reported as a top 3 weakness by at least 1 respondent, but math background, study habits, and reading ability were reported to be the most important sources of weakness for students who take science courses, as at least 63% of respondents reported these as the top 3 weaknesses of students who take science courses.

These data are supported by the literature. Sax et al. (1999) recognized increased academic disengagement among high school students. Biermann and Sarinsky's (1993) findings supported the math and reading weaknesses noted in this study when they reported that many community college students were poorly prepared for sciences because they had weak math and verbal skills, which led them to avoid science in high school, thereby exacerbating the issue of preparedness for science courses.

Survey 2, Question 4

How long have developmental/remedial sciences been in existence at your institution?

- 1-3 years
- 4-6 years
- 7-9 years
- 10+ years

Data: Survey 2, Question 4. Data are presented in Table 24.

Table 24

Length of Time Developmental/Remedial Sciences Have Been in Existence

Length of time developmental/remedial sciences have been in existence	#	%
1-3 years	0	0
4-6 years	1	13
7-9 years	0	0
10+ years	7	88
Total	8	100

Developmental/remedial sciences had been offered for over 10 years at 7 of the 8 (88%) participating institutions. Only at 1 (13%) institution had developmental/remedial sciences been offered for less than 10 years, with the respondent marking the “4-6 years” category.

These data were supported by the literature–developmental/remedial sciences are not new. The issues addressed at institutions offering developmental/remedial sciences are not recent developments, consistent with the comments of Phipps (1998) regarding developmental/remedial education as a whole.

Survey 2, Question 24

If a developmental/remedial science (biology, chemistry, physics/physical science, earth science) course(s) and/or support services are offered at your campus, list the factors that contributed to identifying the need for such courses and support services.

Data: Survey 2, Question 24. This open-ended question led to a variety of responses, which were grouped into three categories. These categories are listed in Table 25.

Table 25

Identifying Need for Developmental/Remedial Sciences

Response Categories – Factors that contributed to identifying the need for developmental/remedial sciences	#	%
Faculty identified need based on student performance in courses	5	63
Assessment/placement test such as Compass or ACT	2	25
State mandated prerequisite	1	13
Total	8	100

The three response categories included:

1. *Faculty identified need based on student performance in courses*. Respondents from 5 (63%) institutions indicated that the need for developmental/remedial sciences was identified by faculty in response to poor student performance or high drop out rates in courses in the areas of anatomy and physiology, chemistry, and the physical sciences. One respondent wrote

> Students entering the ADN [Associate Degree Nursing] program were not allowing time in their schedules to take both prerequisites (chemistry and biology). As a result, they were dropping out or failing Anatomy & Physiology in significant numbers. The Basic Concepts class was developed to provide these students with foundational information that would help them be successful in A&P.

Another respondent indicated that their developmental/remedial science course had already been instituted "based on high failure rates in the introductory science courses, especially physical sciences" when state mandates were put in place. The reason for the state mandate was not clear.

2. *Assessment/placement test such as Compass or ACT*. As reported by 2 (25%) respondents, assessment tests were used at their institutions. The needs of nontraditional students as well as scoring "low on math and reading through the Compass program" were specifically noted by one individual.
3. *State mandated prerequisite*. A respondent from 1 (13%) institution indicated a state mandate to offer a developmental/remedial science course as a prerequisite for another course or in response to a score of 19 or below on any subset of the ACT. The respondent did not indicate whether the institution was required by the state to offer the course for funding purposes or some other reason.

Summary: Survey 2, Question 24. There were three major factors that contributed to identifying the need for developmental/remedial sciences on respondents' campuses: (a) faculty identified need based on student performance in courses (63%), (b) assessment/placement test such as Compass or ACT (25%), or (c) state mandated prerequisite (13%).

State mandates for offering developmental/remedial science courses are consistent with the national trend of community colleges assuming an even greater responsibility for developmental/remedial education in their states (Jenkins & Boswell, 2002; Kozeracki, 2002; Parsad & Lewis, 2003).

Research Question 2b

Research Question 2b: Were developmental/remedial sciences at the selected community colleges offered in the form of a course or an entire program?

Responses to Question 3 on Survey 2 were used to answer this research question.

Survey 2, Question 3

As of November 2006, do you offer a developmental/remedial science course(s) at your campus? Mark with an X the appropriate response. Match the course(s) offered at your campus to the list below. If there is no exact match, describe the course(s) at your campus in the “Other” category.

Data: Survey 2, Question 3. Data are presented in Table 26.

Respondents were given the opportunity to answer “yes” or “no” to a number of categories of developmental/remedial sciences. In most cases, however, there was not an exact match, so they wrote in the names of courses offered at their institutions.

A total of 10 different courses were offered at the 8 institutions. At least 1 developmental/remedial science course was offered at each of the 8 institutions; at 1 institution 3 courses were offered. The courses were grouped into four categories as follows:

Table 26

Developmental/Remedial Science Course Offerings

Categories of developmental/remedial science courses offered	Course Title (Course Number)	# of Courses	%
Introduction to General Science	Intro to the Study of Science (SCI 095) Basic Science (SCI 0103) Fundamentals of Science (PHYS 0123)	3	30
Math Review for Science	Math Review for the Sciences (CH 050) Basic Math for Chemistry (CHEM 090)	2	20
Introduction to Biology and Chemistry	Basic Concepts for Allied Health Studies (BI 100) Basic Biology Concepts (BIO 090) Chemistry Review (BI 105) Critical Concepts in Biology (BI 106)	4	40
Pre-Chemistry	Pre-Chemistry (CHE 0950)	1	10
Total		10	100

1. *Introduction to General Science*. This category included three courses: Introduction to the Study of Science, Basic Science, and Fundamentals of Science. Each course was interdisciplinary and addressed aspects of biology, chemistry, physical, and earth sciences.
2. *Math Review for Science*. The two courses that addressed the basic mathematical skills needed for the study of science were Math Review for the Sciences and Basic Math for Chemistry.
3. *Introduction to Biology and Chemistry*. Included in this category were courses which addressed the basic principles in the disciplines of both biology and chemistry, which were most particularly important for allied health or pre-allied health students who would go on to take courses in anatomy and physiology and microbiology. These four courses were Basic

Concepts for Allied Health Studies, Basic Biology Concepts, Chemistry Review, and Critical Concepts in Biology.

4. *Pre-Chemistry*. Only one course, Pre-Chemistry, was in this category and included topics only in the area of chemistry.

Summary: Survey 2, Question 3. A total of 10 different developmental/remedial science courses were offered at the institutions of 8 respondents. The courses were categorized into 4 groups based on topics covered: Introduction to General Science, Math Review for Science, Introduction to Biology and Chemistry, and Pre-Chemistry. Most courses were interdisciplinary in nature.

Studies of developmental science courses in biology were reported by Hsu et al. (2005), and studies of developmental courses in anatomy and physiology were reported by Jensen and Rush (2000). Similar studies in chemistry were reported by Congos and Mack (2005) and in physical science by Johnson (2001).

Research Question 2b(i)

Research Question 2b(i): If a course, what kind of academic credit did it carry?

Responses to Question 15 on Survey 2 were used to answer this research question.

Survey 2, Question 15

What kind of academic credit is awarded for the developmental/remedial science course(s) at your campus? Mark with an X the appropriate response. If multiple courses, please indicate credit for each.

- No formal credit
- Institutional credit (course counts as part of a student’s course load and appears on the transcript, but hours do not count toward a degree)
- Hours may be counted toward an AA or AS degree

- Other. Please explain.

Data: Survey 2, Question 15. Data are presented in Table 27.

Table 27

Type of Academic Credit

Type of academic credit awarded for the developmental/remedial science course(s)	#	%
No formal credit	1	13
Institutional credit (course counts as part of student's course load and appears on transcript, but hours do not count toward a degree)	6	75
Hours may be counted toward AA or AS degree	1	13
Total	8	100

Most respondents (6 of 8, or 75%) indicated the developmental/remedial science courses offered at their institutions were offered for institutional credit only. That is, the course would count toward the enrolled student's course load and would appear on the student's transcript, but the credit hours of the course would not apply toward a degree at that institution. Another (13%) individual indicated that no formal credit was offered for the course. The hours for the course were able to be counted toward an Associate of Arts or Associate of Science degree at only 1 (13%) institution.

Summary: Survey 2, Question 15. Most respondents noted only institutional credit was offered for developmental/remedial science classes, but at 1 (13%) institution the credit could be applied toward an Associate's degree.

These data are not consistent with best practices in the literature. Offering credit toward a degree for developmental/remedial science courses was noted in the literature as a best practice (Hsu et al., 2005; Kozeracki, 2002), but at only one institution in the study was credit offered toward a degree.

Research Question 2b(ii)

Research Question 2b(ii): What topics were covered?

Responses to Question 5 on Survey 2 were used to answer this research question.

Survey 2, Question 5

For each course you marked in Item 3, please list the topics covered in the course in the spaces provided below. If you would prefer to attach a syllabus, please check "Yes" in the space below.

Data: Survey 2, Question 5. Each of the eight respondents from institutions where developmental/remedial science courses were offered provided syllabi for the courses at their campuses. The list of topics covered in the courses was derived from those syllabi. Topics were grouped into five categories by discipline, then into 31 topic categories. A summary of the topic categories is presented in Table 28.

The topics covered were first grouped into 5 disciplines: chemistry, biology, physics, general science, and math. Topics were then grouped into 31 topic categories within those disciplines.

The most common topic, found in 70% of syllabi, was cell structure and function. At least 60% of the courses covered the following topics:

- organic macromolecules;
- chemical formulas and reactions, balancing equations;
- element names and symbols, periodic table; and
- energy, cell metabolism.

Table 28

Summary of Topics Covered in Developmental/Remedial Science Courses

Discipline Category	Topic Category	# / % of 10 Courses Covering Topic	
Chemistry	Organic macromolecules	6	60
	Chemical formulas and reactions, balancing equations	6	60
	Element names and symbols, periodic table	6	60
	Properties of water, solutions	5	50
	pH, buffers, electrolytes	5	50
	Atomic theory	4	40
	Chemical bonding	3	30
	Matter	2	20
Biology	Cell structure and function (membranes, transport, organelles)	7	70
	Energy, cell metabolism	6	60
	Molecular genetics, DNA replication, gene expression	4	40
	Cell division	4	40
	Enzymes	3	30
	Mendelian genetics, inheritance	2	20
	Levels of organization (human body)	1	10
	Homeostasis	1	10
	Language of anatomy	1	10
Physics	Exploring space	1	10
	Mechanics (mass, motion)	1	10
	Fluids	1	10
General Science	Scientific method	4	40
	Lab skills (safety, lab equipment)	3	30
	Learning skills (how to write and study science)	2	20
	Vocabulary	1	10
Math	Measurements (volume, dilutions, conversions)	4	40
	Basic algebraic functions, manipulating equations	3	30
	Scientific notation, significant figures	3	30
	Constructing graphs	3	30
	Metric system	2	20
	Basic math skills (rounding, ratios, proportions, percents)	2	20
	Use of calculator	1	10

Half of the courses covered the properties of water and solutions, and pH, buffers, and electrolytes. Topics covered in 40% of courses included

- atomic theory;
- molecular genetics, DNA replication, gene expression;

- cell division;
- scientific method; and
- measurements (volume, dilutions, conversions)

Topics covered in 30% of courses included

- chemical bonding;
- enzymes;
- lab skills (safety, lab equipment);
- basic algebraic functions, manipulating equations;
- scientific notation, significant figures; and
- constructing graphs.

The topics covered by 20% of the courses included

- matter;
- Mendelian genetics, inheritance;
- learning skills (how to write and study science);
- metric system; and
- basic math skills (rounding, ratios, proportions, percentages).

The following topics were covered in 10% of the courses:

- levels of organization (human body);
- homeostasis;
- language of anatomy;
- exploring space;
- mechanics (mass, motion);

- fluids;
- vocabulary; and
- use of calculator.

Research Question 2b(iii)

Research Question 2b(iii): Was a lab associated with the course?

Responses to Question 9 on Survey 2 were used to answer this research question.

Survey 2, Question 9

Is there a laboratory component to the developmental/remedial science course(s) offered at your campus?

Data: Survey 2, Question 9. Results may be found in Table 29.

Table 29

Lab Component

Lab component to the developmental/remedial science course(s)	#	%
No	5	63
Yes	3	38
Total	8	100

Of the 8 respondents to this question, 5 (63%) indicated the courses taught at their institutions did not have a laboratory component; however, 1 of these wrote in that they "use a lot of hands-on exercises during class time." The other 3 (38%) respondents of the 8 indicated the courses taught at their institutions did have a laboratory component.

The benefits of using a hands-on approach in developmental/remedial science courses are supported in the literature (Biermann & Sarinsky, 1993). These authors noted the hands-on approach "fostered the intellectual and practical skills necessary to succeed" (Biermann & Sarinsky, 1993, p. 58).

Research Question 2c

Research Question 2c: How were developmental/remedial sciences organized and delivered? Within academic departments? In a developmental/remedial education department/division? Interdepartmental? Through a learning center?

Responses to Question 23 on Survey 2 were used to answer this research question.

Survey 2, Question 23

How are developmental/remedial science courses organized at your campus? Mark your response with an X.

- Course(s) offered through the academic department
- Course(s) offered through a developmental/remedial education department/division
- Course(s) offered through a joint effort of academic department and developmental/remedial education department/division
- Course(s) offered through a learning center
- Other. Please explain.

Data: Survey 2, Question 23. Results may be found in Table 30.

Developmental/remedial science courses were offered through the academic department at 7 of 8 (88%) respondents' institutions. Only 1 (13%) respondent indicated that the course at his/her institution was offered through a developmental/remedial education department/division.

Research Question 2d

Research Question 2d: What were the goals of developmental/remedial sciences?

Table 30

Organization of Developmental/Remedial Sciences

Organization of developmental/remedial sciences	#	%
Course(s) offered through the academic department	7	88
Course(s) offered through a developmental/remedial education department/division	1	13
Course(s) offered through a joint effort of academic department and developmental/remedial education department/division	0	0
Course(s) offered through a learning center	0	0
Total	8	100

Responses to Questions 7 and 8 on Survey 2 were used to answer this research question.

Survey 2, Question 7

Are there formally written goals for the developmental/remedial sciences offered at your campus?

- No
- Yes

Survey 2, Question 8

If there are goals for the developmental/remedial science offerings, please list the goals in the space below or attach a copy of the course/program goals statement.

Data: Survey 2, Questions 7 and 8. Responses for these survey questions are reported and discussed together. Results may be found in Table 31.

Respondents from 4 (50%) institutions indicated no formally written goals for developmental/remedial sciences at their institutions. Individuals from 3 (38%) institutions indicated there were formal goals; one example follows: “Students are

Table 31

Goals of Developmental/Remedial Sciences

Are there formally written goals for the developmental/remedial sciences offered at your campus?	#	%
No	4	50
Yes	3	38
No Response	1	13
Total	8	100

expected to gain a clear understanding of fundamental principles and theories in physics and chemistry. This gain is demonstrated by the student through problem solving skills along with critical thinking."

Hsu et al. (2005) wrote the goals of developmental/remedial science courses were to "help students learn the concepts of a particular field of science as well as the methods of inquiry and ways of knowing used in science" with the addition of course design that helps students "acquire the attitudes and learning skills necessary to be successful in their future college courses, both science and nonscience" (p. 32). The goals presented by the participants in this study are consistent with the goals of Hsu et al. (2005) in that the concepts of the science discipline are stressed along with problem solving and critical thinking, skills with a broader application to courses beyond the sciences. However, the fact that half of the respondents indicated no goals whatsoever is alarming, considering that assessment is typically aligned with goals (Bybee & Fuchs, 2006).

Research Question 2e

Research Question 2e: What were the instructional practices that supported those goals?

Responses to Questions 10, 11, 12, and 17 on Survey 2 were used to answer this research question.

Survey 2, Question 10

For each developmental/remedial science course offered, indicate the instructional approach used.

- Integrate study skills with science content
- Separate study skills from science content

Data: Survey 2, Question 10. Responses are shown in Table 32.

Table 32

Study Skills Integrated With or Separated From Science Content in Developmental/ Remedial Science Courses

Study skills integrated with or separated from science content in developmental/remedial courses	#	%
Integrate study skills with science content	7	88
Separate study skills from science content	0	0
No Response	1	13
Total	8	100

Nearly all respondents (7 of 8, or 88%) indicated the instructional approach used in the developmental/remedial science courses offered at their institutions involved the integration of study skills with the science content of the course. Only one individual did not respond to the question.

The fact that at most respondents' institutions developmental/remedial education study skills were integrated with science content is consistent with the suggestions of

Johnson (2001) who noted that students learn skills easier and faster by practicing and applying their newly learned skills in the content area. Moore (2002a) argued that scientific literacy can occur by "integrating students into content-rich courses" (p. 9), a practice employed by most respondents to this question on Survey 2.

Survey 2, Question 11

Using the scale below (Not used at all → Used extensively), indicate the use of each developmental/remedial teaching strategy in the developmental/remedial science course(s) offered at your campus. Circle your response for each.

- Lecture by the instructor – small class size
- Lecture by instructor – larger class size
- Workbook/study guide
- Computer simulations/video tape/CD/DVD
- Textbook readings in content area
- Look at the "big picture" first, then focus on the details. Look at the whole, then the parts.
- Individual help from the instructor
- Cooperative learning in class/Structured in-class time when students work together
- Cooperative quizzes
- Students generating/solving problems grounded in real-life situations
- Problems sessions
- Other. Please list.

Data: Survey 2, Question 11. Results are presented in Table 33.

- *Lecture by the instructor – small class size*. This strategy was reportedly used sometimes, often, or extensively at 7 of the 8 (88%) institutions; 1 (13%) reported this strategy was not used at all. Hsu et al. (2005) supported small lecture classes in that they were less intimidating (than a larger lecture) for developmental students and better facilitated teaching strategies, which helped students learn the

Table 33

Teaching Strategies Used in Developmental/Remedial Science Courses

Using the scale below, indicate the use of each developmental/remedial teaching strategy in the developmental/remedial science course(s) taught at your campus. Circle your response for each.	Number of responses by scale selection				
	1 Not used at all	2 Used Rarely	3 Used Sometimes	4 Used Often	5 Used Extensively
Lecture by the instructor – small class size	1		2	1	4
Lecture by instructor – larger class size	6		1		1
Workbook/study guide	1		1	4	2
Computer simulations/video tape/CD/DVD	6			2	
Textbook readings in content area	2		1	4	1
Look at the "big picture" first, then focus on the details. Look at the whole, then the parts.	1		3	2	1
Individual help from the instructor			2	2	4
Cooperative learning in class/Structured in-class time when students work together	1	1	4	2	
Cooperative quizzes	5	2	1		
Students generating/solving problems grounded in real-life situations	2	1	5		
Problems sessions	2		2	3	
Other					
• Open Lab		1			
• Hands on (measuring, observations, calculations, etc.)					1

process of science and how to think like a scientist in a supportive environment.

- *Lecture by instructor – larger class size*. This strategy was used sometimes or extensively by only 2 (25%) respondents and was not used at all at the majority (6 of 8, or 75%) of institutions from which responses were received. Jensen and Rush (2000) and Hsu et al. (2005) noted the benefits of larger lectures in preparing developmental students for class sizes they may encounter in subsequent regular science courses. Typically community colleges have smaller class sizes, but students could encounter larger classes upon transfer.
- *Workbook/study guide*. Respondents from 7 of 8 (88%) institutions indicated using a workbook/study guide sometimes, often, or extensively. This strategy was not used at all for developmental/remedial science courses at 1 (13%) institution.
- *Computer simulations/video tape/CD/DVD*. This teaching strategy using various media was reported by only 2 (25%) individuals to be used often in developmental/remedial science courses at their institutions while 6 (75%) indicated this strategy was not used at all.
- *Textbook readings in content area*. This strategy was used sometimes, often, or extensively at 6 (75%) institutions, but not at all at 2 (25%) institutions.
- *Look at the "big picture" first, then focus on the details. Look at the whole, then the parts*. This strategy was used sometimes, often, or extensively at 6 (75%) institutions and never at 1 (13%) institution. There was no response from 1 (13%) individual.

- *Individual help from instructor*. All institutions used this strategy to some extent. Half of the respondents indicated the extensive use of individual help from the instructor in developmental/remedial science courses; at 2 (25%) institutions this strategy was used often, and at 2 (25%) other institutions it was used sometimes. These findings are consistent with the literature. Research findings in the literature pointed out the tendency of developmental/remedial science students to avoid help-seeking (Ryan et al., 2001), that is, seeking individual help from the instructor. Hsu et al. (2005) tested what they called a "course center" where the instructors were available in locations other than their offices to allow students to meet with the instructor (in small groups if preferred), and spread out and study together in a low pressure environment. The idea was to encourage students to seek help from the instructor. A majority of students evaluated the course center positively.
- *Cooperative learning in class/Structured in-class time when students work together*. This strategy was used sometimes or often in developmental/remedial science classes at 6 (75%) institutions; at 2 (25%) other institutions it was used either rarely or not at all. The use of this strategy was supported by the literature as it promoted, among other things, effective problem solving (Watts, 1994) and emphasized critical thinking skills and higher order learning (Slavin, 1991).
- *Cooperative quizzes*. This strategy was used less frequently, with only 1 (13%) responding it was used sometimes. The other 7 (88%) respondents indicated it was used either rarely (25%) or not at all (63%). Cooperative quizzes were not

utilized at most of the surveyed institutions, hence they were not taking advantage of a strategy that Jensen (1996) reported was an effective preparation device for exams and led to positive interdependence among students as well as individual accountability.

- *Students generating/solving problems grounded in real-life situations*. A majority (5 of 8, or 63%) of respondents indicated the use of this strategy sometimes; the other 3 respondents (38%) marked that it was used rarely or not at all. The use of this strategy was supported by Hsu et al. (2005), who noted the highly context-dependent nature of learning and that knowledge and skills learned in an abstract way or in only one specific context may be applied incorrectly or not at all to new situations. Hence, the importance was noted for science courses to "provide a concrete learning context in which students can practice . . . basic skills in the service of learning disciplinary context."
- *Problems sessions*. Problems sessions were used sometimes or often at 5 institutions (63%) and not at all at 2 others (25%); one individual did not respond to this strategy.
- *Other*. Additional teaching strategies were written in by 2 individuals, including "open lab" (used rarely) and "hands on: measuring, observations, calculations, etc." (used extensively). These data are supported by the work of Biermann and Sarinsky (1993).

Summary: Survey 2, Question 11. Respondents to Survey 2 were asked to indicate the level of use of 11 different teaching strategies in the developmental/remedial science courses offered at their institutions. The purpose of the question was to determine which strategies were used and which were not. All strategies were used to some extent, but the most extensively used teaching strategies were individual help from the instructor, lecture by instructor in a small class setting, and the use of a workbook/study guide. Each was used by at least 7 of the 8 (88%) respondents sometimes, often, or extensively. At least 5 (63%) respondents indicated that they used the following strategies at least sometimes: textbook readings in the content area, look at the big picture first, cooperative learning, problem solving grounded in real-life situations, and problems sessions.

Survey 2, Question 12

Considering your response(s) in Item 11 above, which do you think is the *most effective* strategy in preparing the developmental/remedial science student for subsequent science courses? Write your answer in the space below.

Data: Survey 2, Question 12. Written statements from respondents were summarized and are presented in Table 34.

Table 34

Most Effective Strategy to Prepare Developmental/Remedial Science Students for Subsequent Science Courses

Categories for most effective strategy in preparing the developmental/remedial science student for subsequent science courses	#	%
Variety of strategies/integrated approach	5	63
Small class lecture	1	13
Lab-based emphasis	1	13
Individual help from the instructor	1	13
Total	8	100

The majority (5 of 8, or 63%) of respondents answered that an integrated approach using multiple teaching methods was the most effective strategy for preparing developmental/remedial science students for subsequent science courses. As one individual wrote, there is “not a most effective approach because students all learn in different ways. [Instructors] need to use a variety of methods.” Some respondents who indicated that multiple approaches were best included a combination of strategies, such as reviewing math skills, building confidence, use of computer materials, and readings.

A total of three respondents (38%) separately indicated the effectiveness of such singular strategies as lecture in a small class setting, a lab-based emphasis, and individual help from the instructor as effective in teaching the students in these courses.

So, while there was no apparent consensus among the respondents regarding a “most effective” teaching strategy, the diversity of responses supported the “variety of strategies” approach as the most effective strategy to prepare developmental/remedial science students for subsequent science courses.

A multiple strategy approach to teaching developmental/remedial science courses is supported by the literature. Moore (2001), Waycaster (2001), and Wittrock (1994) noted that science is problematic for developmental/remedial science students when it is taught as if there is only one way to teach and learn.

Survey 2, Question 17

What was the class size (average if more than one section) of the developmental/remedial science course(s) in the Fall 2006 academic term? Mark with an X the appropriate response.

- Less than 10
- 10-19
- 20-29
- 30-39
- 40+

Data: Survey 2, Question 17. Data are presented in Table 35.

Table 35

Class Size

Class size of developmental/remedial science course(s)	#	%
Less than 10	3	38
10-19	4	50
20-29	0	0
30-39	1	13
40+	0	0
Total	8	100

Half of the 8 (50%) respondents reported class sizes from 10-19 students, and 3 respondents (38%) reported class sizes smaller than 10 students for a total of 7 (88%) institutions where classes were kept at 19 students or less. Only one (13%) respondent reported developmental/remedial science class sizes at his/her institution were in the 30-39 student range.

Summary: Survey 2, Question 17. The majority of respondents (7 of 8, or 88%) indicated class sizes of 19 students or less.

Research Question 2f(i)

Research Question 2f(i): How were students placed?

Responses to Question 6 on Survey 2 were used to answer this research question.

Survey 2, Question 6

Describe the criteria used to place students in the course(s) you listed in Item 3. For example: ACT Science, cutoff score 17; or ACT Composite score; or Accuplacer math test, cutoff score 30; or in-house placement test; student's feeling about his/her level of preparedness for the course; etc.

Data: Survey 2, Question 6. Summary data for this survey item may be found in Table 36.

Table 36

Placement Criteria

Response Categories – Placement Criteria	#	%
Placement tests	3	38
Recommended/Self-selection	2	25
In lieu of other courses	1	13
No Response	2	25
Total	8	100

Respondents from 3 (38%) institutions indicated the use of formal placement testing, such as ACT scores, Compass Reading scores, and "in-house" placement tests developed by individuals at that institution for use at that institution. Another 2 (25%) individuals who responded to this question used terms such as "recommended" and "self-selection" to describe less formal placement. A respondent from 1 (13%) other institution indicated students were placed into the developmental/remedial science course because they had not taken other science courses in preparation for a course in anatomy and physiology.

Casazza (1999) noted one best practice for developmental/remedial education was the identification of weaknesses and strengths of students. The use of placement tests may help in identifying students' strengths and weaknesses, but the other criteria used at surveyed institutions to place students may not.

Research Question 2f(ii)

Research Question 2f(ii): Was tutoring available?

Responses to Questions 21 and 22 on Survey 2 were used to answer this research question.

Survey 2, Question 21

Are tutoring services available for:

- Developmental/remedial science course(s) taught at your campus?
- Nondevelopmental/Nonremedial science courses taught at your campus?

Survey 2, Question 22

Are tutoring services similar for developmental/remedial and nondevelopmental/ nonremedial sciences?

Data: Survey 2, Questions 21 and 22. These survey questions are addressed together in Table 37.

Tutoring services for developmental/remedial and nondevelopmental/nonremedial science courses were available at 7 (88%) institutions. At these institutions, tutoring services were similar for developmental/remedial and nondevelopmental/nonremedial science courses. The 1 (13%) individual of the 8 respondents who indicated tutoring services were not available at his/her institution for any sciences wrote in that instructors were available to help all science students, but on a limited basis.

Table 37

Tutoring Services

Survey Questions	No		Yes		Total	
	#	%	#	%	#	%
Are tutoring services available for developmental/remedial science courses?	1	13	7	88	8	100
Are tutoring services available for nondevelopmental/nonremedial science courses?	1	13	7	88	8	100
Are tutoring services for developmental/remedial and nondevelopmental/nonremedial science courses similar?	0	0	8	100	8	100

Research Question 2f(iii)

Research Question 2f(iii): Was Supplemental Instruction available?

Responses to Question 19 on Survey 2 were used to answer this research question.

Survey 2, Question 19

Supplemental Instruction (SI) is a national program which focuses on historically-difficult courses, helping students to learn and understand course content, and enhancing thinking skills to help students become independent thinkers. Is Supplemental Instruction (SI) associated with the:

- Developmental/remedial science course(s) taught at your campus?
- Nondevelopmental/nonremedial science courses taught at your campus?

Data: Survey 2, Question 19. The results are presented in Table 38.

The majority (7 of 8, or 88%) of respondents indicated no SI availability for developmental/remedial science courses offered at their institutions; 1 (13%) did not respond. SI for nondevelopmental/nonremedial science courses was available at 2 (25%)

Table 38

Supplemental Instruction (SI)

Survey Questions	No		Yes		No Response		Total	
	#	%	#	%	#	%	#	%
Is SI associated with developmental/remedial science courses?	7	88	0	0	1	13	8	100
Is SI associated with nondevelopmental/nonremedial science courses?	6	75	2	25	0	0	8	100

institutions; SI was not offered for nondevelopmental/nonremedial science courses at the other 6 (75%) institutions.

Congos and Mack (2005) wrote "the emphasis of SI is on helping students acquire and refine the college level learning skills indispensable to mastering college level course content" (p. 1). The benefits of SI for developmental/remedial sciences have been shown (Jensen & Rush, 2000; VerBeek & Louters, 1991). At the two institutions where SI was already offered for nondevelopmental/nonremedial science courses, developmental/remedial science students were not able to take advantage of the benefits of this program.

Research Question 2f(iv)

Research Question 2f(iv): What individuals were involved with advising/counseling developmental/remedial science students?

Responses to Question 18 on Survey 2 were used to answer this research question.

Survey 2, Question 18

What individuals are primarily responsible for advising/counseling students enrolled in a developmental/remedial science course at your campus? Mark with an X the appropriate response.

- Faculty advisor chosen only on the basis of a student's major/career goals
- Faculty who are specifically designated to work with students who are enrolled in developmental/remedial courses
- Non-faculty staff advisors/counselors
- Other. Please explain.

Data: Survey 2, Question 18. Results are shown in Table 39.

Table 39

Advising

What individuals are primarily responsible for advising/counseling students enrolled in a developmental/remedial science course?	#	%	Write in responses
Faculty advisor chosen only on the basis of a student's major/career goals	1	13	
Faculty who are specifically designated to work with students who are enrolled in developmental/remedial courses	1	13	
Non-faculty staff advisors/counselors	3	38	
Other	3	38	No real advising system
			Combination of faculty advisor chosen by major and non-faculty staff advisors
Total	8	100	

A total of 3 (38%) respondents indicated the student's advisor was a non-faculty staff advisor/counselor; another (13%) respondent indicated students were advised by developmental/remedial advisors, who were specifically assigned to work with students enrolled in developmental/remedial courses. Students were advised only by faculty advisors chosen on the basis of a student's major/career goals at 1 (13%) institution. Of the 3 (38%) respondents who wrote in comments in the "other" category, 1 (13%) indicated no real advising system was in place on their campus, and the other 2 individuals wrote that a combination of different advisors was used for developmental/remedial science students, including faculty advisors chosen on the basis of a student's major and non-faculty staff advisors.

Research Question 2g

Research Question 2g: How was student progress assessed in the developmental/remedial sciences so that students could move on?

Responses to Questions 16 and 25 on Survey 2 were used to answer this research question.

Survey 2, Question 16

What grading system is used in the developmental/remedial science course(s) at your campus? Mark with an X the appropriate response. If multiple courses, please indicate grading system for each.

- ABCDF
- Pass/Fail
- Other. Please explain.

Data: Survey 2, Question 16. Results are presented in Table 40.

Half of respondents indicated using an ABCDF grading system, while the other half used a pass/fail grading system for the developmental/remedial science courses taught at their campuses. Casazza (1999) claimed successful developmental/remedial

Table 40

Grading System

Grading system used in developmental/remedial science course(s)	#	%
ABCDF	4	50
Pass/Fail	4	50
Total	8	100

education programs emphasized, among other things, a process involving more than a better grade in a class. Thus, the type of grading system may not be important.

Survey 2, Question 25

What process is used to assess student progress in the developmental/remedial sciences so students can move on to the "regular" science course in their chosen major?

Data: Survey 2, Question 25. A summary of responses is presented in Table 41.

Table 41

Process Used to Assess Student Progress

Categories for the process used to assess student progress	#	%
The student must pass the developmental/remedial science courses with a grade of C or better (or P for passing)	5	63
Course completion only	1	13
Meet required amount of time and work expectations	1	13
Students not required to complete or even take dev/rem science courses	1	13
Total	8	100

Responses to this question were grouped into four categories:

1. *The student must pass the developmental/remedial science courses with a grade of C or better (or P for passing)*. A total of 5 of the 8 (63%)

respondents wrote that students must pass the developmental/remedial science courses with a grade of C, 70% or better in most cases, or a grade of P for passing.

2. *Course completion only*. At 1 (13%) institution, students could proceed to the next course in their curriculum by just completing the developmental/remedial course.
3. *Meet required amount of time and work expectations*. Another (13%) respondent indicated students were expected to log a required number of minutes of work on the PLATO computerized tutoring program and could then move into the next course as long as "outside work was passing."
4. *Students not required to complete or even take developmental/remedial science courses*. Another (13%) respondent wrote "students may opt to complete [developmental] science courses or not, so they can move on whether they are successful or not or even completed the [developmental] course."

Summary: Survey 2, Question 25. When asked how students were assessed so that they could progress from the developmental/remedial science course to the "regular" courses in their curriculum, respondents answered in one of four ways. The majority (63%) indicated students must pass the developmental/remedial science course with at least a C (70% or better) or a grade of P for passing. Others indicated that students were required to complete the developmental/remedial course or log a required number of hours on a computer work system. At 1 (13%) institution, students did not have to even take or complete the developmental/remedial course to move on in their curriculum.

These data are not fully consistent with the literature. In particular, Phipps (1998) and Moore (2002a) noted one best practice for developmental/remedial sciences was that exit standards were enforced for developmental/remedial courses in order to match those standards to regular college course entry expectations, such that students who completed remedial courses would have the skills and knowledge needed to enter college level courses. The survey responses indicated, in most cases, that students had to earn at least a 70% in the developmental/remedial course before moving on. However, for 3 (38%) respondents, criteria were loose, at best, and in direct contradiction to the suggested best practices.

Research Question 2h

Research Question 2h: How was the effectiveness of developmental/remedial sciences assessed?

Responses to Questions 13, 14, and 26 on Survey 2 were used to answer this research question.

Survey 2, Question 13

From your knowledge of the developmental/remedial science course(s) at your campus, estimate a typical overall percentage of those who begin the course(s) who will complete the course(s) with a passing grade. Use any number between 0 and 100%.

Data: Survey 2, Question 13. Results are shown in Table 42.

Table 42

Overall Percentage of Those Who Complete Course with Passing Grade

Overall percentage of those who complete course with passing grade	#	%
50-59%	1	13
60-69%	1	13
70-79%	2	25
80-89%	3	38
90-99%	1	13
100%	0	0
Total	8	100

Respondents estimated that at their institutions 50-90% of the students taking developmental/remedial science courses earned a passing grade. The majority of respondents (6 of 8, or 75%) reported that 70% or more of the students pass these courses; the actual percentage ranged from 70% to 90%. The other 2 (25%) respondents estimated that less than 70% of students in developmental/remedial science courses earn a passing grade; the reported range was actually 50% to 67%.

Survey 2, Question 14

For a typical academic year, estimate the percentage of those who successfully complete the developmental/remedial science course(s) who eventually complete the subsequent science course at your campus with a grade of C or higher. Use any number between 0 and 100%.

Data: Survey 2, Question 14. The data are presented in Table 43. Respondents to this question reported that 40-90% of students completed their subsequent science courses with a grade of C or better after successfully completing a

Table 43

Percentage Who Successfully Completed Subsequent Science Course

Percentage who successfully completed subsequent science course	#	%
40-49%	1	13
50-59%	1	13
60-69%	1	13
70-79%	1	13
80-89%	2	25
90-99%	1	13
100%	0	0
Not applicable	1	13
Total	8	100

developmental/remedial science course. Half of the 8 respondents estimated that 70% or more students successfully completed subsequent science courses; the actual percentage ranged from 75% to 90%. Respondents from 3 (38%) other institutions reported that students successfully completed subsequent science courses less than 70% of the time. The actual range reported was 40 to 67%. A response of "N/A" was written by one individual on the survey, and s/he did not provide an estimated completion percentage.

Survey 2, Question 26

What system is used to assess the effectiveness of developmental/remedial sciences at your campus?

Data: Survey 2, Question 26. Summary data are presented in Table 44.

Responses were grouped into three categories:

1. *Review of success rates*. Respondents from 3 (38%) institutions reported that their method of assessment was to review success rates in the

Table 44

System for Assessing Effectiveness of Developmental/Remedial Sciences

Categories of systems used to assess the effectiveness of developmental/remedial sciences	#	%
Review of success rates	3	38
Tracking student progress in college level science courses and/or by graduation rates	2	25
Other	3	38
Total	8	100

developmental/remedial science course and/or subsequent science course. Of these respondents, one noted specifically that

> in addition to the pass rate, the success rate in the subsequent course is also assessed and compared to pass rates of students who took the prerequisites of General Biology and General Chemistry and students who took nothing prior to Anatomy & Physiology.

Another respondent mentioned that faculty review success rates "to make changes in courses and advising."

2. *Tracking student progress in college-level science courses and/or by graduation rates*. Student tracking was mentioned by 2 (25%) respondents. Interestingly, one of them noted effectiveness "was supposed to be assessed by tracking students' progress in college-level courses and graduation rates, both by the institution and the . . . State Regents office. Neither has occurred." The other respondent noted developmental/remedial sciences were new at his/her institution, and the assessment plan involved tracking students through their college-level courses.

3. *Other*. This category is composed of a variety of responses from 3 (38%) respondents. Comprehensive final exams and pre- and post-testing were mentioned as forms of assessment by one respondent each, and the effectiveness of developmental/remedial sciences was not assessed at all at one institution.

Boylan et al. (1999) reported that developmental/remedial programs utilizing best practices employed regular and systematic program evaluation. But Phipps (1998) called attention to the reality that not all developmental/remedial education was delivered effectively or efficiently, nor did institutions consistently assess the effectiveness of developmental/remedial education (Roueche & Roueche, 1999). Spann (2000) suggested the extent of student benefit should be determined and the information should be used in a formative manner. At a total of 5 (63%) institutions, some method of assessment was utilized to determine the effectiveness of the developmental/remedial sciences offered. However, the other 3 (38%) institutions did not use any method of assessment at the time the survey was administered. These institutions could perhaps benefit from a model of continuous evaluation of courses, curriculum, and instructional practices proposed by Hsu et al. (2005).

The demographic information for respondents and results from Survey 2 were presented in Section 2. In Section 3, case study data are presented.

Section 3: Case Studies

A total of three institutions were selected for case studies based on responses from Survey 2. Case study sites were selected from among institutions where comprehensive programs of developmental/remedial sciences were offered. More specific selection criteria included (a) type of course(s) offered (biology, chemistry, physical science, earth science, or a combination of these); (b) success rates of students in developmental/remedial course(s); and (c) success rates of students in the subsequent science course in order to better reflect the variety of developmental/remedial sciences offerings in the sample and to reflect those that were more successful as measured by student success.

A total of 5 developmental/remedial science courses were offered at the 3 selected institutions. At each institution, a number of support services were offered, including tutoring and advising. The success rate of students in the developmental/remedial course(s) offered at these institutions was at least 70-75%. The percentage of students at these institutions who successfully completed the developmental/remedial science course(s) and who eventually completed the subsequent science course in the curriculum with a grade of C or better was at least 80%.

This section will be presented in the following format:

1. about the interview participants;
2. about the case study institutions;
3. statement of interview questions pertinent to Research Question 3;
4. qualitative data analysis; and
5. summary of data for the pertinent interview questions.

About the Interview Participants

Demographic information for the interviewees follows:

- All case study participants were in administrative positions; two were Deans and one was the Executive Director of Academic Support.
- All case study participants were full-time employees and held a Master's degree.
- The interviewees consisted of two females and one male.
- During the time the survey was administered, two case study participants were teaching courses and one was not.
- Two case study participants each had over 26 years of teaching experience; one had been teaching for 11-15 years.
- All case study participants had experience with developmental/remedial teaching; two had developmental/remedial math experience, and one taught study strategies/learning methods courses.
- None of the case study interviewees had previous teaching experience in the developmental/remedial sciences.
- Two case study participants identified themselves as developmental/remedial educators, while one indicated only an administrative role.

About the Case Study Institutions

Institution I

Institution I was a multicampus institution serving a five county region. The institution operated at 6 locations, 3 suburban (located just outside the largest city in the state) and 3 rural, in addition to a virtual campus. This was the largest of the case study institutions. Developmental/remedial science courses had been offered at most of the campus locations for over 10 years.

Institution II

Institution II was a two-year community college and vocational school in a rural setting with 3 campus locations serving a 3 county area. This was the smallest of the case study institutions. Developmental/remedial science courses had been offered at all of the campus locations for 4-6 years.

Institution III

Institution III was a multicampus institution serving a 15 county area. The campus operated over 3 campus locations; 1 was urban, and the other 2 were rural. Developmental/remedial sciences had been offered for over 20 years, but at only 1 of the rural campuses.

Research Question 3

Research Question 3: Was there commonality among developmental/remedial sciences to develop a set of guidelines for community college administrators and instructors to use in determining if they should implement developmental/remedial sciences? What were the stages and process for implementing a developmental/remedial sciences program?

Interview Question 4

What types of developmental/remedial sciences are offered at your campus? Courses? What disciplines? Support services? Programs?

Data: Interview Question 4. The developmental/remedial science courses offered at case study institutions included: Chemistry Review, Math Review for the Sciences, Critical Concepts in Biology, Basic Concepts for Allied Health Studies, and Pre-Chemistry.

Support services, such as tutoring, academic advising, and counseling, were offered for developmental/remedial science students at all three institutions.

This study defined a "program" as one in which a developmental/remedial science course(s) was offered in one or more disciplines alongside supplemental services, such as placement, tutoring, Supplemental Instruction, academic advising, and/or counseling. All interviewees agreed that while courses and support services were offered at their institutions, they did not consider those offerings a "program" as much as separate entities that may collaborate occasionally. One interviewee noted,

> Tutoring is connected to the department, and the department is the one that develops the courses. So there's probably more of a connection between course development in the academic department and tutoring in the academic department than the advising. The academic departments will *talk* to the advisors . . . especially if we've had a curriculum change. We'll update the advisors on that, but the advising is just kind of off on the side. It's probably not as embedded as it needs to be.

As a whole, these offerings and services in combination were not seen as a program.

> Each department has done developmental courses as they felt were needed. You see it in English, you see it in math, we have a sprinkling of science things, there's reading. But we're not all looked at as a program. It's very splintered. It's very departmental driven.

However, this same interviewee indicated discussions had occurred on her campus regarding a developmental program:

> Do we need to have a developmental ed program with faculty dedicated to developmental courses? My personal stance is yes, because we've seen such a growth in the developmental courses [and some faculty are specifically dedicated to teaching those courses], but it all ends up coming down to money in the end.

This interviewee noted it was likely that the vice president would move the institution in the direction of putting a developmental education program in place.

Summary: Interview Question 4. Developmental/remedial science courses and support services, such as tutoring, academic advising, counseling, and placement, were offered at all three case study institutions, but all interviewees agreed that these offerings and services, taken together, were not seen as a program.

Interview Question 5

Describe the factors that helped in identifying the need for developmental/ remedial sciences at your campus.

Data: Interview Question 5. All case study respondents indicated similar factors that helped in identifying the need for the developmental/remedial science course(s) taught at their institutions. The primary factor, based on faculty and/or administrator observations, was a noted lack of student preparedness for science courses in which the students had enrolled.

Interviewee comments are telling. One interviewee spoke of student preparation for and performance in an anatomy and physiology course that was required for admission into the institution's nursing program:

> Primarily, what was happening was that students entered our ADN program, our nursing program, . . . which doesn't allow them time to take both the prerequisites for Anatomy & Physiology . . . prerequisites being chemistry and biology. And so, as a result, they were getting into A&P, and they were either dropping out or they were failing miserably and in fairly significant numbers, and I think that

> raised a red flag in the Science department to say 'we need to do something to help prepare these students to be successful once they get into the A&P class,' and that's how Basic Concepts was developed.

A second interviewee also spoke of student preparation for courses needed for the nursing program: Anatomy and Physiology and Microbiology:

> The Chemistry Review course came into the catalog . . . when we had a major curriculum change in our nursing program. Chemistry was pulled off that nursing curriculum, much to the science department's dismay. . . . Anatomy and Physiology and Microbiology are standard courses in a nursing curriculum. We do not have chemistry prereqs on those courses . . . because . . . the nursing department is at their upper limit . . . [of what] their accrediting bodies will allow. I don't think you could talk to an A&P or biology teacher [who] would not think chemistry shouldn't be a prereq or be incorporated in there somehow. So the department, at [the] point that [the] nursing curriculum changed, decided to put a Chemistry Review class in place to give students just the basics of what they would need to know as they go into A&P and Microbiology.

The third interviewee also spoke of lacking student preparation for a course that feeds allied health programs:

> On the . . . campus, we have a pretty strong Practical Nursing program and . . . a lot of . . . GED students coming into that program either have not had science for many years or had none at all in high school for however long they attended.

Before the developmental/remedial science course was in place, only General College Chemistry was offered.

> And so [the faculty member] had a number of students who were being unsuccessful with that. [The faculty member] started [the Pre-Chemistry class] . . . out of necessity . . . to try to get those students up to speed a bit with their chemistry.

Each of these interviewees noted that someone noticed students were struggling and decided to do something about it. As one interviewee commented, "The one instructor, I think he just developed the need off of just not wanting to see students fail . . . and said 'this is a void that's out there' and he just created that course. That's the only thing we've done." In other words, a fancy tool for identifying need may not be necessary; you notice a void and develop something effective to fill it.

Summary: Interview Question 5. The primary factor utilized at all three institutions to identify need for the developmental/remedial science course(s), based on faculty and/or administrator observations, was a noted lack of student preparation for science courses in which the students had enrolled. Each of these interviewees noted that someone (e.g., a faculty member or administrator) noticed students were struggling and decided to do something about it. The process of identifying need and implementing a solution was reactive versus proactive. A specific tool or instrument was not required to identify need.

Interview Question 7

Describe the process used in developing the course/program/support services. How it started? Steps followed? People/positions involved?

Interview Question 8

Was governing board approval needed?

Data: Interview Questions 7 and 8. These interview questions are discussed together. The interviewees each indicated that once a need was identified, a course was developed by the faculty in the academic departments. Once developed and approved by the department chairperson, it was presented to the Dean. After this point, the process used at the three institutions varied. In two cases, it was later presented to a governing board. The multilayered approval processes through the administrative ranks of the institutions are illustrated in Figure 3. Variation begins following approval from the Dean.

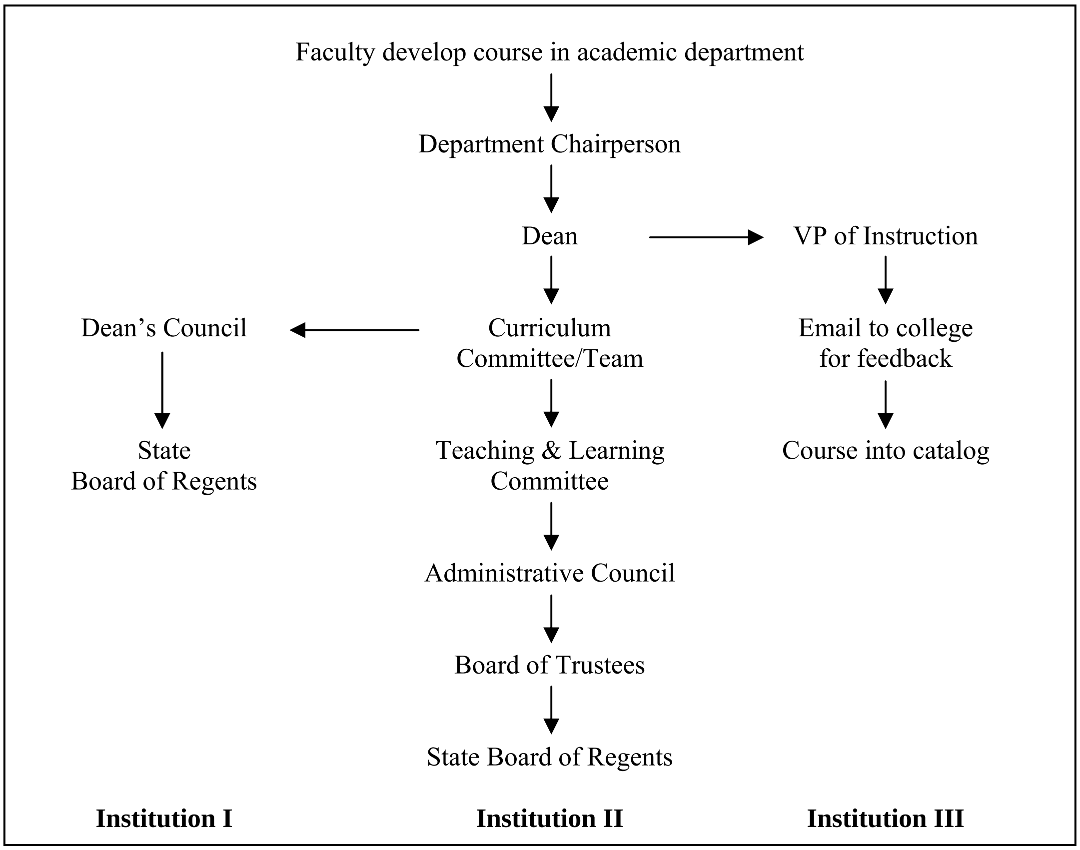


Figure 3. Process for developing/approving course.

Governing board approval for new courses was necessary at 2 of the 3 institutions.

Only one interviewee discussed the process used for putting Supplemental Instruction (SI) in place for a course; however, the service was not provided for developmental/remedial sciences at that institution at that time. The interviewee indicated later in the interview that SI was associated with the developmental/remedial science course at one time but was discontinued as discussed in *Data: Interview Question 19*.

Summary: Interview Questions 7 and 8. At all case study institutions, faculty were the ones to develop the developmental/remedial science courses offered. Once developed, a multilayered process was used to approve the course and offer it for the first time at an institution. Governing board approval of new courses was required at 2 of the 3 institutions. The same process was used for developmental/remedial and regular courses.

Interview Question 12

Are the instructors teaching developmental/remedial sciences trained to teach such classes? If so, how? In developmental/remedial? In sciences only? In both?

Data: Interview Question 12. A common theme related to developmental/remedial teacher training from 2 of the 3 interviewees was stated clearly: “It’s going to depend on the teacher’s background.” While the interviewees could not identify specific developmental/remedial training or education the instructors of developmental/remedial science courses had received, the interviewees recognized that many of those instructors came from a middle school and/or high school teaching background, so they had “definitely had some training in teaching courses at that [developmental/remedial] level.” This says a lot for teaching experience at the secondary level. It’s not just about training, it’s about experience–the bag of tricks instructors bring with them when working with students.

Further, one interviewee added a comment about an instructor's general student-centered attitude: "He's just a really good instructor who's very concerned about student success who continues to try to look at things that are going to help them be successful." The instructor mentioned was a former high school teacher. For this interviewee, specific training for those who teach or will teach developmental/remedial sciences was secondary to instructor attitude and past teaching experience at the secondary level.

The third interviewee indicated that while instructors are very well versed in the course content they teach, they do not possess developmental/remedial teaching skills. Future training opportunities were discussed by this interviewee:

> I'm going to offer a couple of training [sessions] on teaching developmental students, just different developmental strategies and that sort of thing, no matter what curriculum you happen to be teaching. This spring . . . a couple of video conferences [will be offered] and I will invite the person teaching [the developmental/remedial science course] as well as anybody else who's teaching developmental ed. We need to, I think, address the whole training issue. I mean, we have wonderful people, we have good skills and good content, but we can all learn more about how to work with students who are having some obstacles in their way in terms of learning the material.

Summary: Interview Question 12. This question asked interviewees if instructors teaching developmental/remedial sciences were trained to teach such classes. A common theme for 2 of the 3 interviewees involved past teaching experience at the middle school and/or high school level. Even though instructors may not have received specific training in teaching developmental/remedial science classes, they were able to utilize their experiences from the lower educational ranks. The general student-centered attitude of the instructor was also mentioned by one interviewee. Another interviewee mentioned that training opportunities for those teaching developmental/remedial courses in any discipline were forthcoming at her institution.

Interview Question 14

How do developmental/remedial science courses fit into the overall curriculum? Prerequisite(s)? For what courses?

Data: Interview Question 14. Interviewees from two institutions indicated the developmental/remedial science course is a "recommended prerequisite" for regular science courses, such as Anatomy and Physiology, Microbiology, and Chemistry. The term "recommended" referred to an instructor recommending to a struggling student that a course is available that could help them be successful. The interviewee from the third institution noted simply a "prerequisite" for Anatomy and Physiology if a student had not successfully completed courses in both biology and chemistry.

Summary: Interview Question 14. The developmental/remedial science courses were prerequisites or recommended prerequisites for regular science courses, such as Anatomy and Physiology, Microbiology, and Chemistry.

Interview Question 16

What is your method of course/program assessment?

Data: Interview Question 16. Given that all interviewees agreed the developmental/remedial sciences offered at their institutions were not considered programs, program assessment was not considered for this question. Instead, interviewees referred only to course assessment, which involved quizzes, exams, homework assignments, and laboratory work. One interviewee indicated that "faculty review success rates and make changes as appropriate in courses and advising."

Summary: Interview Question 16. Only course assessment was discussed, as interviewees did not define the developmental/remedial sciences offered at their institutions as programs. The more common quizzes and exams were mentioned by two interviewees; one mentioned that course success rates were reviewed by faculty to inform changes in courses and advising.

Interview Question 18

What method is used to assess the effectiveness of support services?

Data: Interview Question 18. The most commonly available support service at all case study institutions was tutoring, but responses from the three interviewees indicated that tutoring was carried out differently at each institution, and each was in a different stage of assessment of those services.

Tutoring was offered through a Learning Resource Center, Student Support Services, and the academic departments at Institution II, but assessment did not address departmental tutoring. Assessment of support services offered at the Learning Resource Center was performed with surveys (for example, Were tutoring services offered at the right times? Were you able to attend? How often did you go?), retention studies (How many people moved on to the next course?) and grade studies (Were they successful in the next course?). Also, the End of Term Supplemental Instruction Survey was given to students who utilized tutoring through Student Support Services (Appendix K).

The interviewee from Institution II indicated that the institutional response was appropriate to the assessment results and data received. She provided an example scenario: If it is discovered that tutoring is not having the desired effect of an improved grade for a student who participates in the tutoring service, then an investigation of sorts ensues: “Did the student go to class? Was the motivation there? Was . . . there a learning disability that nobody knows about? And [then we design] for those students . . . a pretty intensive intervention program” to help them be more successful in their coursework.

At Institution I, tutoring had traditionally been offered through the academic departments; there was no formal assessment of the effectiveness of tutoring. However, a pilot project of centralized tutoring in a learning lab (initially for math, English, and foreign language only, but eventually incorporating science) was planned for the spring 2007 semester. According to the interviewee from Institution I, once all tutoring services are

> under one roof, . . . we’ll probably see more [assessment]: usage rates, what courses are they coming in for help for. . . . We really don’t have any data. That’s one of the reasons why we chose to pull it together so that we could do more assessment in looking at . . . students who came in and got tutoring help. For example, were they more successful than students who didn’t? I think we’re trying to get there, but we’re not there yet.

The interviewee from Institution III indicated at the campus where developmental/remedial sciences were offered, tutoring was available by appointment. The institution also contracted with SmartThinking through a textbook publishing company to give students in some science courses, Chemistry and Pre-Chemistry included, access to 5-6 hours of free online tutoring. The interviewee from this institution noted that outcomes assessment to that point had addressed only “the success of our programs that lead to a degree." The effectiveness of developmental education and support services had not been assessed.

Academic advising was also provided as a support service at all three case study institutions, but at each institution, different individuals were primarily responsible for providing these services to developmental/remedial science students. At one institution, some developmental/remedial science students were advised by a faculty advisor determined according to the student's chosen major, and others were advised by non-faculty staff; the type of advisor depended on when the student happened to come to campus for his/her first advising appointment (e.g., summer session, holiday breaks, or during the fall or spring semesters), as faculty advisors were available to meet with new students primarily during the fall and spring semesters and only at selected times during the summer session.

At another institution, only developmental/remedial faculty advised these students, whereas a different institution utilized centralized advising involving only non-faculty staff advisors. Because only non-faculty staff formally worked directly with students on academic advising, faculty in the biology department at this institution developed a "flow chart approach" to assist in properly advising students. An example flow chart is found in Appendix L. When using the flow chart,

> the advisors are supposed to ask, 'Have you ever had a biology class,' and if the answer is yes, they go here, and if they say no, then they recommend that they take at least General Biology before taking . . . A&P or Micro[biology]. So the faculty kind of laid out a questionnaire that [advisors] can use to help place students in the proper classes.

This interviewee also indicated that "faculty do advising informally all the time," by identifying struggling students and then advising them to take the developmental/remedial science course and/or use support services.

Assessment of advising services was discussed only indirectly by one interviewee; faculty at that institution "review success rates and make changes as appropriate in courses and advising."

Summary: Interview Question 18. At each of the three institutions, tutoring services were provided for developmental/remedial science students, but tutoring was handled in a slightly different way at each institution, and each was in a different stage of assessment of those services. At one institution, tutoring was offered through the academic departments, Student Support Services, and a Learning Resource Center, and extensive assessment was practiced, utilizing surveys, and retention and grade studies. At another institution, tutoring for developmental/remedial sciences was not yet available but was planned for the future to be offered in a centralized location. A major impetus for centralizing all tutoring under one roof was to aid the assessment process, which did not exist at the time of the interview. The third institution utilized only tutoring by appointment and did not assess the effectiveness of any developmental programs.

The advising services offered for developmental/remedial science students at the case study institutions were performed by different individuals. A combination of non-faculty staff advisors and faculty advisors determined according to the student's chosen major was utilized at one school. Another utilized centralized advising with non-faculty staff advisors; the other utilized developmental/remedial education advisors. The interviewee from one institution discussed assessment of advising only indirectly.

Interview Question 19

Describe how the course/program/support services are implemented. Follow any particular model of developmental/remedial sciences? Since implementation of course/program/services, have there been changes? Describe the changes. What worked? What didn't? What were those changes based on? Lessons learned?

Data: Interview Question 19. Again, given that interviewees did not consider the developmental/remedial sciences offered at their institutions to be programs, a model was not even considered. However, implementation of developmental/remedial sciences involved the following components:

1. identifying the need for developmental/remedial sciences;
2. developing courses;
3. scheduling and staffing the courses;
4. assessing the courses;
5. developing academic support services;
6. scheduling and staffing support services; and
7. assessing the support services.

Changes occurred over time at the case study institutions. The interviewee from Institution II noted only one change to the course offered there: SI was offered at one time, but is no longer offered. This change was explained:

> Basic Concepts is taught in an intense week. And so when you've been in class for four hours a day, you don't have time [for SI] or perceive need [for SI]. I

> mean, you're exhausted, so . . . people didn't show up for that, and I think I understand why they wouldn't . . . even though some maybe should've. Another hour or two a week is probably more than [the students] can handle.

Only one other interviewee noted that minor content changes were made to the developmental/remedial science class, depending on the textbook and what the instructor was going to be teaching in the subsequent course.

Summary: Interview Question 19. In general, implementation of developmental/remedial science involved identifying need, developing courses and support services, scheduling and staffing courses and support services, and assessment.

The only changes noted involved minor content changes in one course and the discontinuation of SI at one institution because students were not using the service. The interviewee thought the students were so overwhelmed by the time the one-week class had met for its daily four hour shift that they were unable to perceive the need for SI.

Interview Question 20

Any guidelines/steps you would recommend for other institutions to use when considering developmental/remedial sciences? Needs assessment? Development? Implementation?

Data: Interview Question 20. Interviewee recommendations for others to use when considering developmental/remedial sciences ranged from making sure you have plenty of facilities/space and staff, as "those always seem to be the two factors when you start trying to do a new program of some type," to collaboration, to a short reading list. The interviewee from Institution II said,

> My suggestion would be that they get their support staff together with their department and . . . talk through [the developmental/remedial sciences idea]

> together. I think they will get a stronger, more integrated model, and . . . that can't hurt. I don't think you can do one or the other [course or support services] in isolation. I mean, you *can*, . . . we *have* done . . . isolation. Research would indicate that you get a stronger, more helpful program for students if you can integrate those things.
>
> The other thing would be . . . make sure you really know what you are remediating. What is it that *really* you need to do to help students be successful in whatever course you're trying to help them be successful in? I think what happened with the department is that you all went through and looked . . . specifically in your A&P course; where people [were] falling out, and that's where you came up with those core outcomes. *But you have to be looking* [italics added], you have to look at more than one semester to say, '… nobody gets DNA stuff [for example], and especially if they haven't had biology or chemistry.' You know, that just loses them. That's when they drop out of the course, or that's when they just shut down because they don't, they can't, figure the rest of it out.

The interviewee from Institution I recommended that those considering developmental/remedial sciences read McCabe's (2000) *No One to Waste* and Ruby Payne's (1996) *A Framework for Understanding Poverty*.

> She [Payne] . . . has worked in the public school system, very poor districts all the way up to the very rich and just has some really, I think, neat things we need to think about and why students find themselves in those remedial courses.

A final book was also recommended: *Improving Science, Math, Engineering, and Technology Instruction: Strategies for the Community College* (Mahoney, 1996).

Summary: Interview Question 20. The three interviewees made the following recommendations for those considering developmental/remedial sciences at their institutions:

1. Plan for the appropriate space and staff when implementing a new program.
2. Start a conversation between the academic department and support services staff.
3. Know what you are remediating.

4. Do your homework. Consider reading *No One to Waste* (McCabe, 2000), *A Framework for Understanding Poverty* (Payne, 1996), and *Improving Science, Math, Engineering, and Technology Instruction: Strategies for the Community College* (Mahoney, 1996).

Interview Question 21

How have developmental/remedial sciences specifically impacted your college?

Data: Interview Question 21. Interviewees noted a number of impacts of developmental/remedial sciences on their colleges. Their responses were grouped into three main categories:

1. *Increased access*. Students see developmental sciences as a doorway to a future: higher level classes, a degree, a goal, etc. Also, developmental/remedial sciences help "the students at risk get to and through our practical nursing program in a rural area where you kind of have a limited number of students and a limited number of nurses."
2. *Increased student success*. "We have many students who come here who aren't prepared." Having developmental/remedial science courses available to them helps students understand they can start in these lower level classes "and it's going to improve [their] success down the road."
3. *Increased enrollment*. Developmental/remedial sciences keep "students in school, so retention helps the institution significantly because if you're successful, the likelihood is that you're going to take the next course that you need; you're going to continue in the program."

Summary: Interview Question 21. The three interviewees noted developmental/remedial sciences increased access, student success, and enrollments at their institutions.

Interview Question 22

What do you see as the best thing about your current program?

Data: Interview Question 22. Interviewee responses to this question were grouped into five categories:

1. *Open communication and trust between academic department and academic support services*.

   > Honestly, I think the relationship between the department and support services is pretty decent, and . . . I don't think anybody feels bad going 'hey, can we do this?' on either side. And . . . we're [Academic Support] willing to try to help in any way we can.

2. *Offerings driven by the faculty who teach nondevelopmental/nonremedial science courses and who have a vested interest in students being prepared for those courses*. "I think the best thing is that it is faculty driven [by those] who are working with those students in *non*remedial courses. I think they recognize that need."

3. *Sensitivity toward students*.

   > I do think we try to be very *sensitive* to those students who are very *sensitive* about needing remedial courses. We don't want to make them feel like they *can't* do it. So I think we've been very subtle. I don't think students should feel slapped in the face if they come here and we recommend that they take a developmental course. Because they *can* do it. They just have to start where they're ready.

4. *An attitude of quality improvement*. “See, I’m always thinking that we can do better.”

5. *We have a starting point, something to build upon*. The best thing was

> that it’s there. I need to do some conscious evaluation and try to look at some of our discussion here and try to do something better to get a program implemented across our college, not just in one location. And not just in chemistry. We just need to reevaluate that, so . . . I’ve put that on my 2007 ‘to do’ list.

Summary: Interview Question 22. Interviewees were asked what they thought was the best thing about developmental/remedial sciences at their institutions. Their responses were grouped into five categories: (a) open communication and trust between the academic department and academic support services; (b) offerings driven by the faculty who teach nondevelopmental/nonremedial science courses and who have a vested interest in students being prepared for those courses; (c) sensitivity toward students; (d) a quality improvement attitude; and (e) a starting point to build upon.

Interview Question 23

What do you see in the future of your program? Growth/expansion? Lesser need?

Data: Interview Question 23. All interviewees agreed that the need for developmental/remedial sciences will not decrease in the future. Further, each interviewee had a unique view of the developmental/remedial sciences at his/her institution.

The interviewee from Institution I saw the current developmental/remedial education offerings in a number of areas on her campus evolving into a developmental education *program* under the leadership of the institution’s Vice President. “Centralized tutoring was a step in that direction, . . . and I think as funds are reallocated and become available, we may actually see developmental ed have its own identity and a place to be in a sense." This person also indicated her institution probably would not see expansion of the developmental/remedial science offerings without removing the limitations placed on the nursing department by accrediting bodies.

Learning communities were the vision of the interviewee from Institution II:

> I'd like to see some learning communities developed in the process where you [for example] have a huge chemistry class, but you've got some people who need help with mathematics. So you've got . . . a portion of students who need that help, who would be in an attached class that would be integrated, so they're learning the math they need to learn in order to do the chemistry–that sort of thing.

The interviewee from Institution III saw potential additions to the developmental/remedial offerings and services in the future. It was expected that changes in advising would foster stronger relationships between advisors and students so that needs will be more easily identified.

At the time of the interview, Institution III was planning to try out a new approach to advising with a test group of students who were considered to be "triple deficient," that is, deficient in math, reading, and writing. This group was selected because

> it's a smaller group and . . . they're . . . at the highest risk. And so we're going to nurture them . . . better with advisors who either teach in those areas or at least understand the population and then incorporate along with that a study skills class. And after visiting with [the researcher], I think we may add a science component into that . . . so that they may understand a little bit more about what they're getting into [in the sciences] ahead of time.

The interviewee further commented,

> with the study we're doing to try to deal with triple deficiencies, . . . maybe we'll get a group of folks who know more about our developmental students. There'll

> probably be some more needs that will come out of that that will need to get implemented.

One thing the students struggle with at Institution III is making connections and building relationships on campus. “So hopefully by us getting to know who these students are a little better, . . . we’ll discover there are more needs out there than what we realize.”

Summary: Interview Question 23. All interviewees agreed that the need for developmental/remedial sciences will not decrease in the future. Further, each interviewee had a unique view of the developmental/remedial sciences at their institutions. Developmental/remedial education programs, learning communities, and relationship building to identify needs were all mentioned by interviewees as visions for the future of developmental/remedial sciences.

Interview Question 24

Are there other topics we should explore that I haven’t asked about?

Data: Interview Question 24. Only one interviewee brought up a new topic: the shortage of math and science teachers. The major area of concern for her was that her institution has “such a shortage of math and science people that we will put people in those classrooms that probably shouldn’t be. And I think that then perpetuates that fear and feeling that [students] can’t be successful.” She continued,

> And so . . . as long as we’re going to have a shortage of math and science [teachers], I think institutions have to provide some training to these folks that helps them understand that just because they have a degree in [a subject], they may not have any education experience. We have to help them develop that piece of it. And I think that would probably do a lot toward improving the education in those developmental courses.

Summary: Interview Question 24. The shortage of math and science teachers was mentioned by one interviewee. The concern was that because of this shortage, people with degrees in science fields, who really have no teaching experience, might be placed into classrooms and scare away students. The interviewee recommended that education/teacher training be provided for these individuals by the community colleges where they are employed in order to help them develop their teaching skills to be more effective in the classroom.

Summary

The data for the study were presented in Chapter Four. Responses to Survey 1 and Survey 2 were presented and summarized. From responses to Survey 2, three institutions were selected to participate in case studies. Institutions were selected from among institutions where comprehensive programs of developmental/remedial sciences, according to this study's definition, were offered. More specific selection criteria included the following: (a) type of course(s) offered (biology, chemistry, physical science, earth science, or a combination of these); (b) success rates of students in developmental/remedial course(s); and (c) success rates of students in the subsequent science course, in order to better reflect the variety of developmental/remedial sciences offerings in the sample and to reflect those that were more successful, as measured by student success. The demographics of the interviewees were presented and discussed. Also, their responses to interview questions that spoke to Research Question 3 were presented and summarized.

In Chapter Five, the study is summarized and conclusions are presented, along with guidelines for faculty and administrators considering the implementation of developmental/remedial sciences at their institutions and recommendations for further research.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

Chapter Overview

In this chapter, the conclusions of the study, guidelines for community college administrators and faculty to use in determining if they should implement developmental/remedial sciences at their institutions and recommendations for further study are presented. The chapter is divided into the following sections:

- a review of the research questions;
- a summary of the methodology;
- a summary of the findings;
- a list of conclusions based on the findings;
- guidelines for community college faculty and administrators to use in determining if they should implement developmental/remedial sciences at their institutions;
- recommendations for further study; and
- summary.

Research Questions

1. To what degree were developmental/remedial sciences offered by selected community colleges in five states located in the central part of the United States?

2. What were the descriptive characteristics of developmental/remedial sciences where offered by the selected community colleges? Descriptive characteristics included the following:
    a. What were the factors that contributed to identifying the need for developmental/remedial sciences?
    b. Were developmental/remedial sciences at the selected community colleges offered in the form of a course or an entire program?
        i. If a course, what kind of academic credit did it carry?
        ii. What topics were covered?
        iii. Was a lab associated with the course?
    c. How were developmental/remedial sciences organized and delivered? Within academic departments? In a developmental/remedial education department/division? Interdepartmental? Through a learning center?
    d. What were the goals of developmental/remedial sciences?
    e. What were the instructional practices that supported those goals?
    f. What advising and support services were available to students in developmental/remedial sciences?
        i. How were students placed?
        ii. Was tutoring available?
        iii. Was Supplemental Instruction available?
        iv. What individuals were involved with advising/counseling developmental/remedial science students?

g. How was student progress assessed in the developmental/remedial sciences so that students could move on?

h. How was the effectiveness of developmental/remedial sciences assessed?

3. Was there commonality among developmental/remedial sciences to develop a set of guidelines for community college administrators and instructors to use in determining if they should implement developmental/remedial sciences? What were the stages and process for implementing a developmental/remedial sciences program?

Summary of Methodology

This study occurred in four phases. The first phase involved the distribution of a survey (Survey 1) to the Chief Academic Officers (CAOs) at the main campuses of the community colleges in five states in the central U.S. that were member institutions listed in the *AACC Membership Directory 2005* to identify those that offered developmental/remedial sciences and to identify the individual who had administrative/leadership responsibilities for developmental/remedial sciences courses or programs. CAOs were also asked to identify additional campuses of their institutions where developmental/remedial sciences were offered following different policies and procedures than those in place at the main campus, along with contact information for the CAOs at those campuses so that surveys could be administered to them.

The second phase was an in-depth survey (Survey 2), which was sent to individuals identified by the CAOs as having administrative/leadership responsibilities for developmental/remedial sciences to determine the characteristics [listed as “a-h” of Research Question 2] of the developmental/remedial sciences offered.

In the third phase of the study, the researcher interviewed the identified individuals with administrative/leadership responsibilities for developmental/remedial sciences at three institutions selected for in-depth case studies based on responses from Survey 2. Case study sites were selected from among institutions where comprehensive programs of developmental/remedial sciences were offered. More specific selection criteria included (a) type of course(s) offered (biology, chemistry, physical science, earth science, or a combination of these); (b) success rates of students in developmental/remedial course(s); and (c) success rates of students in the subsequent science course in order to better reflect the variety of developmental/remedial sciences offerings in the sample and to reflect those that were more successful as measured by student success.

The fourth and final phase of the study involved the development of a set of guidelines based on the data collected through the surveys and interviews that may be of use to community college administrators and instructors in determining if they should offer developmental/remedial sciences and provided stages to follow for those who choose to do so.

Summary of the Findings

Summary of Research Question 1

The purpose of Research Question 1 was to identify to what degree developmental/remedial sciences were offered by selected community colleges in five states located in the central part of the United States.

A general survey (Survey 1) was sent to the CAOs of 72 community colleges in a five state area in the central United States. Responses were received from 60 of those CAOs, a return rate of 83%. CAO responses to Survey 1 indicated that developmental/remedial sciences were offered at 20 (33%) of the 60 institutions.

Of the 60 respondents to Survey 1, 40 CAOs (67%) indicated developmental/remedial sciences were *not* offered at their institutions. Some of those indicated that students who were underprepared for the sciences took developmental courses in other areas such as math, English, and writing to “remove” developmental science “deficiencies.” At some institutions, support services were offered, but not specifically for developmental/remedial science students.

The other 20 (33%) CAOs who indicated developmental/remedial sciences *were* offered at their campuses further elaborated on the types of services that were offered. Courses and/or programs were offered at 12 (60%) of the 20 institutions. Criteria were used to identify and place developmental/remedial science students into developmental/remedial science courses and programs at 8 (40%) institutions. At a majority (70%) of institutions, tutoring services were offered, 9 (45%) offered academic advising, and 8 (40%) offered counseling for these students. Supplemental Instruction

(SI) was offered for developmental/remedial sciences at 5 (25%) institutions and 2 (10%) respondents reported offering additional services, such as small study groups with tutoring or a Basic Learning Center.

Nearly half (49%) of Survey 1 respondents reported no plans to offer developmental/remedial sciences at their institutions in the future. These findings are not consistent with the literature, which suggests there is "every reason to conclude that remediation will continue to be a core function of colleges and universities" (Phipps, 1998, p. 6). Further, Boylan et al. (1999) wrote "community colleges are currently the primary provider of developmental education and the need for them to do so will continue" (p. 97).

Of the 60 respondents to Survey 1, the majority (39 of 60, or 65%) reported their institutions had multiple campuses, and at 8 (13%) of those institutions with multiple campus sites, the other campuses followed the same developmental/remedial science policies and practices as the main campus.

Summary of Research Question 2

The purpose of Research Question 2 was to identify the descriptive characteristics of developmental/remedial sciences where offered by the selected community colleges.

Survey 1 was sent to CAOs at 72 community colleges in five states in the central part of the United States. A total of 60 responses were received; 20 of those 60 (33%) indicated developmental/remedial sciences were offered in some form at their institutions. Only 12 of those 20 committed to participate in Survey 2, so Survey 2 was sent to individuals at those 12 institutions. All individuals who received Survey 2 returned the survey to the researcher, but only eight were able to answer the in-depth questions about developmental/remedial sciences offered at their institutions. Thus, only eight institutions were used for the data analysis.

All but two respondents to Survey 2 held an administrative title, all were employed full time, and all but one held a Master's or higher level degree. An equal number of males and females completed the survey. Most (63%) respondents were teaching at the time of the surveys, and most (63%) were veteran teachers with at least 21 years teaching experience. All but one respondent had taught developmental/remedial classes in some field (two had taught developmental/remedial sciences) and most (63%) had taught courses in the sciences. Half of the respondents considered themselves science educators, 38% indicated they were developmental/remedial educators, and one (13%) indicated s/he was an administrator. These data were interesting, given the finding presented earlier that 7 of the 8 held administrative titles at their institutions, but was consistent with the majority of respondents having teaching responsibilities along with those administrative roles.

Research Question 2 had multiple components. Each is summarized below.

Identifying Need for Developmental/Remedial Sciences

A majority (75%) of respondents indicated students were not prepared for non-science majors biology courses. Regarding preparation for biology courses for science majors, 3 respondents (38%) indicated students were prepared and 3 (38%) respondents indicated students were not prepared. For both anatomy and physiology and microbiology courses, at least half of the respondents reported that students were not prepared (50%, for anatomy and physiology; 63%, for microbiology).

For chemistry, a majority (63%) noted that non-science major students were not prepared for the chemistry courses they took. A smaller number (38%) indicated students were not prepared for inorganic chemistry. A majority of respondents to the organic chemistry category indicated students were prepared for this course. The upper level nature of this course is apparent from these data, as students typically progress to organic chemistry after having taken inorganic chemistry, hence their level of preparation would be expected to be greater. Given that half of the respondents wrote either “not applicable” or did not respond, it was further interpreted that not all institutions offered upper level chemistry courses such as organic chemistry.

In the physical science/physics category, 50% of the respondents indicated that students were not prepared for courses in physical science. These are courses typically taken by students not majoring in a science-related field. A lesser percentage (38%) indicated that students who are science majors were not prepared for physics courses taken.

Half of the respondents indicated students were not prepared for geology courses and only 2 (25%) responded that students were prepared for a Weather and Climate course.

Of note was that three respondents (38%) from three different states noted that students were not prepared for courses in *any* of the science disciplines about which the survey inquired.

These findings are consistent with TIMSS (NCES, 2006) and NAEP (NCES, 2005) data, which indicated students were not prepared for math and science. Taken as a whole, TIMSS and NAEP data indicated students are not coming out of high school prepared for secondary sciences, much less college level sciences. These data are further supported by the findings of Bastedo and Gumport (2003), Biermann and Sarinsky (1993), Moore (2002a), Roach (2000), Rutherford and Ahlgren (1990), and Wilke and Straits (2005), which indicated many students entering community college are poorly prepared for introductory sciences. Friedlander (1981) made the case for developmental/remedial work as it better prepares underprepared students for subsequent coursework.

Inadequate math background, poor reading ability, and poor study habits were reported by at least 7 (88%) respondents as weaknesses and by at least 5 (63%) respondents as top 3 weaknesses of students who take science courses.

These data are supported by the literature. Sax et al. (1999) recognized increased academic disengagement among high school students. Biermann and Sarinsky's (1993) findings supported the math and reading weaknesses noted in this study when they reported that many community college students were poorly prepared for sciences because they had weak math and verbal skills, which led them to avoid science in high school, thereby exacerbating the issue of preparedness for science courses.

The fact that inadequate math background, poor reading ability, and poor study habits were reported by such large percentages of participants may have an impact on the number of developmental/remedial science courses offered–the weaknesses are being taken care of in developmental/remedial math, reading, and study skills courses instead.

A majority (88%) of the 8 institutions had offered developmental/remedial sciences for over 10 years. At 1 (13%) institution, developmental/remedial sciences had been in existence for 4-6 years.

These data were supported by the literature–developmental/remedial sciences are not new. The issues addressed at institutions offering developmental/remedial sciences are not recent developments, consistent with the comments of Phipps (1998) regarding developmental/remedial education as a whole.

The need for developmental/remedial sciences at the respondents' institutions was identified in one of three ways: (a) faculty identified need based on student performance in courses (63%), (b) assessment/placement test, such as Compass or ACT (25%), or (c) state mandated prerequisite based on ACT score (13%). The fact that the majority of respondents reported that developmental/remedial sciences were identified by faculty points significantly to faculty responsibility and accountability in assessment.

State mandates for offering developmental/remedial science courses are consistent with the national trend of community colleges assuming an even greater responsibility for developmental/remedial education in their states (Jenkins & Boswell, 2002; Kozeracki, 2002; Parsad & Lewis, 2003).

Developmental/Remedial Science Course or Program?

Responses to Survey 1 indicated that developmental/remedial science courses and/or programs existed at 12 (60%) of the 20 institutions where developmental/remedial sciences were offered. Criteria were used to identify and place developmental/remedial science students into developmental/remedial science courses and programs at 8 (40%) institutions, and at a majority (14 of 20, or 70%) of institutions tutoring services were offered. Advising was offered at 9 (45%), counseling services were available for these students at 8 (40%) institutions, and Supplemental Instruction (SI) was offered for developmental/remedial sciences at 5 (25%) institutions.

The majority of respondents (55%) indicated “Chemistry courses for non-science majors” was the area in which developmental/remedial sciences were most commonly offered, followed closely by the category “Biology courses for non-science majors,” which was reported by 10 (50%) of the 20 respondents. The “Physical Science” category was reported by half as many respondents. Other areas in biological sciences, physical science, and earth science were reported by at least one respondent as presented in Table 12.

A total of 10 different courses were offered at the 8 institutions which participated in Survey 2. The courses were categorized into four groups: Introduction to General Science, Math Review for Science, Introduction to Biology and Chemistry, and Pre-Chemistry. A majority (70%) of the developmental/remedial science courses addressed multiple science disciplines within the same course.

Studies of developmental science courses in biology were reported by Hsu et al. (2005), and studies of developmental courses in anatomy and physiology were reported by Jensen and Rush (2000). Similar studies in chemistry were reported by Congos & Mack (2005) and in physical science by Johnson (2001).

Academic Credit

A majority (75%) of respondents indicated the developmental/remedial science courses offered at their institutions were offered for institutional credit, but the credit would not apply toward a degree. These findings were consistent with developmental/remedial courses in other disciplines. The developmental/remedial course at only one (13%) institution was offered for credit, which could count toward an Associate of Arts or Associate of Science degree, consistent with the suggestions of Hsu et al. (2005) and Kozeracki (2002) that graduation credit be awarded for developmental courses.

Topics Covered

The course syllabi provided by the respondents listed topics covered in the developmental/remedial science courses. The topics were first grouped into 5 categories by discipline: chemistry, biology, physics, general science, and math. Topics were then grouped into 31 categories within those disciplines. The most common topics, covered by at least 50% of the courses, were in the disciplines of chemistry and biology and included

- cell structure and function;
- organic macromolecules;
- chemical formulas and reactions, balancing equations;
- element names and symbols, periodic table;
- energy, cell metabolism;
- properties of water and solutions; and
- pH, buffers, and electrolytes.

Lab Component

The majority (63%) of the courses offered at institutions that participated in this survey did not include a lab component, but one of these indicated the use of “a lot of hands-on exercises during class time.” The other 3 (38%) respondents noted there was a lab component associated with the developmental/remedial science courses offered at their institutions.

The benefits of using a hands-on approach in developmental/remedial science courses are supported in the literature (Biermann & Sarinsky, 1993). These authors noted the hands-on approach “fostered the intellectual and practical skills necessary to succeed” (Biermann & Sarinsky, 1993, p. 58).

Organization of Developmental/Remedial Sciences

All but one (88%) respondent indicated the developmental/remedial science courses at their institutions were organized through the academic department; the course not offered through the academic department was organized through a developmental/remedial education department/division.

Goals of Developmental/Remedial Sciences

Half of the respondents indicated no formal goals for the developmental/remedial sciences offered at their campuses. For the 3 respondents (38%) who indicated formal goals, statements included the goals of (a) building a foundation of knowledge and skills for success in subsequent college courses, (b) developing critical thinking skills, and (c) developing problem solving skills and strategies.

Hsu et al. (2005) wrote that the goals of developmental/remedial science courses were to "help students learn the concepts of a particular field of science as well as the methods of inquiry and ways of knowing used in science" with the addition of course design that helps students "acquire the attitudes and learning skills necessary to be successful in their future college courses, both science and nonscience" (p. 32). The goals presented by the participants in this study were consistent with the goals presented by Hsu et al. (2005) in that the concepts of the science discipline are stressed along with problem solving and critical thinking, skills with a broader application to courses beyond the sciences. However, the fact that half of the respondents indicated no goals whatsoever is alarming, considering that assessment is typically aligned with goals (Bybee & Fuchs, 2006).

Instructional Practices

The majority of the respondents to Survey 1 indicated developmental/remedial education was offered as study skills courses separate from regular (non-developmental/remedial) science courses. At one institution where developmental/remedial sciences were not offered, developmental/remedial education and science content were integrated into regular science courses. At another institution both approaches were incorporated, depending upon the course.

CAOs from three other institutions responded that either tutoring was offered as needed or developmental/remedial study skills were integrated specifically into developmental/remedial science courses, as opposed to integrating skills into the regular, nondevelopmental/nonremedial science courses offered at their institutions.

All but one respondent (88%) to Survey 2 reported the integration of study skills with science content in their developmental/remedial science courses.

The fact that at most respondents' institutions developmental/remedial education study skills were integrated with science content is consistent with the suggestions of Johnson (2001), who noted that students learn skills easier and faster by practicing and applying their newly learned skills in the content area. Moore (2002a) argued that scientific literacy can occur by "integrating students into content-rich courses" (p. 9), a practice employed by most respondents to Survey 2.

Respondents to Survey 2 were asked to indicate the level of use of 11 different teaching strategies in the developmental/remedial science courses offered at their institutions. The purpose of the question was to determine which strategies were used and which were not. All strategies were used to some extent, but the most extensively used teaching strategies were individual help from the instructor, lecture by instructor in a small class setting, and the use of a workbook/study guide. Each was used by at least 7 of the 8 respondents (88%) sometimes, often, or extensively. At least 5 (63%) respondents reported that they used the following strategies at least sometimes: textbook readings in the content area, look at the big picture first, cooperative learning, problem solving grounded in real-life situations, and problems sessions.

Hsu et al. (2005) supported small lecture classes in that they were less intimidating (than a larger lecture) for developmental students and better facilitated teaching strategies, which helped students to learn the process of science and how to think like a scientist in a supportive environment.

All respondents reported individual help from the instructor was used sometimes (25%), often (25%), or extensively (50%). These findings are consistent with the literature. The tendency of developmental/remedial science students to avoid help-seeking, that is, seeking individual help from the instructor has been noted in the literature (Ryan et al., 2001). Hsu et al. (2005) tested what they called a “course center” where the instructors were available in locations other than their offices in order to allow students to meet with the instructor (in small groups if preferred), and spread out and study together in a low pressure environment. The idea was to encourage students to seek help from the instructor. A majority of students evaluated the course center positively, thereby supporting the practice of seeking individual help from the instructor.

While 5 (63%) respondents answered that an integrated approach using multiple teaching methods was the most effective approach for preparing developmental/remedial science students for subsequent science courses, and 3 others indicated different individual strategies as “most effective,” there was no apparent consensus among the 8 respondents regarding a “most effective” teaching strategy. However, the diversity of responses supported the more common response of the effectiveness of using a variety of teaching strategies.

A multiple strategy approach to teaching developmental/remedial science courses is supported by the literature. Moore (2001), Waycaster (2001), and Wittrock (1994) noted that science is problematic for developmental/remedial science students when it is taught as if there is only one way to teach and learn.

At a total of 7 (88%) institutions, class sizes were kept at 19 students or less. Only 1 (13%) respondent indicated developmental/remedial science class sizes larger than 19 by reporting a 30-39 student class size at their institution.

Support Services Availability

Respondents to Survey 1 indicated that support services, such as placement, tutoring, and academic advising and/or counseling, were offered for developmental/remedial sciences at their institutions. The most common support service was tutoring (70% of institutions); academic advising was offered at 45% of the institutions, placement and counseling were each offered at 40% of the institutions, and SI was offered at 25% of the institutions.

Placement

Only 3 (38%) respondents indicated that they use formal placement testing, such as ACT scores, Compass Reading scores, and in-house placement tests. At 2 (25%) institutions, respondents indicated less formal placement criteria, which involved student self-selection or student encouragement to take a course or use support services based on a recommendation from someone, such as an instructor, who had identified weaknesses in a student's background and/or performance. A respondent from 1 (13%) other institution indicated students were placed into the developmental/remedial science course because they had not taken other science courses in preparation for a course in anatomy and physiology.

Casazza (1999) noted one best practice for developmental/remedial education was the identification of weaknesses and strengths of students. The use of placement tests may help in identifying students' strengths and weaknesses, but the other criteria used at surveyed institutions to place students may not.

Tutoring

A clear majority (88%) of respondents indicated similar tutoring services were available for all science students, whether they were enrolled in developmental/remedial or regular science courses. Only one (13%) respondent indicated that no tutoring services were available for the sciences at his/her institution but that instructors were available to help all science students, but on a limited basis.

Supplemental Instruction

Supplemental Instruction (SI) was offered at 2 (25%) institutions, but only for nondevelopmental/nonremedial science courses. The remaining 6 (75%) respondents indicated no SI availability for science courses of any kind on their campuses.

Congos and Mack (2005) wrote "the emphasis of SI is on helping students acquire and refine the college level learning skills indispensable to mastering college level course content" (p. 1). The benefits of SI for developmental/remedial sciences have been shown (Jensen & Rush, 2000; VerBeek & Louters, 1991). At the two institutions where SI was already offered for nondevelopmental/nonremedial science courses, developmental/remedial science students were not able to take advantage of the benefits of this program.

Advising/Counseling

While one (13%) respondent reported no real advising system at his/her institution, another (13%) respondent noted having advisors specifically designated to work with developmental/remedial students, and one other (13%) indicated advisors were chosen solely on the basis of a student's major or career goals. A combination of non-faculty staff and faculty advisors selected on the basis of a student's major was used at 2 (25%) institutions, and a few (3 of 8, or 38%) respondents indicated non-faculty staff advisors/counselors were primarily responsible for advising developmental/remedial science students. This makes obvious the importance of communication between faculty and advisors so that advisors are aware of faculty expectations and course demands to ensure students are guided into the appropriate courses for their skill and knowledge levels.

Assessment of Student Progress

An ABCDF grading system was used in developmental/remedial science courses offered at 50% of the respondents' institutions. The other 50% used a pass/fail system.

Casazza (1999) claimed successful developmental/remedial education programs emphasized, among other things, a process involving more than a better grade in a class. Thus, the type of grading system may not be important.

A variety of responses were received from the respondents regarding how students were assessed so that they could progress from the developmental/remedial science course to "regular" courses in their curriculum. These responses were grouped into four categories, which ranged from a required minimum grade in the developmental/remedial course to the *option* of taking the developmental/remedial science course, such that students would not have to complete or even take the developmental/remedial course to move into the "regular" course. The majority (63%) of respondents wrote that students must pass the developmental/remedial science courses with a grade of C, 70% or better in most cases, or a grade of P for passing.

These data are not fully consistent with the literature. In particular, Phipps (1998) and Moore (2002a) noted one best practice for developmental/remedial sciences was that exit standards were enforced for developmental/remedial courses to match the developmental/remedial course exit standards to regular college course entry expectations so that students who completed remedial courses would have the skills and knowledge needed to enter college level courses. The survey responses indicated, in most cases, that students were to earn at least a 70% in the developmental/remedial course before moving on, but for 3 (38%) respondents, criteria were loose, at best, and in direct contradiction to the suggested best practices.

Assessment of Developmental/Remedial Sciences

Respondents estimated that at their institutions 50-90% of the students taking developmental/remedial science courses earned a passing grade. The majority of respondents (6 of 8, or 75%) reported that 70% or more of the students pass these courses; the actual percentage ranged from 70% to 90%.

Respondents reported that 40-90% of students completed their subsequent science courses with a grade of C or better after successfully completing a developmental/remedial science course. Half of the 8 respondents estimated that 70% or more students successfully completed subsequent science courses; the actual percentage ranged from 75% to 90%.

The effectiveness of developmental/remedial sciences was assessed in a number of ways. Responses were grouped into three categories:

1. Review of success rates in developmental/remedial science course and/or subsequent science course.
2. Tracking student progress in college-level science courses and/or by graduation rates.
3. Other (including comprehensive final exams, pre- and post-testing, and no assessment at all).

The most common response, which came from 3 (38%) of the respondents, was a review of success rates in the developmental/remedial science course and/or subsequent science course.

Boylan et al. (1999) wrote that developmental/remedial programs utilizing best practices employed regular and systematic program evaluation. But Phipps (1998) called attention to the reality that not all developmental/remedial education was delivered effectively or efficiently, nor did institutions consistently assess the effectiveness of developmental/remedial education (Roueche & Roueche, 1999). Spann (2000) suggested that the extent of student benefit should be determined and the information should be used in a formative manner. At a total of 5 (63%) institutions, some method of assessment was utilized to determine the effectiveness of the developmental/remedial sciences offered. However, the other 3 (38%) institutions did not assess effectiveness at the time the survey was administered. These institutions could perhaps benefit from a model of continuous evaluation of courses, curriculum, and instructional practices proposed by Hsu et al. (2005). Of further note was that half of the institutions did not have formal goals for the developmental/remedial sciences offered. Assessment is difficult when there are no goals with which to align.

Summary of Research Question 3

The purpose of Research Question 3 was to identify if commonality existed among developmental/remedial sciences to develop a set of guidelines for community college administrators and instructors to use in determining if they should implement developmental/remedial sciences. Further, this research question asked: What were the stages and processes for implementing a developmental/remedial sciences program?

The following is a summary of major findings that addressed guidelines and processes for the implementation of developmental/remedial sciences at the three institutions included in the case study.

Types of Developmental/Remedial Sciences Offered

A total of 5 courses were offered at the 3 case study institutions. Support services offered at all institutions included tutoring, academic advising, and counseling. None of the interviewees considered the combination of courses and support services at their institutions to be a "program."

Identifying Need for Developmental/Remedial Sciences

The primary factor utilized at all three institutions in identifying need for the developmental/remedial science course(s) was an observed lack of student preparedness for science courses in which the students had enrolled. The process was reactive, not proactive, and no formal instrument was used in the identification of need. The central role of faculty in identifying students who were struggling was noted.

Process for Developing Courses and Support Services

All case study participants noted that faculty were the ones to develop the developmental/remedial science courses offered, and then a multilayered process was used to approve the course and offer it for the first time. Governing board approval was necessary at 2 of the 3 institutions.

Instructor Training for Developmental/Remedial Sciences

A common theme regarding instructor training in developmental/remedial sciences was past teaching experience at the middle school and/or high school level. A single respondent mentioned upcoming developmental/remedial training opportunities for instructors. The need for training was noted in the literature. Spann (2000) pointed out a best practice for developmental/remedial education involved providing training and professional development for faculty involved in teaching developmental/remedial courses.

Developmental/Remedial Courses were Prerequisites

All developmental/remedial courses were prerequisites or recommended prerequisites for regular science courses, such as Anatomy and Physiology, Microbiology, and Chemistry.

Course Assessment

Course assessment involved quizzes, exams, and a review of success rates.

Assessment of Support Services

Tutoring was the most common support service offered at case study institutions, but the service was assessed differently, if at all, at the different schools. Advising services were also offered at the case study institutions, but were not formally assessed.

Implementing Developmental/Remedial Sciences

In general, implementation of developmental/remedial sciences involved identification of need, course and support services development, scheduling and staffing of courses and support services, and assessment. The only changes made to the offerings over time were in response to student demand and content changes in the subsequent science course.

Guidelines and Recommendations for Others Considering Developmental/Remedial Sciences at Their Institutions

The three interviewees made the following recommendations for those considering developmental/remedial sciences at their institutions:

- Plan for the appropriate physical space and staff when implementing a new program.
- Start a conversation between the academic department and support services staff.
- Know what you are remediating.
- Do your homework. Consider reading *No One to Waste* (McCabe, 2000), *A Framework for Understanding Poverty* (Payne, 1996), and *Improving Science,*

Math, Engineering, and Technology Instruction: Strategies for the Community College (Mahoney, 1996).

How Developmental/Remedial Sciences Impacted the Colleges

The three interviewees noted developmental/remedial sciences increased access, student success, and enrollments at their institutions.

Best Thing About Current Program

Interviewees noted a number of "best things" about the developmental/remedial sciences offered at their institutions. Responses were grouped into five categories: (a) open communication and trust between the academic department and academic support services; (b) offerings driven by the faculty who teach nondevelopmental/nonremedial science courses who have a vested interest in students being prepared for those courses; (c) sensitivity toward students; (d) a quality improvement attitude; and (e) a starting point to build upon.

The Future of Developmental/Remedial Sciences

All interviewees agreed that the need for developmental/remedial sciences will not decrease in the future. This was consistent with the literature (Boylan et al., 1999; Phipps, 1998). Further, each interviewee had a unique view of the future of developmental/remedial sciences at his/her institution. Developmental/remedial education *programs*, learning communities, and relationship building to identify needs were all mentioned by interviewees as visions for the future of developmental/remedial sciences at their institutions.

Other Topic: Shortage of Science and Math Instructors

Only one interviewee mentioned a concern about the shortage of math and science teachers, particularly the impact that it has on students in developmental/remedial sciences at the community college. The shortage of science teachers was consistent with the literature, which identified a shortage of graduates in the areas of science, math, and engineering (NCES, 2004a; OECD, 2004). Even though an individual may have a degree in an academic discipline, his/her teaching skills may be poor, so that students in the developmental/remedial course are scared away. This interviewee's recommendation was for training to be provided at the hiring institution for instructors to better develop their teaching skills to increase their ability to clearly communicate with students.

Conclusions

Based on the findings of this study, the researcher drew the following conclusions and grouped them into four categories as follows: general characteristics, importance of faculty, goals and assessment, and promoting reflection.

General Characteristics

- The fact that developmental/remedial sciences were offered at about one-quarter of the 72 institutions included in this study gives administrators and faculty at other community colleges which do not offer developmental/remedial sciences something to consider.
- Some of the need for developmental/remedial sciences is met by general developmental/remedial skills courses such as math, reading, and writing courses.

- Students were not prepared for the science courses they took, particularly introductory level courses in the areas of biology, chemistry, and physical science.
- Interviewees projected, based on their experiences, that the need for developmental/remedial sciences will not decrease in the future, yet only a small percentage of respondents to Survey 1 indicated they had plans to offer developmental/remedial sciences at their institutions in the future. This mismatch in the data underscores the need for communication between faculty and administrators at community colleges regarding developmental/remedial sciences as well as the importance of identifying needs in these areas.
- Community colleges find student success in the areas of biology and chemistry important, probably because of the relationship of these types of courses to Allied Health programs offered at community colleges and because of the large numbers of community college students who transfer to Allied Health professional programs.
- Developmental/remedial sciences are not new. As 7 of 8 respondents indicated, developmental/remedial sciences had been offered at their institutions for at least 10 years.
- Policy consideration should be given to using developmental/remedial science courses for degrees as well as for institutional credit.
- Policy consideration should be given to providing appropriate training for faculty who teach developmental/remedial sciences.

- Faculty should be encouraged to use multiple instructional approaches when teaching developmental/remedial science courses.
- Policy consideration should be given to the identification of student strengths and weaknesses to ensure proper placement of students into science courses.
- Policy consideration should be given to the development of comprehensive and cohesive developmental/remedial science programs, which include a variety of courses and support services.

Importance of Faculty

- Faculty were directly involved in identifying the need for developmental/remedial sciences and developing the developmental/remedial science courses and were either directly or indirectly involved in advising students who took developmental/remedial science courses.
- Because the process involved in offering developmental/remedial sciences was more reactive than proactive, coupled with the fact that no formal process was used to identify need, faculty who teach science courses must be cognizant of what goes on in their classes and with their students so that needs for developmental/remedial sciences can be identified.
- Communication between faculty and advisors is important so that advisors are aware of faculty expectations and course demands to ensure students are guided into the appropriate courses for their skill and knowledge levels.

Goals and Assessment

- Many of the participants in this study indicated that no goals were in place for the developmental/remedial sciences offered at their institutions nor were assessments common. The literature called for the alignment of goals and assessments (Bybee & Fuchs, 2006), but if no goals exist, assessment cannot possibly align.
- At the institutions where respondents indicated developmental/remedial sciences were offered, nearly half offered courses and multiple support services, defined by this study as a program. However, the institutions selected for case studies did not define the combination of courses and support services offered at their institutions as “programs.” Instead, they called the developmental/remedial science offerings at their campuses simply “courses” with support services that were separate. The combination was not recognized as a “program” at their institutions. If the combination of developmental/remedial science courses and support services were considered a program, goals and assessment would be more prevalent.
- If developmental/remedial sciences are offered, goals should be established to support effective instructional strategies and assessment.
- Goals for developmental/remedial sciences should emphasize skills and strategies, such as building foundational knowledge, critical thinking, and problem solving that can be used across disciplines.

- Since goals and/or assessment were not part of developmental/remedial sciences at many of the institutions, developmental/remedial sciences appeared to play second fiddle to nondevelopmental/nonremedial areas and to other developmental/remedial areas (e.g., reading, writing, etc.). That is, developmental/remedial sciences appeared to be less important because of the emphasis, or rather, *lack* of emphasis, placed on assessment. One must ask: Are developmental/remedial sciences important at these institutions? Are the students important?

Promoting Reflection

- Administrative support is essential to institute developmental/remedial sciences.
- It is easy to get caught up in the day-to-day work of administration such that time for reflection and thinking from an institutional perspective is difficult. Administrators should adopt a systems thinking approach in order to see the influence of their decisions on other areas of the institution.
- Individuals holding administrative titles may also have teaching responsibilities along with their administrative duties. The added responsibility of teaching may take away from the already limited time available for reflection; however, teaching may also help administrators better remember the students as they make decisions.

Guidelines for Determining if Developmental/Remedial Sciences Should be Implemented

This research suggested ten guidelines and a process that may be used by faculty and administrators at community colleges when considering the implementation of developmental/remedial sciences at their institutions. Guidelines are listed below, in sequence, to illustrate the process.

1. *Adopt an attitude of quality improvement*. Consider that needs change over time and improvement comes with the identification of those changing needs.
2. *Look to your #1 resource: Faculty*. Faculty have the most regular and direct interaction with the students. If they notice problems or areas in need of improvement–*listen to them*. This will also secure faculty buy-in.
3. *Assess what you currently do in the sciences in the way of instruction, course offerings, etc. Then ask: Is it working?* Are students seeing success? Are they prepared for subsequent courses offered at your institution and at institutions to which they may transfer? If not, why not? Identify the weak areas or areas where gaps exist.
4. *Know what you are remediating.* What skill sets and knowledge should students have when they finish the developmental/remedial course or program? Ideally, developmental/remedial courses should be developed based on the competencies, knowledge, and skills needed for subsequent courses. At case study institutions, the developmental/remedial sciences were driven by

faculty who teach *non*developmental/*non*remedial science courses and who, therefore, have a vested interest in students being prepared for those courses.

5. *Start a conversation between the academic department and support services staff to create a truly integrated program*. Consider the student population and the needs they may have within and beyond the classroom.
6. *Consider placement and advising.* How will students be guided into the developmental/remedial courses and/or support services?
7. *Consider assessment*. Define goals and a process for assessing those goals.
8. *Consider training and experience of faculty*.
9. *Plan for the appropriate physical space and staff when implementing a new program.*
10. *Do your homework*. Look at best practices and attempt to incorporate as many as are appropriate and feasible. Be aware of the student population at your institution and the types of courses and support services that will best meet their needs. Further, be aware of the needs of the marketplace and how your programs can assist in meeting those needs by better preparing students to be productive members of the marketplace.

Recommendations for Further Study

Based on the findings and conclusions of this study, the following recommendations for further study are made:

- The data from this study indicated no specific tools were employed to identify the need for developmental/remedial sciences; needs were primarily identified by faculty who worked closely with students. Further research could address the use of various tools in comparison to faculty and administration observation of students in the identification of needs.

- Research could be conducted to look at the impacts of different grading systems on student motivation in developmental/remedial science courses.
- Further research should be conducted to address the development of goals and assessment methods for developmental/remedial science courses, support services, and programs.
- Because of the variety of advising methods utilized at the institutions in this study, further studies could identify and research the effectiveness of different models of advising developmental/remedial science students.
- Research could address the instructional practices used by instructors with developmental education training versus instructors with work/teaching experience and also compare their perspectives on teaching developmental/remedial sciences.
- Further research could investigate student weaknesses in the different fields of study in the sciences to determine if weaknesses vary by science course.
- This study could be expanded to a national level to identify and describe the developmental/remedial science courses, services, and programs offered at community colleges across the United States to further develop best practices for developmental/remedial sciences.

- State and national studies could be performed to identify the percentage of institutions at which developmental/remedial science courses are offered in a particular discipline so that high need areas and the source(s) for those needs may be addressed.

Summary

The purposes of this research were to identify and examine the characteristics of developmental/remedial sciences at community colleges in five states in the central part of the United States and to develop a set of guidelines for community college faculty and administrators to use in making decisions about whether or not to offer developmental/remedial sciences and then to identify the general steps to follow in implementation.

Developmental/remedial sciences were described for the institutions in the study. In general, developmental/remedial sciences were offered at few community colleges. While the measures of student success both in the developmental/remedial science courses and in subsequent science courses at those institutions were positive, few had goals and assessed their practices.

The qualitative aspect of this research involved the selection of three case study institutions based on student success rates in the developmental/remedial science course and the subsequent science course. The similarities that existed among case study institutions were used to develop guidelines in the areas of assessment, utilizing your best resources, and implementing best practices.

Phipps (1998) emphasized interinstitutional collaboration among colleges to share and replicate best practices and ideas as a strategy to improve the effectiveness of developmental/remedial education. Johnson (2001) noted

> as I examine science teaching journals, much of the emphasis is content-centered, not student-centered. On the other hand, the developmental education journals are more student-centered, but they usually do not address the teaching of . . . science. The ideal is to get both groups talking to each other (p. 154).

Let the conversation commence!

REFERENCES

Adelman, C. (1999). *Answers in the toolbox: Academic intensity, attendance patterns, and bachelor's degree attainment*. Washington, DC: Department of Education, Office of Educational Research and Improvement.

Albert, J. (2004). A study of faculty perceptions of under-prepared students in selected Iowa community colleges. (Doctoral dissertation, University of Nebraska-Lincoln, 2004). *Dissertation Abstracts Online*, OCLC First Search Accession Number AAI3142071.

American Association of Community Colleges (AACC). (2005). *AACC membership directory 2005*. Washington, DC: Community College Press.

American Association for the Advancement of Science (AAAS). (2006). *Scientific literacy for a changing future*. Washington, DC: Project 2061/AAAS.

American Film Institute (AFI). (2006). *Catalyst workshop: Communicating science and engineering*. Retrieved July 6, 2006, from http://www.afi.com/education/catalyst/default.aspx

Anderson, R. (1983). Are yesterday's goals adequate for tomorrow? *The Science Teacher, 67*, 171-176.

Arendale, D. (2002). History of Supplemental Instruction: Mainstreaming of developmental education. In D. B. Lundell & J. L. Higbee (Eds.), *Histories of developmental education* (pp. 15-27). Minneapolis, MN: Center for Research on Developmental Education and Urban Literacy, General College, University of

Minnesota. Retrieved August 28, 2006, from http://www.gen.umn.edu/research/crdeul/monographs.htm

Astin, A. (1998). Remedial education and civic responsibility. *National Crosstalk*, *6*, 12-13.

Astin, A. (2000). The civic challenge of educating the underprepared student. In T. Ehrlich (Ed.), *Civic responsibility and higher education* (pp. 124-146). Phoenix, AZ: Oryx.

Astin, A., Parrott, S., Korn, W., & Sax, L. (1997). *The American freshman: Thirty year trends*. Los Angeles, CA: Higher Education Research Institute, UCLA.

Atwater, M. (1994). Research on cultural diversity in the classroom. In D. Gabel (Ed.), *Handbook of research in science teaching and learning* (pp. 558-576). Washington, DC: National Science Teachers Association.

Bastedo, M., & Gumport, P. (2003). Access to what? Mission differentiation and academic stratification in U.S. public higher education. *Higher Education, 46*, 341-359.

Biermann, C., & Sarinsky, G. (1993). Hands-on versus remediation: Alternative strategies for a community college biology preparatory course. *Community College Review, 21*(3), 53-61.

Blanc, R., DeBuhr, L, & Martin, D. (1983). Breaking the attrition cycle: The effects of Supplemental Instruction on undergraduate performance and attrition. *Journal of Higher Education, 54*(1), 80-90.

Bloom, B. (1956). *Taxonomy of educational objectives: The classification of educational goals*. New York: David McKay.

Boylan, H. (1999). Demographics, outcomes, and activities. *Journal of Developmental Education*, *23*, 2-8.

Boylan, H., Bliss, L., & Bonham, B. (1997). Program components and their relationship to student performance. *Journal of Developmental Education, 20(3)*, 2-8.

Boylan, H., Bonham, B., & White, S. (1999). Developmental and remedial education in postsecondary education. *New Directions for Higher Education*, *27*, 87-101.

Breneman, D., & Haarlow, W. (1998). *Remediation in higher education: A symposium*. Retrieved May 31, 2006, from http://www.edexcellence.net/foundation/publication/publication.cfm?id=34

Bryant, M. (2004). *The portable dissertation advisor*. Thousand Oaks, CA: Corwin.

Bybee, R., & Fuchs, B. (2006). Preparing the 21st century workforce: A new reform in science and technology education. *Journal of Research in Science Teaching, 43(4)*, 349-352.

Casazza, M. (1999). Who are we and where did we come from? *Journal of Developmental Education*, *23*, 2-7.

Center for Academic Development. (2006). *The leader's guide to supplemental instruction: Peer assisted study sessions*. Kansas City, MO: The Curators of the University of Missouri.

Clement, J. (1982). Students' preconceptions in introductory mechanics. *American Journal of Physics, 50*(1), 66-71.

Clowes, D. (1980). More than a definitional problem: Remedial, compensatory, and developmental education. *Journal of Developmental and Remedial Education*, *4*, 8-10.

Cohen, A., & Brawer, F. (2003). *The American community college* (4th ed.). San Francisco: Jossey-Bass.

Congos, D., & Mack, A. (2005). Supplemental instruction's impact in two freshman chemistry classes: Research, modes of operation, and anecdotes. *Research and Teaching in Developmental Education, 21(2).*

Creswell, J. (1998). *Qualitative inquiry and research design: Choosing among the five traditions*. Thousand Oaks, CA: Sage.

Creswell, J. (2002). *Educational research: Planning, conducting, and evaluating quantitative and qualitative approaches to research*. Upper Saddle River, NJ: Merrill/Pearson Education.

Creswell, J. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: Sage.

Creswell, J., & Miller, D. (2000). Determining validity in qualitative inquiry. *Theory into Practice, 39*(3), 1-7.

Cross, P. (1976). *Accent on learning*. San Francisco: Jossey-Bass.

Davidson, W., House, W., & Boyd, T. (1984). A test-retest policy for introductory psychology courses. *Teaching of Psychology, 11(3)*, 182-184.

Dillman, D. (2000). *Mail and internet surveys: The tailored design method* (2nd ed.). New York: John Wiley.

DiMuro, P. (2006). Best practices in mathematics instruction: Teaching for understanding. *NADE Digest, 2*(1), 1-8.

Fensham, P., Gunstone, R., & White, R. (1994). Science content and Constructivist view of learning and teaching. In P. Fensham, R. Gunstone, & R. White (Eds.), *The content of science: A constructivist approach to its teaching and learning* (pp. 1-8). Washington, DC: Falmer.

Fowler, A. (1988). Chemistry education in two-year colleges of the SREB region: A survey of the nature of developmental/remedial courses. (Doctoral dissertation, University of Tennessee, Knoxville, 1988). *Dissertation Abstracts Online*, OCLC First Search Accession Number AAG8824310.

Francisco, J., Trautmann, M., & Nicoll, G. (1998). Integrating a study skills workshop and pre-examination to improve students' chemistry performance. *Journal of College Science Teaching, 27*, 273-278.

Friedlander, J. (1981). Should remediation be mandatory? *Community College Review*, *9*(3), 56-64.

Fuhrman, S., & Malen, B. (1991). *The politics of curriculum and testing: The 1990 yearbook of the politics of association*. Bristol, PA: Falmer Press.

Fullilove, R., & Triesman, P. (1990). Mathematics achievement among African American undergraduates at the University of California, Berkeley: An evaluation of the Mathematics Workshop Program. *Journal of Negro Education, 59*, 463-478.

Gebelt, J., Parilis, G., Kramer, D., & Wilson, P. (1996). Retention at a large university: Combining skills with course content. *Journal of Developmental Education, 20*(1), 2-10.

Hadden, C. (2000). The ironies of mandatory placement. *Community College Journal of Research and Practice, 24*(10), 823-838.

Halloun, I., & Hestenes, D. (1985). The initial knowledge state of college physics students. *American Journal of Physics, 53*(11), 1043-1055.

Horn, L., & Nevill, S. (2006). *Profile of undergraduates in U.S. postsecondary education institutions: 2003-04: With a special analysis of community college students*. U.S. Department of Education. Washington, DC: National Center for Education Statistics.

Hoyt, J., & Sorenson, C. (2001). High school preparation, placement testing, and college remediation. *Journal of Developmental Education, 25*(2), 26-33.

Hsu, L., Jensen, M., Moore, R., & Hatch, J. (2005). Ideas in practice: Science courses in developmental education. *Journal of Developmental Education, 29*(1), 30-38.

Hurd, P. (1983). Science education: The search for a new vision. *Educational Leadership, 41*(4), 20.

Ignash, J. (1997). Who should provide postsecondary remedial/developmental education? In J. Ignash (Ed.), *New Directions for Community College* (pp. 5-20). San Francisco: Jossey Bass.

Institute for Higher Education Policy and The Education Resources Institute (TERI). (1996). *Life after 40: A new portrait of today's – and tomorrow's – postsecondary students*. Washington, DC: The Institute for Higher Education Policy.

Jenkins, D., & Boswell, K. (2002). *State policies on community college remedial education: Findings from a national survey*. Denver: Center for Community College Policy, Education Commission of the States (ECS).

Jensen, M. (1996). Cooperative quizzes in the anatomy and physiology laboratory: A description and evaluation. *Advances in Physiology Education, 16*(1), S48-S54.

Jensen, M. (2006). *WebAnatomy*. Retrieved June 16, 2006, from http://msjensen.education.umn.edu/Webanatomy/

Jensen, M., Moore, R., & Hatch, J. (2002). Cooperative learning – part I: Cooperative quizzes. *The American Biology Teacher, 64*(1), 29-34.

Jensen, M., & Rush, B. (2000). Teaching a human anatomy and physiology course within the context of developmental education. In J. Higbee & P. Dwinell (Eds.), *The many faces of developmental education* (pp. 47-57). Warrensburg, MO: National Association for Developmental Education.

Jensen, M., Wilcox, K., Hatch, J., & Somdahl, C. (1996). A computer-assisted instruction unit on diffusion and osmosis with a conceptual change design. *Journal of Computers in Mathematics and Science Teaching, 15*, 49-64.

Johnson, A. (2001). Theoretical views and practices supporting in-context developmental strategies in the physical sciences. In D. Lundell & J. Higbee (Eds.), *Theoretical perspectives for developmental education* (pp. 153-161). Minneapolis, MN:

Center for Research on Developmental Education and Urban Literacy, General College, University of Minnesota.

Johnson, D., & Johnson, R. (1999). *Learning together and alone: Cooperative, competitive, and individualistic learning*. Boston: Allyn & Bacon.

Johnson, D., Johnson, R., & Smith, K. (1998). *Active learning: Cooperation in the college classroom*. Edina, MN: Interaction Book.

Juhler, S., Rech, J., From, S., & Brogan, M. (1998). The effect of optional retesting on college students' achievement in an individualized algebra course. *The Journal of Experimental Education, 66*(2), 125-137.

Koballa, T. (1986). Teaching hands-on science activities: Variables that moderate attitude-behavior consistency. *Journal of Research in Science Teaching, 23*(6), 493-502.

Kotnik, L. (1974). What is being done to help the underprepared student? *Journal of Chemical Education, 51*(3), 165-167.

Kozeracki, C. (2002). Issues in developmental education. *Community College Review*, *29*, 83-100.

Kull, K. (1999). A developmental education survey: Results of a national survey of program design and mathematics instruction. *Research and Teaching in Developmental Education, 16*(1).

Leonard, W. (2000). How do college students learn science? *Journal of College Science Teaching, 29*, 385-388.

Levin, M., & Levin, J. (1991). A critical examination of academic retention programs for at-risk minority college students. *Journal of College Student Development, 32*(4), 323-334.

Lewis, L., & Farris, E. (1996). *Remedial education at higher education institutions in the fall 1995*. Washington, DC: National Center for Education Statistics.

Mahoney, J. (1996). *Improving science, mathematics, engineering, and technology instruction: Strategies for the community college*. Washington, DC: American Association of Community Colleges.

Marx, J., Honeycutt, K., Rahmati Clayton, S., & Moreno, N. (2006). The Elizabethtown incident: An inquiry-based approach to learning anatomy developed through high school-university collaboration. *The American Biology Teacher, 68*(3), 140-147.

Mazur, E. (1997). *Peer instruction: A user's manual*. Upper Saddle River, NJ: Prentice Hall.

McCabe, R. (2000). *No one to waste: A report to public decision-makers and community college leaders*. Washington, DC: Community College Press.

McDonald, J., & Dominguez, L. (2005). Moving from content knowledge to engagement. *Journal of College Science Teaching, 35*(3), 18-22.

Moore, R. (2001). New directions in science education for developmental education. In D. Lundell & J. Higbee (Eds.), *Theoretical perspectives for developmental education* (pp. 143-151). Minneapolis, MN: Center for Research on Developmental Education and Urban Literacy, General College, University of Minnesota.

Moore, R. (2002a). Science education and the urban achievement gap. In D. Lundell & J. Higbee (Eds.), *Exploring urban literacy and developmental education* (pp. 33-46). Minneapolis, MN: Center for Research on Developmental Education and Urban Literacy, General College, University of Minnesota.

Moore, R. (2002b). The lessons of history: Transforming science to include developmental education. In D. Lundell & J. Higbee (Eds.), *Histories of developmental education* (pp. 83-92). Minneapolis, MN: Center for Research on Developmental Education and Urban Literacy, General College, University of Minnesota.

Moore, R. (2004). Do colleges identify or develop intelligence? *Journal of Developmental Education, 28*(1), 28-34.

Morrow, J. (1999). When students design experiments: What students learn by performing like scientists. *The Science Teacher, 66*, 44-47.

Morse, J., & Richards, L. (2002). *Read me first for a user's guide to qualitative methods*. Thousand Oaks, CA: Sage.

Murray, J. (1990). Better testing for better learning. *College Teaching, 38*(4), 148-152.

National Association for Developmental Education (NADE). (2001a). *Definition of developmental education*. Retrieved June 14, 2006, from http://www.nade.net/A1.%20de_definition.htm

National Association for Developmental Education (NADE). (2001b). *Goals of developmental education*. Retrieved June 14, 2006, from http://www.nade.net/A3.%20de_goals.htm

National Association for Developmental Education (NADE). (2005). *2005 fact sheet: Responses to frequently asked questions about the National Association for Developmental Education*. Retrieved June 14, 2006, from http://www.nade.net/documents/Fact%20Sheet/Fact%20Sheet.2005.pdf

National Center for Education Statistics (NCES). (1996). *Percentage distribution of beginning postsecondary students, by type of first institution attended and year enrolled according to the highest level of education completed by either parent, student expectations, and remedial course-taking: 1989–90 and 1995–96*. Retrieved June 16, 2006, from http://nces.ed.gov/das/library/tables_listings/show_nedrc.asp?rt=p&tableID=710

National Center for Education Statistics (NCES). (2004a). *Digest of education statistics, 2004: International comparisons of education*. Retrieved June 16, 2006, from http://nces.ed.gov/programs/digest/d04/tables/dt04_412.asp

National Center for Education Statistics (NCES). (2004b). *National postsecondary student aid study 2003-04*. Retrieved July 12, 2006, from http://nces.ed.gov/surveys/npsas/

National Center for Education Statistics (NCES). (2005). *National assessment of educational progress. The nation's report card*. Retrieved May 31, 2006, from http://nationsreportcard.gov/science_2005/

National Center for Education Statistics (NCES). (2006). *Special analysis 2006: U.S. student and adult performance on international assessments of educational achievement*. Retrieved June 16, 2006, from http://nces.ed.gov/programs/coe/2006/analysis/sa03d.asp

National Center for Supplemental Instruction in the Center for Academic Development at the University of Missouri at Kansas City. (1997). *Supplemental Instruction: Peer assisted study sessions*. Kansas City, MO: Author.

National Research Council (NRC). (1996). *National science education standards*. Washington, DC: National Academy Press.

National Science Foundation (NSF). (2005). *Teacher institutes: A special report*. Retrieved May 31, 2006, from http://www.nsf.gov/news/special_reports/teacher/park.jsp

Organisation for Economic Co-Operation and Development (OECD). (2004). *OECD statistics, graduates by field of education*. Retrieved June 16, 2006, from http://stats.oecd.org/WBOS/Default.aspx

Oudenhoven, B. (2002). Remediation at the Community College: Pressing Issues, Uncertain Solutions. *New Directions for Community Colleges*, *117*, 35-44.

Paldy, L. (2005). No time for complacency. *Journal of College Science Teaching, 35*(3), 4-5.

Parsad, B., & Lewis, L. (2003). *Remedial education at degree-granting postsecondary institutions in Fall 2000*. Washington, DC: National Center for Education Statistics.

Patton, M. (1980). *Qualitative evaluation methods*. Newbury Park, CA: Sage.

Payne, E., & Lyman, B. (1996). Issues affecting the definition of developmental education. In J. L. Higbee & P. L. Dinwell (Eds.), *Defining developmental education: Theory, research, and pedagogy*. *Annual monograph of the National Association for Developmental Education*. Retrieved May 31, 2006, from http://www.nade.net/documents/Mono96/mono96.2.pdf

Payne, R. (1996). *A framework for understanding poverty*. Highlands, TX: Aha Process!

Perin, D. (2002). The location of developmental education in community colleges: A discussion of the merits of mainstreaming vs. centralization. *Community College Review*, *30*, 27-44.

Perkins, D., & Solomon, G. (1989). Are cognitive skills context-bound? *Educational Researcher, 18*, 16-25.

Phipps, R. (1998). *College remediation: What it is, what it costs, what's at stake*. Washington, DC: The Institute for Higher Education Policy.

Piaget, J. (1970). *The science of education and the psychology of the child*. New York: Orion.

Roach, R. (2000). Remediation reform. *Black Issues in Higher Education, 17*(12), 16-22.

Roschelle, J. (1992). Learning by collaborating: Convergent conceptual change. *The Journal of Learning Sciences, 2*(3), 235-276.

Roueche, J., & Roueche, S. (1993). *Between a rock and a hard place: The at-risk student in the open-door college*. Washington, DC: Community College Press.

Roueche, J., & Roueche, S. (1999). *High stakes, high performance: Making remedial education work*. Washington, DC: Community College Press.

Rutherford, F. J., & Ahlgren, A. (1990). *Science for all Americans-online*. Retrieved July 6, 2006, from http://www.project2061.org/publications/sfaa/online/sfaatoc.htm

Ryan, A., Pintrich, P., & Midgley, C. (2001). Avoiding seeking help in the classroom: Who and why? *Educational Psychology Review, 13*(2), 93-114.

Sax, L., Astin, A., Korn, W., & Mahoney, K. (1999). *The American freshman national norms for 1999*. Los Angeles, CA: Higher Education Research Institute, UCLA.

Shaw, K. (1997). Remedial education as ideological background: Emerging remedial education policies in the community college. *Educational Evaluation and Policy Analysis, 19*(3), 284-296.

Slavin, R. (1991). Synthesis of research on cooperative learning. *Educational Leadership, 48*, 71-82.

Southard, A., & Clay, J. (2004). Measuring the effectiveness of developmental writing courses. *Community College Review, 32*(2), 39-50.

Spann, M. (2000). Remediation: A must for the 21st-century learning society. *Education Commission of the States Policy Paper*, *4*, 1-8.

Sundberg, M., Armstrong, J., Dini, M., & Wischusen, E. (2000). Some practical tips for instituting investigative biology laboratories: The nuts and bolts of successful laboratory instruction. *Journal of College Science Teaching, 29*, 353-359.

Texas Higher Education Coordinating Board. (2007). *Developmental education: Teaching strategies: Successful best practices*. Webcast presented on February 27, 2007.

Tinto, V. (2003, February 27). *Enhancing student success in community college: A presentation to Hutchinson Community College*. Presentation at Hutchinson Community College.

Tobias, S. (1992). *Revitalizing undergraduate science: Why some things work and most don't*. Tucson, AZ: Research Corporation.

Trombley, W. (1998). Remedial education under attack: Controversial plans for the City University of New York. *National Crosstalk*, *6*, 1-16.

VerBeek, K., & Louters, L. (1991). Chemical language skills. *Journal of Chemical Education, 68*(5), 389-391.

Watts, M. (1994). Constructivism, re-constructivism and task-oriented problem-solving. In P. Fensham, R. Gunstone, & R. White (Eds.), *The content of science: A constructivist approach to its teaching and learning* (pp. 39-58). Washington, DC: Falmer.

Waycaster, P. (2001). *Community college collaborative on developmental mathematics*. Paper presented at the NADE 25th Annual Conference.

Weinstein, C. (1994). Students at risk for academic failure: Learning to learn classes. In K. Prichard & R. M. Sawyer (Eds.), *Handbook of college teaching: Theory and applications* (pp. 375-385). Westport, CT: Greenwood.

Whitaker, D., & Pascarella, E. (1994). Two year college attendance and socioeconomic attainment: Some additional evidence. *Journal of Higher Education, 65*, 194-210.

Wilke, R., & Straits, W. (2005). Practical advice for teaching inquiry-based science process skills in the biological sciences. *The American Biology Teacher, 67*(9), 534-540.

Wittrock, M. (1994). Generative science teaching. In P. Fensham, R. Gunstone, & R. White (Eds.) *The content of science: A constructivist approach to its teaching and learning* (pp. 29-38). Washington, DC: Falmer.

Woodhams, F. (1998, December 11). Report says remedial classes are cost-effective. *The Chronicle of Higher Education*: A54.

Zoller, U. (2000). Teaching tomorrow's college science courses – Are we getting it right? *Journal of College Science Teaching, 29*(6), 409-414.

Appendix A

Pilot Study Cover Letter

November 6, 2006

Dear Pilot Study Participant,

Thank you for agreeing to participate in a pilot of my dissertation study. The study is entitled "Developmental/Remedial Sciences at Community Colleges in Five States in the Central Part of the United States" (IRB approval #2006-09-016EP) and involves four phases. A brief description of the study in its entirety is stapled to this page. As a way to measure validity of the second phase of the study, this pilot study is being conducted. You were selected to participate in this pilot because you share characteristics with the individuals who may be responding to the surveys. Again, thanks for your participation.

I ask that you please identify any stumbling blocks you encounter such that I may fix them before the survey is administered to the sample. Please make notes directly on the survey instrument if a question is not clear or if the question is ambiguous. Also, please comment on how an unclear question should be changed or improved in your opinion. To help guide your review, I have included a number of questions for you to answer once you have completed the survey.

I appreciate your input. If you have questions of any kind, please note them and feel free to contact me at 620-665-3438 (work) or 620-662-4986 (home) or by email at paramoret@hutchcc.edu . I would appreciate it if you would complete the survey by November 10 and return to me by mail in the enclosed envelope.

Thank you for your time and assistance.

Tricia Paramore
Co-Chair, Natural Science and Math Department
Hutchinson Community College and Area Vocational School
1300 N. Plum
Hutchinson, KS 67501

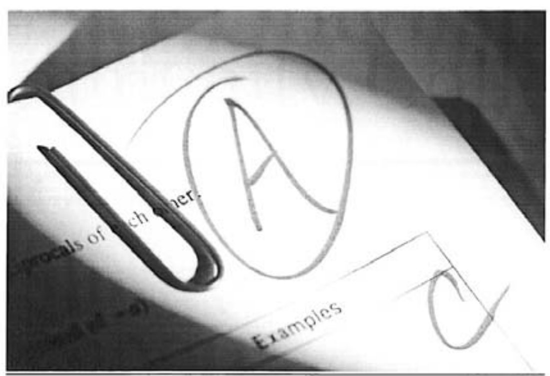
Appendix B

Survey 1:

Community College Developmental/Remedial

Science Offerings & Support Services

Survey 1: Community College Developmental/Remedial Science Offerings & Support Services



Please return your completed survey in the enclosed envelope to:

Tricia Paramore
Hutchinson Community College and Area Vocational School
Natural Science and Mathematics Department
1300 N. Plum
Hutchinson, KS 67501

Developmental/Remedial Science Offerings & Support Services

This survey asks questions about developmental/remedial science courses and/or programs in the **science** areas offered at your campus. When answering the questions, please keep in mind all science areas including the **biological, chemical, physical, and earth sciences**.

1. **As of November 2006, do you offer developmental/remedial science courses or support services for students on the campus where you are located? Check "No" or "Yes" for each of the following:**

	No	Yes	
My institution offers developmental/remedial science courses and/or programs.	☐	☐	
My institution uses criteria to identify developmental/remedial students and uses that information to place students into developmental/remedial science courses/programs.	☐	☐	If yes, in which discipline(s)?__________
My institution offers tutoring for developmental/remedial science students.	☐	☐	If yes, in which discipline(s)?__________
My institution offers academic advising for developmental/remedial science students.	☐	☐	
My institution offers counseling for developmental/remedial science students.	☐	☐	
My institution offers Supplemental Instruction (SI) for developmental/remedial science students.	☐	☐	If yes, in which discipline(s)?__________
My institution offers other developmental/remedial science services not listed here.	☐	☐	Please explain. __________

******If you answered "NO" to ALL of the above, skip to Item 6.******

2. **In which areas are developmental/remedial sciences offered at your campus? Mark all that apply with an X.**

Biological Sciences		Chemistry	
Biology courses for non-science majors	______	Chemistry courses for non-science majors	______
Biology courses for science majors	______	Inorganic Chemistry	______
Human Anatomy and Physiology	______	Organic Chemistry	______
Microbiology	______	Other ____________	______
Other ____________	______		

Physical Science/Physics		Earth Sciences	
Physical Science	______	Geology	______
Physics courses for science majors	______	Weather and Climate	______
Other ____________	______	Other ____________	______

3. **How are developmental/remedial sciences offered on your campus? Mark your response with an X.**

Developmental/remedial education is integrated into the content of regular science courses. _______
Developmental/remedial education is offered as separate study skills courses. _______
Both of the above. _______
Other. Please explain. ____

4. **Please provide the name and contact information for the individual who has administrative/leadership responsibility for developmental/remedial sciences at your campus in the spaces provided below.** This leader may be a department chair, developmental education coordinator, learning center coordinator, instructor, etc. This person will be contacted for in-depth information about the course(s) and/or programs offered in developmental/remedial sciences at your campus.

Campus name ____

Name of developmental/remedial sciences leader at your campus ______________________

Title ____

Email address ______________________

Phone number ( ) ______________________ **Fax number** ( ) ______________________

Mailing address ____
____

5. **If developmental/remedial sciences are offered at your campus, I would like to ask the person you identified above to complete a survey and participate in an interview at your institution. So that you may make an informed decision, copies of the survey and the interview protocol are provided for you in this packet.**

Will you authorize me to contact this individual to complete a survey and interview?

Yes ____ → [If yes, I will need a short letter of commitment stating that I have permission to administer the survey and conduct the interview at your campus. A sample letter is provided for you in this packet. Please make the appropriate changes to the letter of commitment, print on <u>your institution's</u> letterhead, and return to me either by mail with this completed survey or by fax at 620.665.3310. Feel free to add to the text of the statement if you wish.]

No ____

6. **As of November 2006, do you have plans to offer developmental/remedial science courses or programs at your campus in the future?**

Yes ____

No ____

7. **Does your institution have multiple campuses?**

Yes ____ → **(Proceed to Item 8.)**

No ____ (If no, your survey is complete. Please return the survey in the enclosed envelope. Thank you for your time.)

8. **Are developmental/remedial science courses or support services offered on any other campuses of your institution?**

Yes ____ → **(Proceed to Item 9.)**

No ____ (If no, your survey is complete. Please return the survey in the enclosed envelope. Thank you for your time.)

9. **Are the developmental/remedial science policies and practices the same at all campuses of your institution?**

Yes ____ (If yes, your survey is complete. Please return the survey in the enclosed envelope. Thanks for your time.)

No ____ → **(Proceed to Item 10.)**

10. **Please provide a name and contact information for the Chief Academic Officer/Dean at the other campus(es) of your institution. These individuals will be contacted for further information regarding the developmental/remedial science courses and services offered on their campuses.**

Name/title of campus____

Name of CAO____

Position/Job Title____

Email address ____

Phone number (___) ________________ **Fax number** (___) ________________

Mailing address ____
____

Name/title of campus____

Name of CAO____

Position/Job Title____

Email address ____

Phone number (___) ________________ **Fax number** (___) ________________

Mailing address ____
____

Name/title of campus____

Name of CAO____

Position/Job Title____

Email address ____

Phone number (___) ________________ **Fax number** (___) ________________

Mailing address ____
____

Thank you for taking the time to complete this survey.
Your assistance in providing this information is very much appreciated.

Please return your completed survey in the stamped return envelope provided.

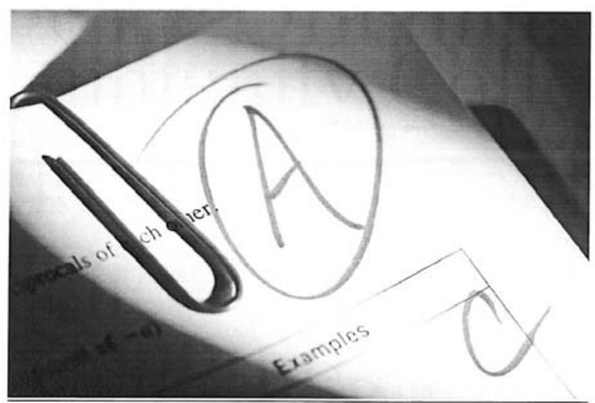
Appendix C

Survey 2:

Community College Developmental/Remedial Science

Offerings & Support Services

Survey 2: Community College Developmental/Remedial Science Offerings & Support Services



Please return your completed survey in the enclosed envelope to:

Tricia Paramore
Hutchinson Community College and Area Vocational School
Natural Science and Mathematics Department
1300 N. Plum
Hutchinson, KS 67501

Developmental/Remedial Science Offerings & Support Services

This survey asks questions about developmental/remedial science courses and/or programs in the **science** areas offered at your campus. When answering the questions, please keep in mind all science areas including the **biological, chemical, physical, and earth sciences**.

1. **Based on the experience at your campus, are students prepared for the science courses they take? Mark with an X the appropriate responses.**

	Yes	No
Biological Sciences		
Biology courses for non-science majors	_______	_______
Biology courses for science majors	_______	_______
Human Anatomy and Physiology	_______	_______
Microbiology	_______	_______
Other _______________________	_______	_______
Chemistry		
Chemistry courses for non-science majors	_______	_______
Inorganic Chemistry	_______	_______
Organic Chemistry	_______	_______
Other _______________________	_______	_______
Physical Science/Physics		
Physical Science	_______	_______
Physics courses for science majors	_______	_______
Other _______________________	_______	_______
Earth Sciences		
Geology	_______	_______
Weather and Climate	_______	_______
Other _______________________	_______	_______

2. **Please identify the apparent sources of weaknesses for students who are underprepared for science courses they will take at your campus. Mark all that apply with an X.**

   Then, of the weaknesses you marked, indicate the top 3 sources of student weaknesses with 1 being the greatest weakness and 3 being the lesser weakness.

		Rank			Rank
_______	Inadequate math background	______	_______	Lack of confidence	_______
_______	Inadequate biology background	______	_______	A general fear of science courses	_______
_______	Inadequate chemistry background	______	_______	Lack of motivation	_______
_______	Poor reading ability	______	_______	Poor study habits	_______
_______	Poor writing ability	______	_______	Poor time management	_______
_______	Overall lack of ability	______	_______	Poor attitude toward the course	_______

_______ Other. Please list and rank. ____

____

3. **As of November 2006, do you offer a developmental/remedial science course(s) at your campus? Mark with an X the appropriate response. Match the course(s) offered at your campus to the list below. If there is no exact match, describe the course(s) at your campus in the "Other" category.**

	Yes	No
Biological Sciences		
Biology courses for non-science majors	_______	_______
Biology courses for science majors	_______	_______
Human Anatomy and Physiology	_______	_______
Microbiology	_______	_______
Other ______________________	_______	_______
Chemistry		
Chemistry courses for non-science majors	_______	_______
Inorganic Chemistry	_______	_______
Organic Chemistry	_______	_______
Other ______________________	_______	_______
Physical Science/Physics		
Physical Science	_______	_______
Physics courses for science majors	_______	_______
Other ______________________	_______	_______
Earth Sciences		
Geology	_______	_______
Weather and Climate	_______	_______
Other ______________________	_______	_______

4. **How long have developmental/remedial sciences been in existence at your institution?**

_______ 1-3 years _______ 4-6 years _______ 7-9 years _______ 10+ years

5. **For each course you marked in Item 3, please list the topics covered in the course in the spaces provided below. If you would prefer to attach a syllabus, please check "Yes" in the space below.**

Course Title:______________________________ Syllabus attached? Yes_________ No__________ Topics Covered:	Course Title:______________________________ Syllabus attached? Yes_________ No__________ Topics Covered:
Course Title:______________________________ Syllabus attached? Yes_________ No__________ Topics Covered:	Course Title:______________________________ Syllabus attached? Yes_________ No__________ Topics Covered:

6. **Describe the criteria used to place students in the course(s) you listed in Item 3. For example: ACT Science, cutoff score 17; or ACT Composite score; or Accuplacer math test, cutoff score 30; or in-house placement test; student's feeling about his/her level of preparedness for the course; etc.**

Course Title:____________________________ Placement Criteria:	Course Title:____________________________ Placement Criteria:
Course Title:____________________________ Placement Criteria:	Course Title:____________________________ Placement Criteria:

7. **Are there formally written goals for the developmental/remedial sciences offered at your campus?**

   No ____ → (Skip to Item 9.)

   Yes ____

8. **If there are goals for the developmental/remedial science offerings, please list the goals in the space below or attach a copy of the course/program goals statement.**

Goals:

9. **Is there a laboratory component to the developmental/remedial science course(s) offered at your campus?**

   No ____

   Yes ____

10. **For each developmental/remedial science course offered, indicate the instructional approach used.**

	Integrate study skills with science content	Separate study skills from science content
Biological Sciences		
Biology courses for non-science majors	_______	_______
Biology courses for science majors	_______	_______
Human Anatomy and Physiology	_______	_______
Microbiology	_______	_______
Other _______________________	_______	_______
Chemistry		
Chemistry courses for non-science majors	_______	_______
Inorganic Chemistry	_______	_______
Organic Chemistry	_______	_______
Other _______________________	_______	_______
Physical Science/Physics		
Physical Science	_______	_______
Physics courses for science majors	_______	_______
Other _______________________	_______	_______
Earth Sciences		
Geology	_______	_______
Weather and Climate	_______	_______
Other _______________________	_______	_______

11. **Using the scale below, indicate the use of each developmental/remedial teaching strategy in the developmental/remedial science course(s) offered at your campus. Circle your response for each.**

	Not used at all				Used extensively
Lecture by the instructor – small class size	1	2	3	4	5
Lecture by instructor – larger class size	1	2	3	4	5
Workbook/study guide	1	2	3	4	5
Computer simulations/video tape/CD/DVD	1	2	3	4	5
Textbook readings in content area	1	2	3	4	5
Look at the "big picture" first, then focus on the details. Look at the whole, then the parts.	1	2	3	4	5
Individual help from the instructor	1	2	3	4	5
Cooperative learning in class / Structured in-class time when students work together	1	2	3	4	5
Cooperative quizzes	1	2	3	4	5
Students generating/solving problems grounded in real-life situations	1	2	3	4	5
Problems sessions	1	2	3	4	5
Other. Please list. _____________________ _________________________________	1	2	3	4	5

12. **Considering your response(s) in Item 11 above, which do you think is the *most effective* strategy in preparing the developmental/remedial science student for subsequent science courses? Write your answer in the space below.**

____

13. **From your knowledge of the developmental/remedial science course(s) at your campus, estimate a typical overall percentage of those who begin the course(s) who will complete the course(s) with a passing grade. Use any number between 0 and 100%.**

_____________%

14. **For a typical academic year, estimate the percentage of those who successfully complete the developmental/remedial science course(s) who eventually complete the subsequent science course at your campus with a grade of C or higher. Use any number between 0 and 100%.**

_____________%

15. **What kind of academic credit is awarded for the developmental/remedial science course(s) at your campus? Mark with an X the appropriate response. If multiple courses, please indicate credit for each.**

_______ No formal credit

_______ Institutional credit (course counts as part of the student's course load and appears on the transcript, but hours do not count toward a degree)

_______ Hours may be counted toward an AA or AS degree

_______ Other. Please explain. ____

16. **What grading system is used in the developmental/remedial science course(s) at your campus? Mark with an X the appropriate response. If multiple courses, please indicate grading system for each.**

_______ ABCDF

_______ Pass/Fail

_______ Other. Please explain. ____
____

17. **What was the class size (average if more than one section) of the developmental/remedial science course(s) in the Fall 2006 academic term? Mark with an X the appropriate response.**

_____ Less than 10 _____ 10-19 _____ 20-29 _____ 30-39 _____ 40+

18. **What individuals are primarily responsible for advising/counseling students enrolled in a developmental/remedial science course at your campus? Mark with an X the appropriate response.**

_______ Faculty advisor chosen only on the basis of a student's major/career goals

_______ Faculty who are specifically designated to work with students who are enrolled in developmental/remedial courses

_______ Non-faculty staff advisors/counselors

_______ Other. Please explain. ____

19. Supplemental Instruction (SI) is a national program which focuses on historically-difficult courses, helping students to learn and understand course content, and enhancing thinking skills to help students become independent thinkers.

Is Supplemental Instruction (SI) associated with the:

Developmental/remedial science course(s) taught at your campus?	**Nondevelopmental/nonremedial science courses taught at your campus?**
No ____	No ____
Yes ____	Yes ____

20. **Is Supplemental Instruction similar for the developmental/remedial and nondevelopmental/nonremedial sciences?**

No ____ Yes ____

21. **Are tutoring services available for:**

Developmental/remedial science course(s) taught at your campus?	**Nondevelopmental/nonremedial science courses taught at your campus?**
No ____	No ____
Yes ____	Yes ____

22. **Are tutoring services similar for developmental/remedial and nondevelopmental/nonremedial sciences?**

No ____ Yes ____

23. **How are developmental/remedial science courses organized at your campus? Mark your response with an X.**

_______ Course(s) offered through the academic department

_______ Course(s) offered through a developmental/remedial education department/division

_______ Course(s) offered through a joint effort of academic department and developmental/remedial education department/division

_______ Course(s) offered through a learning center

_______ Other. Please explain. ____
____

24. **If a developmental/remedial science (biology, chemistry, physics/physical science, earth science) course(s) and/or support services are offered at your campus, list the factors that contributed to identifying the need for such courses and support services? Please write your answer in the space below.**

25. **What process is used to assess student progress in the developmental/remedial sciences so students can move on to the "regular" science course in their chosen major? Please write your answer in the space below.**

26. **What system is used to assess the effectiveness of developmental/remedial sciences at your campus? Please write your answer in the space below.**

Information about the person completing the survey

1. **Position/Job Title**: ____

2. **Employment Status**: _______ Full Time _______ Part Time

3. **Credentials**: Mark *all* of your academic credentials with an X.

   _______ AA/AS _______ BA/BS _______ Masters _______ EdD/PhD

4. **Gender**: ______ Male _______ Female

5. **Are you currently an instructor?** _______ No _______ Yes

6. **Indicate the number of years of teaching experience you have**:

   _______ Less than 5 years _______ 16-20 years
   _______ 6-10 years _______ 21-25 years
   _______ 11-15 years _______ 26+ years

7. **Have you ever taught a developmental/remedial education course in *any* field?**

   _____ No _____ Yes → Name the course(s) you taught: ____________________________

8. **Have you ever taught courses in the sciences?**

   _____ No _____ Yes → Name the course(s) you taught: ____________________________

9. **Do you consider yourself a developmental/remedial educator or a science educator?**

   _____ Developmental/remedial educator
   _____ Science educator
   _____ Both
   _____ Other. Please explain.____

There are several documents that would be helpful to this study. Please attach the following as they are available to you:

- Course syllabi for developmental/remedial science courses
- Date action was taken by the governing boards or dates programs/courses were approved (meeting minutes would be fine)
- Goals statements for developmental/remedial sciences
- Brochures or pamphlets used for marketing developmental/remedial science courses and/or support services
- Criteria for course placement
- Assessment procedures

Thank you so much for your time and effort in completing this survey.

Your assistance in providing this information is very much appreciated.

Please return your completed survey, syllabi, etc., in the stamped return envelope provided.

Thanks!

Appendix D

Relationship of Survey Items to Research Questions

Research Question	Survey Item #
To what degree were developmental/remedial sciences offered by selected community colleges in five states located in the central part of the United States?	Survey 1, Items 1, 6, 7, 8, 9
What were the descriptive characteristics of developmental/remedial sciences where offered by the selected community colleges? Descriptive characteristics included the following: a. What were the factors that contributed to identifying the need for developmental/remedial sciences?	Survey 2, Items 1, 2, 4, 24
b. Were developmental/remedial sciences at the selected community colleges offered in the form of a course or an entire program? i. If a course, what kind of academic credit did it carry? ii. What topics were covered? iii. Was a lab associated with the course?	Survey 1, Items 1-2 Survey 2, Item 3 Survey 2, Item 15 Survey 2, Item 5 Survey 2, Item 9
c. How were developmental/remedial sciences organized and delivered? Within academic departments? In a developmental/remedial education department/division? Interdepartmental? Through a learning center?	Survey 2, Item 23
d. What were the goals of developmental/remedial sciences?	Survey 2, Items 7, 8
e. What were the instructional practices that supported those goals?	Survey 1, Item 3 Survey 2, Items 10, 11, 12, 17
f. What advising and support services were available to students in developmental/remedial sciences? i. How were students placed? ii. Was tutoring available? iii. Was Supplemental Instruction available? iv. What individuals were involved with advising/counseling developmental/remedial science students?	Survey 1, Item 1 Survey 2, Item 6 Survey 2, Items 21, 22 Survey 2, Item 19 Survey 2, Item 18
g. How was student progress assessed in the developmental/remedial sciences so that students could move on?	Survey 2, Items 16, 25
h. How was the effectiveness of developmental/remedial sciences assessed?	Survey 2, Items 13, 14, 26
Was there commonality among developmental/remedial sciences to develop a set of guidelines for community college administrators and instructors to use in determining if they should implement developmental/remedial sciences? What were the stages and process for implementing a developmental/remedial sciences program?	

Appendix E

Survey 1 – Cover Letter and Follow-Up Letters

First Contact, Prenotice Letter

November 13, 2006

<FIRST NAME> <LAST NAME>
<COLLEGE>
<ADRESS>
<CITY>, <STATE> <ZIP>

A few days from now you will receive in the mail a request to fill out a brief survey to determine which community colleges in a five state area offer developmental or remedial science courses or programs. You were selected to participate in this study because you are the Chief Academic Officer (or have a similar position) at your campus and your campus was a member of the American Association of Community Colleges in 2005. If developmental/remedial sciences are offered on your campus, I ask your assistance in identifying the individual on your campus who has administrative/leadership responsibility for such courses and services. Completing the survey will take approximately 10 minutes.

I am writing in advance because many people like to know ahead of time that they will be contacted. This study is important as it will help community college science educators, developmental/remedial educators, and administrators share and identify practices and experiences with developmental/remedial science courses and support services. The second purpose is to develop a set of guidelines for community colleges to use in determining if they should implement developmental/remedial sciences.

Thank you for your time and consideration. It should take about 10 minutes to complete the survey. This study is being conducted as part of my PhD research at the University of Nebraska-Lincoln (IRB approval #2006-09-016EP). It is only with the help of Chief Academic Officers like you that such a research study can be successful.

Sincerely,

Tricia Paramore
Co-Chair, Natural Science and Mathematics Department
Hutchinson Community College and Area Vocational School
1300 N. Plum
Hutchinson, Kansas 67501
1.800.289.3501, x3438
Fax: 620.665.3310
paramoret@hutchcc.edu

Second Contact, Cover Letter with Sample Letter of Commitment and Description of Study

November 15, 2006

<FIRST NAME> <LAST NAME>
<COLLEGE>
<ADDRESS>
<CITY>, <STATE> <ZIP>

I am writing to ask your assistance in completing a survey that will be used in my doctoral dissertation, "Developmental/Remedial Sciences at Community Colleges in Five States in the Central Part of the United States" (IRB approval #2006-09-016EP). The information on this survey will be used to contact leaders on your campus who may be able to answer more in-depth questions about developmental/remedial sciences offered at your campus.

The definition for "developmental sciences" is:

- courses offered for developmental/remedial students in biology, chemistry, physics/physical science or earth sciences or related fields, and/or
- supplemental support services such as academic advising, tutoring, and Supplemental Instruction.

In addition to completing this survey, this letter is requesting permission from you and your institution to participate in an in depth survey and case study interview. A detailed description of the study, the in depth survey, and the interview protocol are enclosed for your review. The data from this survey will be summarized and presented in an aggregate form such that no individual answers can be identified. Neither names of individuals nor institutions will be used in the final write up of the research. The results of this study may be published in professional journals or presented at professional meetings, but, again, results will only be presented in the aggregate.

If your institution is willing to participate in these phases of the study, I am requesting a short letter of commitment. A sample letter is attached. Please make the appropriate changes to the sample letter of commitment, print on your institution's letterhead, and return to me by mail (with the completed first survey) or fax at 620.665.3310. Feel free to add to the text of the statement if you wish.

Upon receipt of your letter of commitment, I will mail copies of the in depth survey to the individual you identified on your completed first survey. I will also send to you a copy of the University of Nebraska's Institutional Review Board Approval letter.

You have the right to not participate in this survey without losing any benefits to which you are entitled from the University of Nebraska-Lincoln, the researcher, or your institution. Return of the survey implies consent to use your responses, however the data will be summarized and presented in an aggregate form such that no individual answers can be identified. The results of this study may be published in professional journals or presented at professional meetings, but, again, results will only be presented in the aggregate.

If you have further questions about completing the survey or the research before or after completing the survey, please contact me toll free at 800.289.3501, x3438 or paramoret@hutchcc.edu . Or, you may call my doctoral advisor, Professor Alan Seagren, at 402.472.0972 or aseagren1@unl.edu . If you have questions about your rights as a research participant, please call the University of Nebraska-Lincoln's Institutional Review Board at 402.472.6965.

Thank you for your willingness to participate in this research study. After you complete this survey and the letter of commitment, please place in the stamped return mail envelope and mail it by **November 30**.

Again, thank you so much for helping me with this important study.

Sincerely,

Tricia Paramore, Primary Investigator
Co-Chair, Natural Science and Mathematics Department
Hutchinson Community College and Area Vocational School
Hutchinson, KS 67501

Dr. Alan Seagren, Secondary Investigator
Professor of Educational Administration
University of Nebraska-Lincoln
Lincoln, NE 68588

SAMPLE LETTER OF COMMITMENT

Please put on your college's letterhead stationery.

Date

Tricia Paramore
Hutchinson Community College
1300 N. Plum
Hutchinson, KS 67501

Dear Ms. Paramore:

Please write something like: "This letter is to confirm my community college's commitment to allowing our campus leaders in developmental/remedial sciences to participate in your survey. Feel free to send the survey at this time.

This also confirms commitment to participate in an interview should our institution be selected to participate in a case study based on the criteria communicated in your letter. Please contact me if my institution is selected to participate in the case study. The person I am recommending you survey and interview is:

Name and Title/Position:______________________________
Campus Name:______________________________
Email:______________________________
Phone Number:______________ Fax Number:______________
Mailing address:______________________________

Please contact this member of our campus community for an interview after informing me of our selection to participate in the case study."

Sincerely,

Your signature
Your typed name

<u>Description of the Study</u>: ***Developmental/Remedial Sciences at Community Colleges in Five States in the Central Part of the United States***

The dissertation involves four phases, the first being this survey asking if science courses or student support services are offered in a developmental/remedial education context on your campus and asking you to identify individuals at your campus who have administrative/leadership responsibilities for developmental/remedial science education. The second phase is a second, more in-depth survey sent to the leaders identified from the first survey in order to learn more about the offerings at your campus. The third phase of the study will be a case study of several community colleges that offer developmental/remedial courses and services in the sciences.

Criteria to be used in selecting case study institutions will be geared toward reflecting a variety of developmental/remedial sciences offerings in the sample of institutions. These criteria include:

- Comprehensiveness of the developmental/remedial sciences (course(s) versus comprehensive program of developmental/remedial courses/tutoring/advising/counseling)
- Integrated skills and content versus separate courses for skills and content
- Structure of developmental/remedial sciences (delivered within academic departments, in a developmental/remedial education department/division or through a learning center).

Should your institution be selected as a case study institution based on these criteria, I would like to personally visit your campus, tour your facilities, and interview your developmental/remedial sciences administrator/leader face-to-face. If a campus visit is not possible, a phone interview would be fine. You will be notified if your institution is selected. The interview should take no longer than one hour. Please keep in mind that the names of all study participants and names of community colleges will be kept confidential. Institutions will only be referred to as ‘Community College A,’ ‘Community College L,’ etc.

Information from the case studies will be used to further describe developmental/remedial science offerings at community colleges in a five state area and to develop guidelines for faculty and administrators at other community colleges considering the implementation of developmental/remedial sciences.

<u>Third Contact, Thank You/Postcard Reminder</u>

Front of postcard

Thank

You!

Back of postcard

November 27, 2006

About two weeks ago you received a survey asking about developmental/remedial science courses and student support services offered at your campus. My sincere thanks to those of you who have already completed and returned the survey!

If you have not completed the survey, please do so today! Your response is important for this study. It is through feedback from community college leaders such as yourself that I will be able to describe the characteristics of community college developmental/remedial science courses and support services.

If you did not receive the survey or if you have misplaced it, please contact me at paramoret@hutchcc.edu or 1.800.289.3501, ext. 3438. I will send another survey to you today.

Thanks for your help with this important study. I appreciate your time.

Sincerely,

Tricia Paramore
Co-Chair, Natural Science and Math Department
Hutchinson Community College and Area Vocational School
Hutchinson, KS 67501

Fourth Contact, Reminder Letter with Replacement Survey

December 4, 2006

<FIRST NAME> <LAST NAME>
<COLLEGE>
<ADRESS>
<CITY>, <STATE> <ZIP>

At the beginning of November you received a survey asking you about developmental/remedial science courses and student support services offered at your campus (IRB approval #2006-09-016EP). As a community college academic administrator, your feedback is important to the outcome of this dissertation study as the study seeks to identify community colleges offering developmental/remedial science courses, programs, and support services. To the best of my knowledge, you have not yet returned your survey.

Feedback from other academic administrators in a five state area who have completed and returned the survey has been very helpful. Some offer developmental/remedial sciences, others don't, and some are considering such an option. All of this information will be useful to this study as the goal is to identify community colleges that offer developmental/remedial sciences, determine the characteristics of those courses, programs, and services, and then to develop guidelines for institutions considering implementation of developmental/remedial sciences.

As a community college administrator, you understand the importance of accuracy of data. I am writing again to ask you to complete the survey because your input is very important in helping to achieve the most accurate results. Although surveys were sent to a large number of community colleges, it is only by hearing from everyone in the sample that the results will be truly representative.

Several people have called to inform me that they are no longer in an administrative role at their campuses; others have let me know they are not the best person to answer the questions on the survey. If either of these situations applies to you or if you feel you have been contacted in error, please let me know by calling 1.800.289.3501, ext. 3438, or by emailing paramoret@hutchcc.edu and your name will be removed from the mailing list. I am happy to answer any questions about the study.

As a reminder, your answers to this short survey will be kept confidential. Only a random code will be used to identify your completed survey when it is returned. While the survey is voluntary, I hope you can help me with my dissertation study by taking a few minutes to fill out the survey, letting me know if you offer developmental/remedial science courses and/or support services on your campus and the name of a contact person who has administrative/leadership responsibilities for those offerings who might be able to answer more in-depth questions about those offerings.

A stamped return envelope has been provided for your convenience in returning the completed survey. It should take a maximum of 10 minutes to complete. If you choose not to participate, please return the blank survey in the enclosed prepaid envelope.

Thank you very much for helping with this important study.

Sincerely,
Tricia Paramore
Co-Chair, Natural Science & Math Department
Hutchinson Community College & Area Vocational School
1300 N. Plum
Hutchinson, KS 67501
1.800.289.3501, ext. 3438
Fax: 620.665.3310
paramoret@hutchcc.edu

Fifth/Final Contact for Survey 1, Phone Script

Phone script for non-respondents December 11-18, 2006:

Hello, I'm calling for____________________. My name is Tricia Paramore and I'm calling from Hutchinson Community College. Over the past several weeks you have received a number of mailings about a study to identify community colleges in a five state area that offer developmental/remedial science courses, programs, and/or support services to students.

I'm preparing for the second phase of the study, so I'm making final contacts with anyone who has not yet responded. In order for the results to be accurate, I need to include as many institutions as possible regarding the developmental/remedial science offerings on their campuses.

I want to stress that all responses are confidential and that participation in the study is voluntary. We would really appreciate your help in completing the survey.

Q: Do you still have the survey?

Q: Would you like me to send you another one?

Q: I can email it to you or send it through the mail. Or I could read the questions to you now and you could just complete it over the phone – it takes less than 10 minutes. Which would you prefer?

Q: Do you have any questions?

Thanks so much for your help with this important study!

Appendix F

Survey 2 – Cover Letter and Follow-Up Letters

First Contact, Cover Letter

December 18, 2006

<FIRST NAME> <LAST NAME>
<COLLEGE>
<ADRESS>
<CITY>, <STATE> <ZIP>

I am writing to ask your help by completing a survey that will be used in my doctoral dissertation (IRB approval #2006-09-016EP). The dissertation, "Developmental/Remedial Sciences at Community Colleges in Five States in the Central Part of the United States" will involve four phases, the first phase was a survey that went to community college Chief Academic Officers asking if developmental/remedial science courses or student support services were offered on your campus and asking them to identify individuals at your campus who had administrative/leadership responsibility for developmental/remedial sciences. The second phase is the in-depth survey enclosed in this mailing, sent to the leaders identified from the first survey in order to learn more about the offerings at your campus. The third phase of the study will be a case study of several community colleges that offer developmental/remedial courses and services in the sciences.

You were selected to participate in this phase of the study because you were identified as the leader on your campus who is closely associated with developmental/remedial sciences and who will be able to answer more in-depth questions regarding developmental/remedial sciences on your campus. Completing the survey takes approximately 30 minutes.

The definition for "developmental sciences" is:

- courses offered for developmental/remedial students in biology, chemistry, physics/physical science or earth sciences or related fields, and/or
- supplemental support services such as academic advising, tutoring, and Supplemental Instruction.

The information on this survey will be used to determine the characteristics of developmental/remedial sciences at community college campuses in a five state area. The code that appears in the upper right corner of the survey will be used to identify which institutions have completed the survey. Your name and the name of your institution will be kept confidential. Neither names of individuals nor institutions will be used in the final write up of the research.

You have the right to not participate in this survey without losing any benefits to which you are entitled from the University of Nebraska-Lincoln, the researcher, or your institution. Return of the survey implies consent to use your responses, however the data will be summarized and presented in an aggregate form such that no individual answers can be identified. The results of this study may be published in professional journals or presented at professional meetings, but, again, results will only be presented in the aggregate.

If you have further questions about completing the survey or the research before or after completing the survey, please contact me toll free at 1.800.289.3501, x3438 or paramoret@hutchcc.edu . Or, you may call my doctoral advisor, Professor Alan Seagren, at 402.472.0972 or aseagren1@unl.edu . If you have questions about your rights as a research participant, please call the University of Nebraska-Lincoln's Institutional Review Board at 402.472.6965.

Thank you for your willingness to participate in this research study. After you complete this survey, please place it in the stamped return mail envelope and mail it by **January 3**.

Again, thank you so much for helping me with this important study.

Sincerely,

Tricia Paramore, Primary Investigator
Co-Chair, Natural Science and Mathematics Department
Hutchinson Community College & Area Vocational School
Hutchinson, KS 67501

Dr. Alan Seagren, Secondary Investigator
Professor of Educational Administration
University of Nebraska-Lincoln
Lincoln, NE 68588

Second Contact, Thank You/Postcard Reminder

Front of postcard

Thank You!

Back of postcard

January 1, 2007

About a week ago you received a survey asking about developmental/remedial science courses and student support services offered at your campus.

My sincere thanks to those of you who have already completed and returned the survey! If you have not completed the survey, please do so today! Your response is important for this study. It is through feedback from community college leaders such as yourself that I will be able to describe the characteristics of community college developmental/remedial science courses and support services.

If you did not receive the survey or if you have misplaced it, please contact me at paramoret@hutchcc.edu or 1.800.289.3501, ext. 3438. I will send another survey to you today.

Thanks for your help with this important study. I appreciate your time.

Sincerely,

Tricia Paramore
Co-Chair, Natural Science and Math Department
Hutchinson Community College and Area Vocational School
Hutchinson, KS 67501

Third Contact, Reminder Letter with Replacement Survey

January 5, 2007

<FIRST NAME> <LAST NAME>
<COLLEGE>
<ADRESS>
<CITY>, <STATE> <ZIP>

In December you received a survey asking you about developmental/remedial science courses and student support services at your campus (IRB approval #2006-09-016EP). As a leader in these areas at your campus, your feedback is important to the outcome of this dissertation study as the study seeks to describe community college developmental/remedial science courses, programs, and support services. To the best of my knowledge, you have not yet returned your completed survey.

Feedback from other community college leaders in developmental/remedial sciences who have completed and returned the survey has been very helpful. Some offer developmental/remedial science courses in one discipline, others offer courses in multiple science disciplines, and still others offer only support services. All of this information will be useful to this study as the goal is to determine the characteristics of developmental/remedial sciences courses, programs, and services.

As a leader in this area on your campus, you understand the importance of accuracy of data. I am writing again to ask you to complete the survey because your input is very important in helping to achieve the most accurate results. Although surveys were sent to a number of community colleges in a five state area, it is only by hearing from all institutions in the sample that the results will be truly representative.

Several people have called to inform me that they are not the best person to answer the questions on the survey and have provided names of others who would be more helpful. If this situation applies to you or if you feel you have been contacted in error, please let me know by calling 1.800.289.3501, ext. 3438, or by emailing paramoret@hutchcc.edu and your name will be removed from the mailing list. I am happy to answer any questions about the study.

As a reminder, your answers to this survey will be kept confidential. Neither your name nor your institution's name will be used in the final write up of the research. While the survey is voluntary, I hope you can help me with my dissertation study by taking a few minutes to fill out the survey, describing the developmental/remedial sciences courses and/or support services on your campus. A stamped return envelope has been provided for your convenience in returning the completed survey. It should take 30 minutes to complete. If you choose not to participate, please return the blank survey in the enclosed prepaid envelope today.

Thank you very much for helping with this important study.

Sincerely,

Tricia Paramore
Co-Chair, Natural Science and Mathematics Department
Hutchinson Community College
1300 N. Plum
Hutchinson, KS 67501
1.800.289.3501, ext. 3438
Fax: 620.665.3310
paramoret@hutchcc.edu

Fourth/Final Contact for Survey 2, Phone Script

Phone script for non-respondents January 15-19, 2007:

Hello, I'm calling for____________________. My name is Tricia Paramore and I'm calling from Hutchinson Community College. Over the past several weeks you have received a number of mailings about a study to describe developmental/remedial science courses and support services offered at community colleges.

I'm preparing for the next phase of the study, so I'm making final contacts with anyone who has not yet responded. In order for the results to be accurate, I need to hear from as many institutions as possible regarding the developmental/remedial science offerings on their campuses.

I want to stress that all responses are confidential and that participation in the study is voluntary. I would really appreciate your help in completing the survey.

Q: Do you still have the survey?

Q: Would you like me to send you another one?

Q: I can email it to you or send it through the mail. Or I could read the questions to you now and you could just complete it over the phone – it take around 30 minutes. Which would you prefer?

Q: Do you have any questions?

Thanks so much for your help with this important study!

Appendix G

Panel of Experts

Name	Position/Title	Institutional Affiliation	Experience
Dr. Randy Moore	Professor	University of Minnesota	University developmental science educator who has written much of the literature involving developmental sciences
Dr. Linda Crow	Professor of Biology, Chair – Biology Dept.	Montgomery College	Career-long college biology educator (over 30 years experience); Currently teaching at a community college, but has taught at four-year and research universities
Dr. Ronald Bonnstetter	Professor, Teacher Learning and Teacher Education	University of Nebraska-Lincoln	University science education educator who also has seven years experience teaching a variety of science courses and disciplines at the community college level

Appendix H

Interview Protocol

Developmental/Remedial Sciences at Community Colleges in Five States in the Central Part of the United States

Name____ Date______________________________

Title____________________________________ Location of Interview________________________

Community College ____

Time of interview: Start______________________________ End______________________________

Interviewer____

Introduction

I want to say thank you for taking the time to talk to me today. With your approval, I will be audiotape recording and then transcribing what we say today. Next week I will be asking you to review the transcription which may include thoughts from some of the notes I make regarding my interpretations of what you say. It is important that I accurately reflect your perceptions in my writing, so please review the transcript carefully. The transcription will be verbatim, so be prepared to see any “uhs” or “ahs” that are spoken (these will not be reflected in the final written paper).

This is one phase of a dissertation study that previously involved two surveys. The first survey went to Chief Academic Officers (CAOs) of community colleges in a five state area in the central part of the U.S. in order to identify any community college campuses that offer courses, programs, or support services in developmental/remedial sciences. In that survey, if a campus had such offerings, the CAO was asked to identify individuals with administrative/leadership responsibilities for developmental/remedial sciences offered such that those individuals could be contacted for further information about the developmental/remedial sciences on their campuses. The second, more in-depth survey was sent to the people identified in the first survey and allowed those individuals to describe the characteristics of the developmental/remedial sciences. From the respondents to that survey, three community colleges were selected to participate in the case study component of this research.

In *this* part of the study, I am interested in finding out more about your campus, the developmental/remedial sciences offered here, the structure of the course(s)/program, and the process used to put the course(s)/program in place. Ultimately I plan to develop guidelines for other community colleges to follow when considering implementation of developmental/remedial sciences on their campuses.

You’ve had a chance to review the questions I am going to ask you today and give them some thought. Some of the questions today will simply expand upon the questions you answered in the survey. I am interested to hear your perspective on this topic, so please feel free to openly discuss your views. I may ask you some additional questions as we go along in order for me to clarify what you’re saying. Please keep in mind that your responses will remain confidential and your name will not be used in the study. Are you ready to start?

Question	Descriptive Notes	Reflective Notes
1. Describe your campus. -Size? -Location? -Unique characteristics?		
2. Describe your experience/involvement with developmental/remedial sciences. -Teach courses? -Organize support services? -Provide support services? -Administrator? [expanding on demographic questions from survey]		

3. How long have developmental/remedial sciences been offered at your campus? [expanding on survey item 4]		
4. What types of developmental/remedial sciences are offered at your campus? -Courses? What disciplines? -Support services? -Programs? [expanding on survey items 3, 18-22]		
5. Describe the factors that helped in identifying the need for developmental/remedial sciences at your campus. -Provide some background / history -Student preparation? -Particular student weaknesses? [expanding on survey items 1-2, 24]		

6. How are the developmental/remedial sciences organized at your campus? -Academic departments? -Developmental ed dept.? -Interdepartmental? -Learning center? -Other? -Course/Program? -Credit? [expanding on survey items 15, 23]		
7. Describe the process used in developing the course/program/support services. -How it started? -Steps followed? -People/positions involved?		
8. Was governing board approval needed?		

9. What are the goals of developmental/remedial sciences at your campus? -Artifacts needed? -Written goals statements? -Syllabi? -Brochures, etc., describing dev/rem sciences? -Meeting minutes? -Other? [expanding on survey items 7-8]		
10. If courses in developmental/remedial sciences are offered at your campus, what instructional practices are utilized? -Cooperative learning? -Labs? -Integration of content with academic skills? -Other? -Class size? [expanding on survey items 10-12, 17; if courses in multiple disciplines, repeat questions for each discipline/course]		
11. What topics are covered? -Syllabi? -Differences from "regular" courses? [expanding on survey item 5]		

12. Are the instructors teaching developmental/remedial sciences trained to teach such classes? -If so, how? -In developmental/remedial? -In sciences only? -In both?		
13. Are students placed into developmental/remedial science courses? -What instruments are used for determining placement? -Is placement mandatory or optional? [expanding on survey item 6]		
14. How do developmental/remedial science courses fit into the overall curriculum? -Prerequisite(s)? -For what courses?		
15. How is student progress assessed such that students can move on to the next course in their curriculum? -Assessment consistent from one course to another? -Grading system? [expanding on survey items 16, 25]		

16. What is your method of course/program assessment?		
17. Describe the support services offered. -Advising/counseling --Who advises dev/rem science students? -Supplemental Instruction --Available for dev/rem sciences? --For regular science courses? --Differences? -Tutoring --Available for dev/rem sciences? --For regular science courses? --Differences? [expanding on survey items 18-22]		

18. What method is used to assess the effectiveness of support services?		
19. Describe how the course/program/support services are implemented. -Follow any particular model of developmental/remedial sciences? -Since implementation of course/program/services, have there been changes? -Describe the changes. What worked? What didn't? -What were those changes based on? -Lessons learned?		
20. Any guidelines/steps you would recommend for other institutions to use when considering developmental/remedial sciences? -Needs assessment? -Development? -Implementation?		
21. How have developmental/remedial sciences specifically impacted your college?		

22. What do you see as the best thing about your current program?		
23. What do you see in the future of your program? -Growth/expansion? -Lesser need?		
24. Are there topics we should explore that I haven't asked about?		

Closing Notes

If possible, I would like to have a copy of syllabi for any developmental/remedial science courses, goals statements, copies of formal policies, meeting minutes applicable to the development and implementation stages, brochures/pamphlets, placement criteria, assessment procedures, etc. – anything that might be helpful in accurately and thoroughly portraying what is done at this campus.

I appreciate you taking the time and effort to complete this interview today. I assure you that neither your name nor your institution's name will be associated with the comments made today. I will be contacting you within one week to look over the transcribed notes. If you have any questions, or think of any additional comments you'd like to include, please contact me at 1.800.289.3501, ext. 3438, or at paramoret@hutchcc.edu .

THANK YOU!

Appendix I

Interview Codes and Categories

Interview Question	Code	Categories
4	Separate entities	Courses and support services are separate, not a program
5	Nursing limits	Maximum number of hours for nursing program, determined by accrediting body
	Nursing	Student preparation for nursing program
	Prep studs.	Prepare students
	Fac	Faculty involved in identifying need
	Curr Δ	Curriculum changes in nursing
12	MS/HS	Former middle school/high school teacher
	Experience	Overall teaching experience and background
	Content	Trained in science content
	Opps	Opportunities for other training
	Attitude	Instructor has attitude of student success
14	Prereq	Prerequisite
	Rec'd prereq	Recommended prerequisite
16	Course assess	Assessment of courses
18	Support assess	Assessment of support services
	Tutoring	Tutoring
	Advising	Advising
	None	No assessment
	Survey	Surveys used for assessment
	Ret	Retention study used for assessment
	Grade	Grade study used for assessment
	How respond	Response to assessment
19	ID need	Identify need for developmental/remedial science courses or support services
	Dev course	Develop developmental/remedial courses or support services
	Schedule & staff	Schedule and staff developmental/remedial courses or support services
	Assessment	Assess developmental/remedial courses or support services
	Δ	Change
20	Reading refs	Readings/books referenced
	Comms	Communication and collaboration between department and support services
	Focus	Focus on specific need
	Observe	Observe student performance
	Space & staff	Facilities space and staffing issues
21	↑ enrollment	Increase enrollment
	↑ stud. success	Increase student success
	↑ retention	Increase student retention
	↑ access	Increase access in rural areas
	Helps nursing	Aids the nursing program

Interview Question	Code	Categories
22	Fac driven	Driven by faculty
	Sensitivity	Sensitivity to students who need developmental/remedial courses
	Trust/comms	Trust and communication between departments and academic support
	It's there	Have a starting point
23	No less need	No lesser need for developmental/remedial sciences expected in the future
	Build program	Build a developmental/remedial education program
	Dev LCs	Develop learning communities
	Advising system	Advising system to better identify student needs
24	Shortage	Shortage of math/science teachers
	Wrong people	Putting wrong teachers in classrooms
	Training	Provide teacher training

Appendix J

External Audit Attestation

Dr. Kenneth Gaeddert

External Audit Attestation

By Ken Gaeddert, Ph.D.
Hutchinson Community College Instructor

This is a report of the external audit I performed on Tricia Paramore's dissertation, *Developmental/Remedial Sciences at Community College in Five States in the Central Part of the United States*. Tricia is a doctoral candidate in Educational Administration at the University of Nebraska-Lincoln.

At the first meeting, Tricia outlined her project in detail and showed me the documents she used for gathering her data. I was then given her entire set of documents which included:

Survey I results
Survey II results
Interviewee-validated transcripts of all of her interviews

Additionally, I was given a copy of her dissertation.

My approach to performing this audit took the following steps:

1. Thorough read-through of the dissertation.
2. Identify the sections in the dissertation requiring validation. For the semi-quantitative data, this included all tables, any text references to tables, and text containing data and analyses. For the qualitative data, this included any statements referencing one or more of the interviewees.
3. For semi-quantitative data:
    a. Compile Survey II results by reading through each institution's survey. Repeat all of the calculations Tricia performed and were presented in the dissertation.
    b. Compare my tabulations and calculations with what appeared in the tables in the dissertation and note "suspected" discrepancies next to each table.
    c. Review each table for proper use of tabulated data. This included asking the questions: 1) Is the text for a column heading an accurate reflection of the survey question?; 2) Does the way she presents the data or calculations lead the reader or misrepresent the survey question? Make comments in the dissertation.
    d. Look for any errors or misrepresentation of data and/or calculations in the text, and note "suspected errors" in the dissertation.
    e. Give Tricia the dissertation for her to read my comments and formulate a response. And then meet with Tricia to discuss each item.
    f. For each item, either she will make the change or I will be satisfied with her explanation.
4. For qualitative data:
    a. Thoroughly read-through each interviewee-validated transcript.
    b. Compare quotations and paraphrases in the dissertation with the transcripts. Note any "suspected" discrepancies in the dissertation.

c. Give Tricia the dissertation for her to read my comments and formulate a response. And then meet with Tricia to discuss each item.
d. For each item, either she will make the change or I will be satisfied with her explanation.

After completing the above steps to the best of my ability, I conclude that Tricia Paramore's dissertation, *Developmental/Remedial Sciences at Community College in Five States in the Central Part of the United States*, is an accurate portrayal and fair treatment of the data she collected in her surveys and interviews. All concerns I had about either the semi-quantitative data or qualitative data reported in her dissertation were satisfactorily remedied. Moreover, I want to commend Tricia Paramore for an exceptionally transparent presentation of her survey results. (This makes the job of an auditor much easier, and actually ensures that mistakes are discovered so they can be corrected.)

Attested to by Ken Gaeddert on March 30, 2007.

Ken Gaeddert

Ken Gaeddert, Ph.D.
Instructor in the Department of Natural Sciences and Mathematics
Hutchinson Community College

Appendix K

End of Term Supplemental Instruction Survey

End-of-Term
Supplemental Instruction Survey

(This information is for research purposes only, and will in no way influence your final grade.)

Course Name: ______________________________

Your Name: ______________________________

Term: ______________________________

Please fill out only the side of this questionnaire that applies to you.

If you attended even one SI session, please fill out this side.

1. How helpful were the sessions to you?
   ☐1 ☐2 ☐3 ☐4 ☐5
   not helpful — very helpful

2. What grade do you expect to make in this course?
   ☐A ☐B ☐C ☐D ☐F

3. How many sessions did you attend?
   ☐1-2 ☐3-5 ☐5-10 ☐more than 10

4. If you have any comments on the sessions and/or suggestions for improving future sessions we would appreciate having them. Use the back of the page if needed.

5. If you are interested in becoming an SI leader for this or other courses please provide us with the following information:

Name ______________________________

Address ______________________________

____

Phone ______________________________

Course(s) ______________________________

____

If you did not attend any SI sessions, please fill out this side.

1. Please indicate the reason(s) you didn't attend any sessions.

☐ I wanted to but couldn't. The session schedule conflicted with work or other classes.

☐ I didn't feel it was necessary.

☐ I have been to similar kinds of study sessions for other courses and did not find them helpful.

☐ I have been to SI sessions for other courses and did not find them helpful.

☐ I intended to, but couldn't find the time.

☐Other. Please explain, using the back of the page if needed.

2. What grade do you expect to make in this course?
   ☐A ☐B ☐C ☐D ☐F

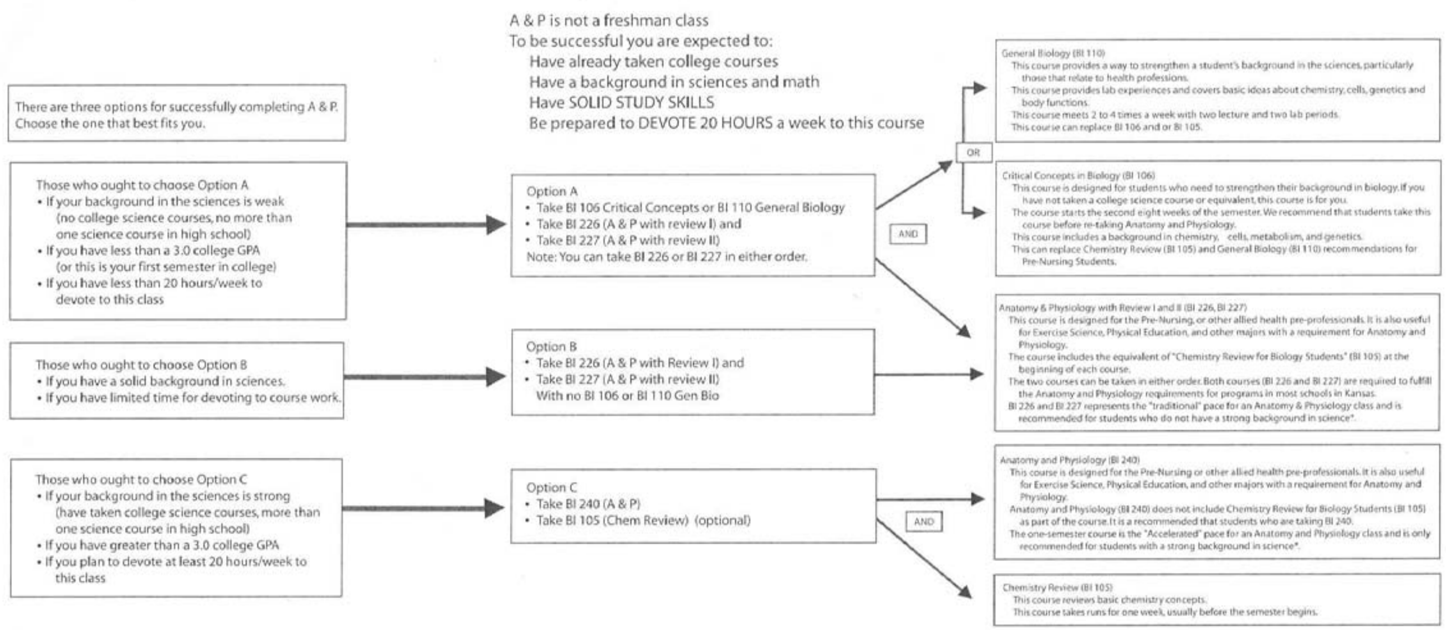
3. Did you fill out the time schedule questionnaire for SI sessions at the beginning of the term?
   ☐Yes ☐No ☐Can't remember

Source: The Center for Academic Development (2006). The leader's guide to Supplemental Instruction: Peer assisted study sessions. Kansas City, MO: The Curators of the University of Missouri. Used with permission from F. Kim Wilcox, National SI Training Coordinator, University of Missouri-Kansas City.

Appendix L

Advising Flow Chart Example from Institution II

So you plan to take Anatomy & Physiology



Appendix M

Informed Consent Form

Nebraska UNIVERSITY OF Lincoln

IRB#2006-09-016 EP
Date Approved: 10/06/06
Valid Until: 10/05/07

COLLEGE OF EDUCATION AND HUMAN SCIENCES
Department of Educational Administration

INFORMED CONSENT FORM

***Identification of Project*:** Dissertation

***Project Title*:** Developmental/Remedial Sciences at Community Colleges in Five States in the Central Part of the United States

***Purpose of the Research*:** This research study examines science courses, programs, and support services offered in a developmental/remedial education context at community colleges in five states in the central part of the U.S. The purposes of the study are to identify how widespread are developmental/remedial sciences and the characteristics of developmental/remedial sciences where offered. Guidelines will be developed for faculty and administrators considering implementation of developmental/remedial sciences on their campuses.

***Procedures*:** You were identified for participation in this study because you have administrative/leadership responsibilities for developmental/remedial sciences on your campus. Participation in the study will require a personal interview taking approximately one hour of your time. You will be asked questions about developmental/remedial science offerings (courses, programs and/or support services) at your campus. The interview will be audio taped with your consent at a quiet place, convenient for you to use, or over the phone if necessary. Documents such as course syllabi, brochures, policy and goals statements for developmental/remedial sciences, and dates of committee/governing board approval of developmental/remedial science courses/programs may be requested.

***Risks*:** As confidentiality will be maintained, there are no known risks involved with this research.

***Benefits*:** The data from this research will be used to develop guidelines for use at community colleges when considering the implementation of developmental/remedial sciences. There are no direct personal benefits to participating in this study.

***Confidentiality*:** Any information obtained during this study which could identify you will be kept strictly confidential. The data will be stored in a locked cabinet in the principal investigator's office and will only be seen by the investigator during the study and for three years after the study is complete. The information obtained in this study may be published in professional journals or presented at professional meetings but the data will be reported as aggregated data. The audio tapes will be erased after transcription. Institution names will be reported by letter designation, such as 'Community College L,' etc.

***Compensation*:** There is no compensation for participation in this study.

***Opportunity to Ask Questions*:** You may ask any questions concerning this research study prior to agreeing to participate or at any time during the research process. You may call the principal investigator, Tricia Paramore, at any time, office phone 1.800.289.3501, ext. 3438, or after hours at 620.662.4986. Or you may call the secondary investigator, Dr. Alan Seagren 402.472.0972. If you have questions concerning your rights as a research participant that have not been answered by the investigators, you may contact the University of Nebraska-Lincoln Institutional Review Board, telephone 402.472.6965.

IRB#2006-09-016 EP
Date Approved: 10/06/06
Valid Until: 10/05/07

***Freedom to Withdraw*:** You are free to decide not to participate in this study or to withdraw at any time without adversely affecting your relationship with the investigators, the University of Nebraska-Lincoln, or your institution. Your decision will not result in any loss of benefits to which you are otherwise entitled.

***Consent, Right to Receive a Copy*:** You are voluntarily deciding whether or not to participate in this research study. Your signature will indicate that you have decided to participate and that you have read and understood the information presented to you. You will be given a copy of this consent form to keep.

_____ Check if you agree to be audio taped for your interview.

***Signature of Participant*:**

______________________________________ ________________
Signature of Research Participant Date Signed

***Name and Phone number of investigators*:**

Tricia Paramore, Principal Investigator Office: 620.665.3438 paramoret@hutchcc.edu
Dr. Alan Seagren, Secondary Investigator Office: 402.472.0972 aseagren1@unl.edu

Appendix N

IRB Approval Letters

Nebraska UNIVERSITY OF Lincoln

October 6, 2006

HUMAN RESEARCH PROTECTIONS
Institutional Review Board

Tricia Paramore
Dr. Alan Seagren
3 East 37th Avenue
Hutchinson KS
67502

IRB # 2006-09-016 EP

TITLE OF PROJECT: **Developmental\/Remedial Sciences at Community Colleges in Five States in the Central Part of the United States**

Dear Tricia:

This letter is to officially notify you of the approval of your project by the Institutional Review Board (IRB) for the Protection of Human Subjects. It is the Board's opinion that you have provided adequate safeguards for the rights and welfare of the participants in this study. Your proposal seems to be in compliance with this institution's Federal Wide Assurance 00002258 and the DHHS Regulations for the Protection of Human Subjects (45 CFR 46).

Date of EP Review: **09/28/06.**

You are authorized to implement this study as of the Date of Final Approval: **10/06/06.** This approval is Valid Until: **10/05/07.**

1. Enclosed is the IRB approved Consent form for this project. Please use this form when making copies to distribute to your participants. If it is necessary to create a new informed consent form, please send us your original so that we may approve and stamp it before it is distributed to participants.
2. When you begin receiving the institutional letters, please submit them and you will receive approval on a site-by-site basis for the second survey.
3. Please include the IRB approval number on the 1st, 2nd and 4th contact letters for survey 1. This should also be included on the 1st and 3rd contact for Survey 2. Please submit one copy of each letter, with the IRB number included, for our files.

We wish to remind you that the principal investigator is responsible for reporting to this Board any of the following events within 48 hours of the event:

- Any serious event (including on-site and off-site adverse events, injuries, side effects, deaths, or other problems) which in the opinion of the local investigator was unanticipated, involved risk to subjects or others, and was possibly related to the research procedures;
- Any serious accidental or unintentional change to the IRB-approved protocol that involves risk or has the potential to recur;
- Any publication in the literature, safety monitoring report, interim result or other finding that indicates an unexpected change to the risk/benefit ratio of the research;
- Any breach in confidentiality or compromise in data privacy related to the subject or others; or
- Any complaint of a subject that indicates an unanticipated risk or that cannot be resolved by the research staff.

For projects which continue beyond one year from the starting date, the IRB will request continuing review and update of the research project. Your study will be due for continuing review as indicated above. The investigator must also advise the Board when this study is finished or discontinued by completing the enclosed Protocol Final Report form and returning it to the Institutional Review Board.

If you have any questions, please contact Shirley Horstman, IRB Administrator, at 472-9417 or email shorstman1@unl.edu.

Sincerely,

Dan R. Hoyt, Chair
for the IRB

Shirley Horstman
IRB Administrator

209 Alexander Building West / 312 N. 14th Street / P.O. Box 880408 / Lincoln, NE 68588-0408 / (402) 472-6965 / FAX (402) 472-6048

Nebraska
UNIVERSITY OF
Lincoln

HUMAN RESEARCH PROTECTIONS
Institutional Review Board

February 2, 2007

Tricia Paramore
Dr. Alan Seagren
3 East 37th Avenue
Hutchinson KS 67502

IRB# 2006-09-016 EP

TITLE OF PROJECT: **Developmental/Remedial Sciences at Community Colleges in Five States in the Central Part of the United States**

Dear Tricia:

The Institutional Review Board for the Protection of Human Subjects has completed its review of the Request for Change in Protocol submitted to the IRB.

1. It has been approved for you to add three questions to the interview protocol.

2. It has also been approved to only select institutions offering comprehensive programs of developmental/remedial sciences courses and support services for the case study.

This letter constitutes official notification of the approval of the protocol change. You are therefore authorized to implement this change accordingly.

If you have any questions, please contact Shirley Horstman, IRB Administrator, at 472-9417 or email shorstman1@unl.edu.

Sincerely,

D R Hoyt

Dan R. Hoyt, Chair
for the IRB

Shirley Horstman

Shirley Horstman
IRB Administrator

cc: Faculty Advisor

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